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AIIMS 1 RANK
Sathvik Reddy Erla

NEET PRACTICE PAPER PHASE II

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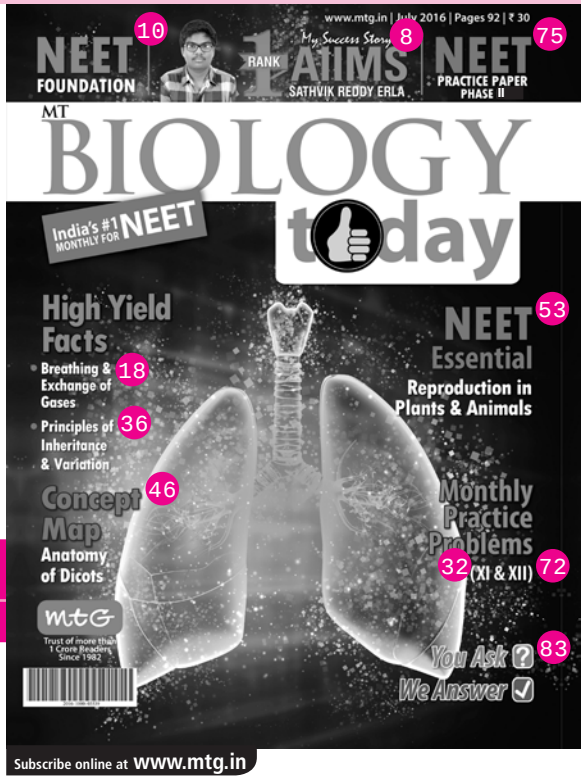
Corporate Office:
Plot 99, Sector 44 Institutional Area,
Gurgaon -122 003 (HR), Tel : 0124-6601200
e-mail : info@mtg.in website : www.mtg.in

Regd. Office:
406, Taj Apartment, Near Safdarjung Hospital,
Ring Road, New Delhi - 110029.
Managing Editor : Mahabir Singh
Editor : Anil Ahlawat



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GOOD NEWS FOR OUR READERS

We had earlier shared our intention to increase the price of this magazine and its sister magazines due to steep all round increase in costs.

We have since been flooded with calls & mails requesting us not to increase the costs to benefit the student community at large and especially students from the economically weaker section.

We are happy to share that our editorial board has accepted the request in an endeavour to ensure that the largest circulating monthly magazines continue to be available to students at very reasonable costs.

MTG Team Applauds

AIIMS 2016 TOPPER

*"We feel pleasure to felicitate the achievement of our reader Sathvik Reddy Erla **(MTG Subscription Code PCB-88790)** and are proud to be a part of his accomplishment. It gives us immense pleasure that we could lay a brick for the foundation of his success. We are sharing his success story here so that it can inspire others to ace in exams."*

Sathvik Reddy Erla

1 Rank

- **MTG : Why did you choose medical stream?**

  Sathvik : I always dreamt of becoming a doctor, and my parents also encouraged me to choose this stream.

- **MTG : What exams you have appeared for and what is your rank in these exams?**

  Sathvik : I have appeared in NEET 1 (result not out yet), AIIMS (AIR 1), JIPMER (AIR 20), AP EAMCET (Rank 2), TS EAMCET (Rank 15).

- **MTG : Any other achievements?**

  Sathvik : I am also an NTSE scholar.

- **MTG : How did you prepare for AIIMS and other medical exams?**

  Sathvik : I focused mainly on mastering NCERT text books for all three subjects.Once I was through with the NCERT text books I referred some reference books for additional information. I also tried to solve as many mock tests as possible.

- **MTG : On which topic and chapters you laid more stress in each subject?**

  Sathvik : I laid more stress on Human Physiology (Biology), Modern Physics topics (Physics) and Organic Chemistry (Chemistry).

"I have used the MTG AIIMS Explorer, Physics For You, Chemistry Today and Biology Today magazines. They provided me with additional information that proved very useful in AIIMS.The MCQs in the magazines gave me a good idea of what to expect in the exam. I have also taken the MTG AIIMS rank indicator series which proved very useful especially for the physics section."

- **MTG : How much time does one require for serious preparation for this exam?**

  Sathvik : Two years must be dedicated to sincere study for a good result.Once NEET is done the one month time post NEET must be used to solve previous year papers and mock tests.

- **MTG : Which subjects/ topics you were strong/ weak at?**

  Sathvik : I was strong at Physics particularly the Modern Physics topics and found all the topics equally good in Biology. I was strong in Physical Chemistry and Inorganic Chemistry but weak in Organic chemistry.

- **MTG : What basic difference you found in various papers you cleared?**

  Sathvik : Unlike other papers in AIIMS most theory questions were assertion reason based and it requires a clear understanding of concepts to answer these questions.

  Also in AIIMS the Physics numericals were time consuming and required accurate mathematics as the options had very close values.

- **MTG : In your words what are the components of an ideal preparation plan?**

  Sathvik : An ideal preparation plan would be to master NCERT book for all three subjects before going for the reference books. Every aspirant must solve all NCERT in-text questions, additional exercises and the exemplar questions.

  Once preparation is completed post NEET, sufficient time must be devoted to take mock tests and solve previous year papers.

- **MTG : What role did the following play in your success:**

  (a) parents (b) teachers and school?

  Sathvik : (a) Parents were always supportive and encouraged me to do better.

  (b) Teachers were always there to clarify doubts and to help rectify mistakes made in my weekly tests. School provided a competitive atmosphere that encouraged me to study.

- **MTG : Your family background?**

  Sathvik : My mother is a software engineer and my father is an advocate.

- **MTG : How have our various MTG products like explorers, magazines, etc. helped you in your preparation?**

  Sathvik : I have used the MTG AIIMS Explorer and the PCB magazines.They provided me with additional information that proved very useful in AIIMS.The MCQs in the magazines gave me a good idea of what to expect in the exam. I have also taken the MTG AIIMS rank indicator series which proved very useful especially for the physics section.

- **MTG : What mistake you think you shouldn't have made?**

  Sathvik : I should have stuck to NCERT for Biology instead of reading additional syllabus. Also I should have focussed more on current affairs for GK as they were extensively covered in the exam.

- **MTG : Was this your first attempt?**

  Sathvik : Yes, this was my first attempt.

- **MTG : What do you think is the secret of your success?**

  Sathvik : Regular revision of syllabus, rectification of mistakes made in mock tests and constant support from my parents is the secret of my success.

- **MTG : Had you not been selected then what would have been your future plan?**

  Sathvik : I was sure I would be selected in a good medical college if not AIIMS.If I had not been selected I would have tried for another attempt.

- **MTG : What advice would you like to give our readers who are MEDICAL aspirants?**

  Sathvik : I would advise the aspirants to work hard and never take stress.Be cool on the day of the exam.

All the Best!☺☺

NEET FOUNDATION

Class-11

Maximise your chance of success in NEET by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

- Recall question or single concept question – indicated by a single finger.
- Application question or question which requires 2 or 3 concepts - indicated by 2 fingers.
- Application question or question which requires 3 or more concepts - indicated by 3 fingers.

UNIT-II : STRUCTURAL ORGANISATION IN PLANTS AND ANIMALS

CHAPTER-5 : MORPHOLOGY OF FLOWERING PLANTS

Multiple Choice Questions

1. Which of the following is an example of scaly bulb?
(a) Garlic (b) Lily
(c) Tulip (d) Onion

2. The minute scale-like outgrowths present at the upper end of leaf sheath in grasses are called
(a) stipules (b) ligules
(c) prophylls (d) bracteoles.

3. Which of the following has dichotomously branched veins?
(a) *Colocasia* (b) *Circeaster*
(c) *Zizyphus* (d) *Smilax*

4. Which of the following fruits is developed from hypanthodium type of inflorescence?
(a) *Ficus carica* (b) *Ananas camosus*
(c) *Cryptostegia* (d) *Musa paradisiaca*

5. The example of free central and basal placentation are respectively
(a) primrose and sunflower
(b) marigold and lemon
(c) larkspur and sunflower
(d) tomato and mustard.

6. Trimerous, hypogynous and pentacyclic flowers are characteristic features of Family
(a) Fabaceae (b) Solanaceae
(c) Liliaceae (d) Asteraceae.

7. Which of the following represents green stems of limited growth modified to take over the main function of leaves?
(a) Phylloclades (b) Cladodes
(c) Sporophylls (d) Stolons

8. Which of the following is partial root parasite?
(a) *Rafflesia* (b) *Cuscuta*
(c) *Santalum* (d) *Viscum*

9. The cotyledon of monocotyledonous seeds is known as
(a) aleurone (b) scutellum
(c) perisperm (d) caruncle.

10. Which of the following is an example of hypogynous and perigynous flower respectively?
(a) Mustard and cucumber
(b) Brinjal and rose
(c) Guava and plum
(d) China rose and sunflower

True or False

11. Marginal placentation develops in simple, unilocular and monocarpellary ovary.

12. In racemose type of inflorescence the main axis terminates in a flower and flowers are borne in a basipetal order.

13. The epidermal cells form very fine and delicate, thread-like structures called root hairs in the zone of elongation in a root.

14. Aleurone layer with cells possessing dense cytoplasm filled with aleurone or protein grain is found on the outside of endosperm.

15. Leaves of dicotyledonous plants generally possess parallel venation, while reticulate venation is the characteristic feature of monocotyledonous plants.

16. The region of the stem where leaves are borne are called nodes while internodes are the portions between two nodes.

17. Legume is a schizocarpic fruit formed from superior bilocular ovary.

18. When there is no distinction of sepals and petals, the non essential floral whorl is called perianth.

19. A flower which can be divided into two equal vertical halves by one plane only is termed as zygomorphic.

20. The floral diagram is a diagrammatic representation of theoretical transverse section and ground plan of a floral bud in relation to mother axis which lies at the posterior side.

Match The Columns

21. Match Column I with Column II.

	Column I		Column II
A.	Syngenesious anthers	(i)	Epiphytic root
B.	Phyllode	(ii)	Siliqua
C.	Velamen	(iii)	Embryo axis
D.	Replum	(iv)	Sunflower
E.	Tigellum	(v)	*Acacia longifolia*

22. Match Column I with Column II. (There can be more than one match for items in Column I).

	Column I		Column II
A.	Stilt root	(i)	Coconut
B.	Exalbuminous seeds	(ii)	*Sorghum*
C.	Drupe	(iii)	*Sagittaria*
D.	Cyathium inflorescence	(iv)	*Euphorbia*
E.	Stem tendrils	(v)	*Passiflora*
		(vi)	*Luffa*
		(vii)	*Anthostemma*
		(viii)	Orchid
		(ix)	Maize
		(x)	*Zizyphus*

Passage Based Questions

23.(A) Complete the given passage with appropriate words or phrases.

(i) is composed of stamens. Each stamen which represents the (ii) consists of a (iii) and an (iv). A sterile stamen is called (v). When stamens are attached to the petals they are (vi) as in brinjal and (vii) when attached to perianth as in flower of lily. The stamens in a flower may either remain free or may be united in varying degrees. The stamens may be (viii) as in china rose, or (ix) as in pea or (x) as in *Citrus*.

(B) Read the given passage and correct the errors, wherever present.

The seed is generally covered by two seed coats. The outer seed coat is known as tegmen and inner seed coat is termed as testa. The surface of the seed possesses a fine pore at one end called hilum and there is also a scar called micropyle where funiculus or stalk of the seed is borne. Some seeds show place of origin of seed coats called raphe and part of funiculus fused with seed wall called chalaza. The embryo consists of an axis or tigellum to which seed leaves or cotyledons are attached. The place of attachment of cotyledons on the embryo axis is called cotyledonary internode. Micropylar end of tigellum bears plumule and the other end contains radicle. The tigellum between the embryonic root and cotyledonary node is known as epicotyl while the one between embryonic bud and cotyledonary node is called hypocotyl.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) if both A and R are true and R is the correct explanation of A
(b) if both A and R are true but R is not the correct explanation of A
(c) if A is true but R is false
(d) if both A and R are false.

24. **Assertion :** In epigynous flowers the ovary is said to be inferior.
Reason : In these flowers the margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arise above the ovary.

25. **Assertion :** The aestivation of corolla or petals in flower of pea plants is known as vexillary.
Reason : In flower of pea plant, the largest petal (standard) overlaps the two lateral petals (wings) which in turn overlap the two smallest anterior petals (keel).

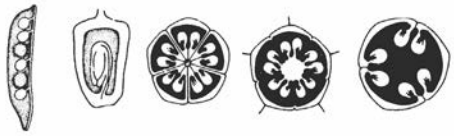
26. **Assertion :** Sorosis is a type of composite fruit.
Reason : Composite fruit is a group of simple fruitlets that develop from the free ovaries of a single flower.

27. **Assertion :** Phylloclade is a flattened petiole of a leaf which performs the function of photosynthesis.
Reason : Phylloclade has a limited or definite growth.

28. **Assertion :** Flower is a specialised reproductive shoot which possesses a highly condensed axis called thalamus.
Reason : Thalamus bears four types of floral organs (sepals, petals, stamens and carpels).

Figure Based Questions

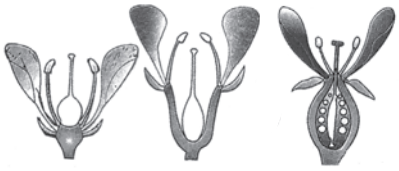
29. Refer to the given figures and answer the following questions.



A B C D E

(a) Identify the figures A, B, C, D and E.
(b) Which figure (out of A, B, C, D and E) represents the type of ovary which is one chambered (unilocular) but may later become two chambered (bilocular)?
(c) Differentiate between figures A and C.

30. Refer to the given figures and answer the following questions.



A B C

(a) Identify figures part A, B and C.
(b) In which figure hypanthium is formed?
(c) Differentiate between figures A and C.

CHAPTER-6 : ANATOMY OF FLOWERING PLANTS

Multiple Choice Questions

1. Intrafascicular cambium, interfascicular cambium and cork cambium are examples of
(a) apical meristem (b) lateral meristem
(c) intercalary meristem (d) both (a) and (b).

2. Which of the following are generally absent in the primary phloem but are found in the secondary phloem?
(a) Phloem parenchyma (b) Phloem fibres
(c) Companion cells (d) Sieve tube elements

3. The ring arrangement of vascular bundles is a characteristic of
(a) dicot root (b) dicot stem
(c) monocot stem (d) dicot leaf.

4. Radial vascular bundles are characteristic of
(a) monocot root (b) dicot stem
(c) monocot stem (d) monocot leaf.

5. Bark refers to
(a) tissues lying outside the vascular cambium
(b) tissues lying in between pith and cortex
(c) tissues lying in between epidermis and cortex
(d) tissues lying in between cortex and endodermis.

6. Secondary ground tissue consists of
(a) phellem, phellogen and phelloderm
(b) phellem and phelloderm
(c) phellogen and phelloderm
(d) phellem and phellogen.

7. Cortex and endodermis are formed from
(a) dermatogen (b) periblem
(c) plastochron (d) plerome.

8. Which of the following constitute the ground tissue?
(a) Epidermis, cortex, endodermis and pericycle
(b) Cortex, endodermis and pericycle
(c) Cortex, endodermis, pericycle and vascular bundle
(d) Epidermis, cortex, endodermis, pericycle and vascular bundle

9. Which of the following is not the component of stele?
(a) Endodermis (b) Pericycle
(c) Vascular bundles (d) Pith

10. Closed vascular bundles are those which
(a) possess lysigenous cavity
(b) lack cambium
(c) lack xylem
(d) possess cambium.

True or False

11. In dicot root the conjunctive tissue consists of parenchymatous cells which lie between the xylem and the phloem.

12. Mostly in monocotyledonous stems cambium is present between phloem and xylem.

13. Phloem of monocot stem consists of sieve tubes, companion cells and few phloem fibres whereas phloem parenchyma is absent.

14. Heartwood is involved in the conduction of water and minerals from root to leaf.

15. Lenticels permit the exchange of gases between the outer atmosphere and the internal tissue of the stem.

16. Fusiform initials of vascular cambium divide to form secondary phloem on the outer side and secondary xylem on the inner side.

17. Sieve tube is made up of a number of dead cells.

18. Root hairs are multicellular and heavily cutinised.

19. The complementary cells are formed from loosely arranged phellogen cells and division of substomatal parenchyma cells.

20. Adaxial epidermis of a dorsiventral mesophytic leaf consists of barrel shaped transparent parenchymatous cells which are devoid of chloroplasts.

Match The Columns

21. Match Column I with Column II.

	Column I		Column II
A.	Sclereids	(i)	Alburnum
B.	Casparian strips	(ii)	Cork cambium
C.	Sapwood	(iii)	Sclerenchyma
D.	Phellogen	(iv)	Protoxylem cavity
E.	Lacuna	(v)	Endodermis

22. Match Column I with Column II. (There can be more than one match for items in Column I).

	Column I		Column II
A.	Concentric bundles	(i)	Guard cells
B.	Stomatal apparatus	(ii)	Pericycle
C.	Vascular cambium	(iii)	Trichomes
D.	Stele	(iv)	Leptocentric
E.	Epidermal appendages	(v)	Subsidiary cells
		(vi)	Fusiform initials
		(vii)	Pith
		(viii)	Ray initials
		(ix)	Emergences
		(x)	Hadrocentric

Passage Based Questions

23.(A) Complete the given passage with appropriate words or phrases.

In old trees, the greater part of _(i)_ is dark brown due to deposition of organic compounds and essential oils in the _(ii)_ layers. These substances make it hard, durable and resistant to the attacks of _(iii)_ and insects. This region comprises _(iv)_ elements with highly _(v)_ walls and is called _(vi)_. It is (vii) part of secondary xylem. The peripheral region of secondary xylem is _(viii)_ in colour and is known as the _(ix)_.

(B) Read the given passage and correct the errors, wherever present.

Sieve tube is a long distance channel for transport of water. It is made up of a number of dead cells with thick walls. Sieve tube elements are arranged transversely and are associated with the bulliform cells. A mature sieve element possesses a peripheral nucleus and a small vacuole but lacks cytoplasm. The functions of sieve tubes are controlled by the nucleus of companion cells. Companion cells are specialised sclerenchymatous cells which help in maintaining the pressure gradient in the sieve tubes.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) if both A and R are true and R is the correct explanation of A
(b) if both A and R are true but R is not the correct explanation of A
(c) if A is true but R is false
(d) if both A and R are false.

24. **Assertion :** The upper surface of a dorsiventral leaf, appears deeper green as compared to the lower surface.

Reason : The chloroplast are more abundant in the loosely arranged spongy mesophyll cells as compared to the compact palisade mesophyll cells in dorsiventral leaf.

25. **Assertion :** Endodermis acts as biological check post between vascular strand and cortex in roots of angiosperms.

Reason : Due to presence of Casparian strips, the endodermal cells do not allow wall to wall movement of substances between cortex and pericycle.

26. **Assertion :** Softwood and hardwood are called porous wood and non porous wood respectively.

Reason : Softwood contains vessels while hardwood is devoid of vessels.

27. **Assertion :** Phloem parenchyma is absent in stems of most of the monocots.

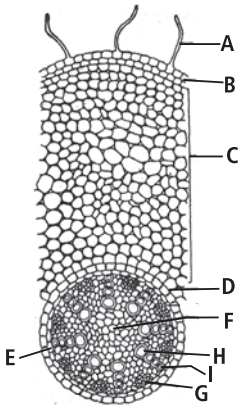
Reason : The phloem parenchyma stores food material and other substances like resins, latex and mucilage.

28. **Assertion :** Collenchyma is found below the epidermis in the petiole, leaves and stems of herbaceous dicots.

Reason : Collenchyma provides mechanical strength as well as flexibility to the organs and allows their bending.

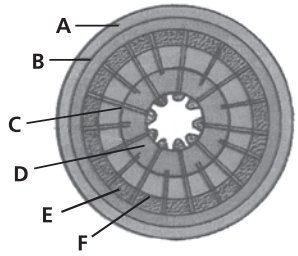
Figure Based Questions

29. Refer to the given figure showing T.S of a monocot root and answer the following questions.



(a) Identify parts A, B, C, D, E, F, G, H and I in the given figure.
(b) Which part in the given figure produces lateral roots?
(c) Write the functions of part C.

30. Refer to the given figure showing pattern of secondary growth in dicot stem and answer the following questions.



(a) Identify parts A, B, C, D, E and F in the given figure.
(b) Which part in the given figure forms periderm?
(c) Briefly describe part E.

CHAPTER-7 : STRUCTURAL ORGANISATION IN ANIMALS

Multiple Choice Questions

1. The epithelium that helps in gamete formation is
(a) simple squamous epithelium
(b) simple columnar epithelium
(c) simple cuboidal epithelium
(d) ciliated columnar epithelium.

2. Which of the following statement is incorrect?
(a) Simple squamous epithelium forms lining of Fallopian tube and Eustachian tube.
(b) Ciliated epithelium maintains the circulation of cerebrospinal fluid in brain and spinal cord.
(c) Columnar epithelium is present on secretory and absorptive surface.
(d) Stretching of urinary bladder is due to transitional epithelium.

3. Connective tissue found in tendon is
(a) dense regular yellow elastic connective tissue
(b) dense regular white fibrous connective tissue
(c) dense irregular white fibrous connective tissue
(d) dense irregular yellow elastic connective tissue.

4. Blood cells having antihistamine properties are
(a) basophils (b) neutrophils
(c) monocytes (d) eosinophils.

5. Characteristics of skeletal muscles are
(a) cylindrical, branched, striated and uninucleate
(b) spindle shaped, branched, striated and multinucleate
(c) cylindrical, unbranched, striated and multinucleate
(d) spindle shaped, unbranched, non-striated and multinucleate.

6. Cells of nervous tissue, rich in mitochondria and microtubules and found near medullated nerve fibres are
(a) oligodendrocytes (b) astrocytes
(c) ependymal cells (d) neurosecretory cells.

7. In earthworm, which of the following is present in segment 4, 5 and 6?
(a) Septal nephridia (b) Gizzard
(c) Typhlosole (d) Pharyngeal nephridia

8. Juvenile hormone, neotinin in cockroach is secreted by
(a) corpora cardiaca
(b) corpora allata
(c) inter-cerebral gland cells
(d) prothoracic glands.

9. During buccopharyngeal respiration in frog
(a) nostrils remain closed and glottis remains open
(b) nostrils remain open and glottis remains closed
(c) both nostrils and glottis remain closed
(d) both nostrils and glottis remain open.

10. Nucleated RBCs during early embryonic life are formed in
(a) liver (b) spleen
(c) bone marrow (d) yolk sac.

True or False

11. Spongy parts of the bones contain yellow bone marrow, which produces blood corpuscles.

12. Gap junctions are meant for chemical exchange between adjacent cells and provide physical support.

13. Nissl's granules synthesise proteins in a cyton.

14. Both cardiac and smooth muscles are uninucleate and involuntary.

15. Secretion of sebaceous glands are discharged by cells by simple diffusion, and there is no loss of cells or their parts.

16. Areolar connective tissue acts as packing material in various organs.

17. Clitellar segments of earthworm lacks setae.

18. In a cockroach, secretion of phallic gland forms the middle layer of the spermatophore.

19. In frog, rate of heart beat is controlled by hormones adrenalin and thyroxine.

20. The saliva of cockroach contains amylase, cellulase and chitinase enzymes.

Match The Columns

21. Match Column I with Column II.

Column I	Column II
A. Simple cuboidal epithelium	(i) Intestine
B. Ciliated columnar epithelium	(ii) Retina
C. Transitional epithelium	(iii) Respiratory tract
D. Pigmented epithelium	(iv) Seminiferous tubules of testes
E. Absorptive epithelium	(v) Urinary bladder

22. Match Column I with Column II. (There can be more than one match for items in Column I).

Column I	Column II
A. Adipose tissue	(i) Fibroblast
B. Hyaline cartilage	(ii) Serotonin
C. Compact bone	(iii) Brown fat
D. Basophils	(iv) Bradykinin
E. Areolar tissue	(v) Articular surface of long bones
	(vi) Yellow bone marrow
	(vii) Signet ring cells
	(viii) Embryonic skeleton
	(ix) Mast cells
	(x) Haversian system

Passage Based Questions

23.(A) Complete the given passage with appropriate words or phrases.

Cockroach utilises atmospheric oxygen for respiration. There are (i) pairs of spiracles, situated on either side of the body wall. The (ii) pairs are known as thoracic spiracles and remaining (iii) pairs are called (iv) spiracles. The first pair is placed between (v) and (vi) and second pair lies between (vi) and (vii). Each spiracle leads into atrium. From the atrium arise the (viii). The (viii) divides into fine branches called (ix).

(B) Read the given passage and correct the errors, wherever present.

Smooth muscle fibres are striated muscles. These are found in urinary bladder, iris of eye, dermis of skin. These muscle fibres are elongated and cylindrical. Each muscle fibre is multinucleate and light and dark bands are present. Action of these muscle fibres are controlled by central nervous system and are not under control of animal's will.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) if both A and R are true and R is the correct explanation of A
(b) if both A and R are true but R is not the correct explanation of A
(c) if A is true but R is false
(d) if both A and R are false.

24. **Assertion :** Cuboidal epithelium plays major role in secretion and absorption.

Reason : Cells of cuboidal epithelium have microvilli on their free surface.

25. **Assertion :** Earthworm show cross-fertilisation.

Reason : Earthworm is hermaphrodite.

26. **Assertion :** If head of cockroach is cut, it dies immediately.

Reason : Nervous system of cockroach is localised to head region.

27. **Assertion :** Frogs are poikilotherms.

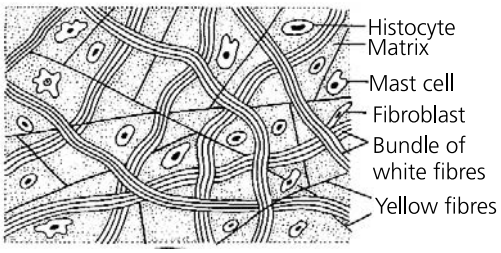
Reason : Frogs maintain constant body temperature.

28. **Assertion :** Frogs have polyphyodont teeth.

Reason : In frogs, broken or worn out teeth are easily replaced many times.

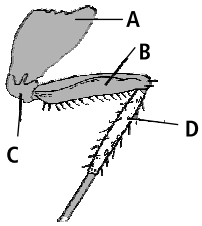
Figure Based Questions

29. Refer to the given figure and answer the following questions.



(a) Identify the type of tissue.
(b) To which category of animal tissue, do the tissue shown in figure belongs?
(c) Describe the functions performed by above tissue?

30. Refer to the given figure and answer the following questions.



(a) The given figure shows leg of cockroach. Identify labelled parts A, B, C and D.
(b) Name the part of leg that articulates with thoracic segments.
(c) Which is the stoutest part of leg bearing sensory bristles?

SOLUTIONS

CHAPTER-5 : MORPHOLOGY OF FLOWERING PLANTS

1. (b) **2.** (b) **3.** (b) **4.** (a) **5.** (a)
6. (c) **7.** (b) **8.** (c) **9.** (b) **10.** (b)

11. **True**

12. **False.** In racemose type of inflorescence the main axis continues to grow and flowers are borne in an acropetal order.

13. **False.** The epidermal cells form very fine and delicate, thread-like structures called root hairs in the zone of maturation in a root.

14. **True**

15. **False.** Leaves of dicotyledonous plants generally possess reticulate venation while parallel venation is the characteristic feature of most monocotyledonous plants.

16. **True**

17. **False.** Legume is a capsular fruit formed from superior unilocular ovary.

18. **True** **19.** **True** **20.** **True**

21. A-(iv), B-(v), C-(i), D-(ii), E-(iii)

22. A-(ii, ix), B-(iii, viii), C-(i, x), D-(iv, vii), E-(v, vi)

23. **(A)** (i) Androecium
(ii) male reproductive organ
(iii) filament (iv) anther
(v) staminode (vi) epipetalous
(vii) epiphyllous/epitepalous (viii) monoadelphous
(ix) diadelphous (x) polyadelphous

(B) The seed is generally covered by two seed coats. The outer seed coat is known as ~~tegmen~~ testa and inner seed coat is termed as ~~testa~~ tegmen. The surface of the seed possesses a fine pore at one end called ~~hilum~~ micropyle and there is also a scar called ~~micropyle~~ hilum where funiculus or stalk of the seed is borne. Some seeds show place of origin of seed coats called ~~raphe~~ chalaza and part of funiculus fused with seed wall called ~~chalaza~~ raphe. The embryo consists are of an axis or tigellum to which seed leaves or cotyledons are attached. The place of attachment of cotyledons on the embryo axis is called cotyledonary ~~internode~~ node. Micropylar end of tigellum bears ~~plumule~~ radicle and the other end contains ~~radicle~~ plumule. The tigellum between the embryonic root and cotyledonary node is known as ~~epicotyl~~ hypocotyl while the one between embryonic bud and cotyledonary node is called ~~hypocotyl~~ epicotyl.

24. (a) **25.** (a) **26.** (c) **27.** (d) **28.** (b)

29. **(a)** The given figures represent sections of ovaries showing different types of placentation.
A : Section of ovary showing marginal placentation
B : Section of ovary showing basal placentation
C : Section of ovary showing axile placentation
D : Section of ovary showing free central placentation
E : Section of ovary showing parietal placentation

(b) Figure E represents parietal placentation which is found in one chambered (unilocular) ovary that, later becomes two chambered (bilocular) due to the formation of the false septum called replum, *e.g.*, mustard.

(c) The differences between figure A (marginal placentation) and figure B (axile placentation) is as follows :

	Marginal placentation	Axile placentation
(i)	The ovary is always unilocular.	The ovary is two or more locular.
(ii)	The ovary is simple or monocarpellary.	The ovary is compound and syncarpous.
(iii)	Ovules are attached to the wall of the ovary.	Ovules are attached to a central or axile column.
(iv)	Ovules occur in a single file.	The number of ovule files depends upon the number of fusing carpels or septa.

30. **(a)** Figure A represents hypogynous flower, figure B represents perigynous flower and figure C represents epigynous flower.

(b) In figure B (perigynous flower) thalamus grows to varying degree to form an expanded structure called hypanthium or floral cup.

(c) The differences between figure A (hypogynous flower) and figure C (epigynous flower) is as follows:

	Hypogynous flower	Epigynous flower
(i)	Thalamus is convex or conical.	Thalamus is usually flask shaped.
(ii)	Androperianth is borne below the level of ovary.	Androperianth is borne above the level of ovary.
(iii)	Ovary is superior while other parts are inferior.	Ovary is inferior while other parts are superior.
(iv)	Thalamus is not fused with the wall of ovary.	Thalamus is fused with the wall of ovary.
(v)	No part of the thalamus is expanded except for a central projection.	Thalamus is hollowed out.
(vi)	Whole of the pistil is visible from outside.	Only style and stigma are visible from outside.
(vii)	Constituents of androperianth develop separately and are well-spread.	Constituents of androperianth develop jointly from the neck of hollowed out thalamus.

CHAPTER-6 : ANATOMY OF FLOWERING PLANTS

1. (b) **2.** (b) **3.** (b) **4.** (a) **5.** (a)
6. (a) **7.** (b) **8.** (b) **9.** (a) **10.** (b)

11. **True**

12. **False :** In monocotyledonous stems generally the vascular bundles have no cambium *i.e*, they are closed.

13. **True**

14. **False :** Heartwood is non-functional part of secondary xylem as tracheary elements are plugged by tyloses hence it is not involved in conduction of water.

15. **True** **16.** **True**

17. **False.** Sieve tube is made up of a number of a living cells.

18. **False.** Root hairs are unicellular and are not cutinised.

19. **True** **20.** **True**

21. A-(iii), B-(v), C-(i), D-(ii), E-(iv)

22. A-(iv, x), B-(i, v), C-(vi, viii), D-(ii, vii), E-(iii, ix)

23. **(A)**

(i)	secondary xylem	(ii)	innermost
(iii)	microorganisms	(iv)	dead tracheary
(v)	lignified	(vi)	heartwood
(vii)	non-functional	(viii)	lighter
(ix)	sapwood		

(B) Sieve tube is a long distance channel for transport of ~~water~~ organic nutrients. It is made up of a number of ~~dead~~ living cells with ~~thick~~ thin walls. Sieve tube elements are arranged ~~transversely~~ longitudinally and are associated with the ~~bulliform~~ companion cells. A mature sieve element possesses a peripheral ~~nucleus~~ cytoplasm and a ~~small~~ large vacuole but lacks ~~cytoplasm~~ nucleus. The functions of sieve tubes are controlled by the nucleus of companion cells. Companion cells are specialised ~~sclerenchymatous~~ parenchymatous cells which help in maintaining the pressure gradient in the sieve tubes.

24. (c) **25.** (a) **26.** (d) **27.** (b) **28.** (a)

29. **(a)** In the given figure representing T.S. of monocot root, A is root hair, B is epiblema, C is cortex, D is endodermis E is pericycle, F is pith, G is phloem, H is metaxylem and I is protoxylem.

(b) In the given figure, part E which represents pericycle produces lateral roots.

(c) In the given figure, part C represents cortex. The functions of cortex are as follows:

(i) Conduction of water from the root hairs to the inner tissues.

(ii) Storage of food

(iii) The outermost layer or layers of cortex produce protective exodermis in the older roots.

30. **(a)** In the given figure A is phellem, B is phellogen, C is medullary ray, D is secondary xylem, E is Secondary phloem, F is cambium ring.

(b) In the given figure, part B which represents phellogen forms periderm.

(c) Part E in the given figure represents secondary phloem. Secondary phloem is made up of sieve tubes, companion cells, phloem fibres and phloem parenchyma. It develops from a lateral meristem called vascular cambium and is found only during secondary growth of dicots and gymnosperms. It forms a narrow circle on the outer side of vascular cambium. Secondary phloem does not grow in thickness because the primary and the older secondary phloem present on the outer side gets crushed with the development of new functional phloem. The crushed or non-functioning phloem may have fibres and sclereids.

CHAPTER-7 : STRUCTURAL ORGANISATION IN ANIMALS

1. (c) **2.** (a) **3.** (b) **4.** (d) **5.** (c)
6. (a) **7.** (d) **8.** (b) **9.** (b) **10.** (d)

11. **False :** Spongy parts of bones contain red bone marrow whereas compact bone contain yellow bone marrow.

12. **False :** Gap junctions do not provide physical support.

13. **True** **14.** **True**

15. **False :** In sebaceous glands, entire cells get filled with secretory products, disintegrates and discharge as a part of the secretion.

16. **True** **17.** **True**

18. **False :** In a cockroach, secretion of phallic gland forms outermost layer of the spermatophore.

19. **True** **20.** **True**

21. A-(iv), B-(iii), C-(v), D-(ii), E-(i)

22. A-(iii, vii), B-(v, viii), C-(vi, x), D-(ii, iv), E-(i, ix)

23. **(A)**

(i)	10	(ii)	first two
(iii)	eight	(iv)	abdominal
(v)	prothorax	(vi)	mesothorax
(vii)	metathorax	(viii)	tracheae
(ix)	tracheoles		

(B) Smooth muscle fibres are ~~striated~~ non-striated muscles. These are found in urinary bladder, iris of eye, dermis of skin. These muscle fibres are elongated and ~~cylindrical~~ spindle shaped. Each muscle fibre is ~~multinucleate~~ uninucleate and light and dark bands are ~~present~~ absent. Action of these muscle fibres are controlled by ~~central~~ autonomic nervous system and are not under control of animal's will.

24. (a) **25.** (b) **26.** (d) **27.** (c) **28.** (a)

29. **(a)** Areolar tissue

(b) Loose connective tissue

(c) It binds parts together and provides strength, elasticity and support. It allows rapid diffusion of materials and migration of wandering cells towards area of infection and repair.

30. **(a)** In the given figure of leg of cockroach

A – Coxa B – Femur
C – Trochanter D – Tibia

(b) Coxa (A)

(c) Femur (B) ☺☺

HIGH YIELD FACTS

Class XI

Breathing and Exchange of Gases

Breathing refers to the muscular movement that sends fresh air to the respiratory organs **(inspiration)** and removes foul air from them **(expiration)**. During normal breathing, inspiration is an **active** process, and expiration is a **passive** process.

Respiration is a biochemical process by which organic compounds are oxidised to liberate chemical energy from the food in a step-wise manner. The terms 'breathing' and 'respiration' are not synonymous.

Breathing and Respiration involve

i. Inflow of air between atmosphere and the alveoli of the lungs.

ii. Diffusion of gases (O_2 and CO_2) across alveolar membrane.

iii. Transport of gases by the blood.

iv. Diffusion of O_2 and CO_2 between the blood and the tissues.

v. Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2 (cellular respiration).

Differences

Breathing	Respiration
It is simply an intake of fresh air and removal of foul air.	It is an oxidation of food to form carbon dioxide, water and energy.
It occurs outside the cells, hence it is an extracellular process.	It occurs inside the cells, hence it is an intracellular process.
It is a physical process.	It is a biochemical process.
No energy is released, rather used.	Energy is released in the form of ATP.
No enzymes are involved in the process.	A large number of enzymes are involved in the process.

Analysis of various PMTs from 2012-2016

	2012	2013	2014	2015	2016
AIPMT/NEET	1	1	1	1	3
AIIMS	–	1	–	1	-
AMU	–	2	–	3	-
Kerala	3	4	4	2	1
K.CET	1	2	1	–	–
J & K	2	–	1	1	2

Types of respiration

Aerobic respiration

- Oxygen is used for oxidation of food.
- It provides much more energy.
- It occurs both in cytoplasm (glycolysis) and in the mitochondria (Krebs' cycle and Electron transport chain).
- Examples: In most of plants and animals.

External respiration

The absorption of O_2 from surrounding medium and giving out CO_2 into surrounding medium.

Internal respiration

Uptake of oxygen by tissue cells, oxidation of food inside cells by oxidising enzymes and elimination of carbon dioxide from tissues.

Anaerobic respiration

- Food is oxidised without using molecular oxygen.
- It takes place in cytoplasm and provides less energy.
- Examples: In muscles, anaerobic bacteria, yeast, and parasitic worms like *Ascaris*, *Fasciola*, *Taenia*.
- In microorganisms, term **fermentation** is used in place of anaerobic respiration.

Lactic acid fermentation

It occurs in some bacteria and muscle cells, where glucose is metabolised to lactic acid.

$$\underset{\text{Glucose}}{C_6H_{12}O_6} \rightarrow \underset{\text{Lactic acid}}{2CH_3CHOHCOOH} + \text{Energy}$$

Alcoholic fermentation

It occurs in yeasts, where they oxidise glucose to ethyl alcohol and carbon dioxide.

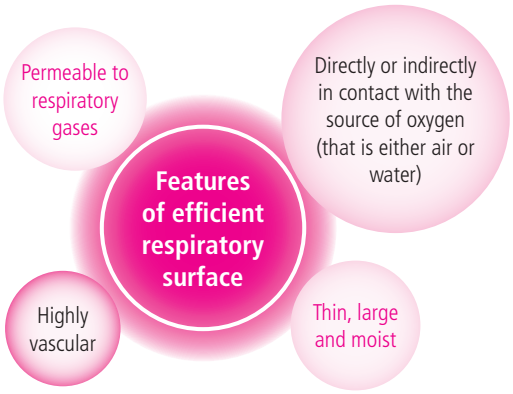
$$\underset{\text{Glucose}}{C_6H_{12}O_6} \rightarrow \underset{\text{Ethyl alchol}}{2C_2H_5OH} + 2CO_2 + \text{Energy}$$

Cellulose fermentation

It occurs in anaerobic bacteria and protozoa found in rumen and reticulum chambers of ruminant stomach, where cellulose is converted into volatile fatty acids.

RESPIRATORY SURFACE AND MEDIUM

- The surface at which exchange of gases (O_2 and CO_2) takes place is called respiratory surface. Respiratory surface should have following features for efficient gaseous exchange:

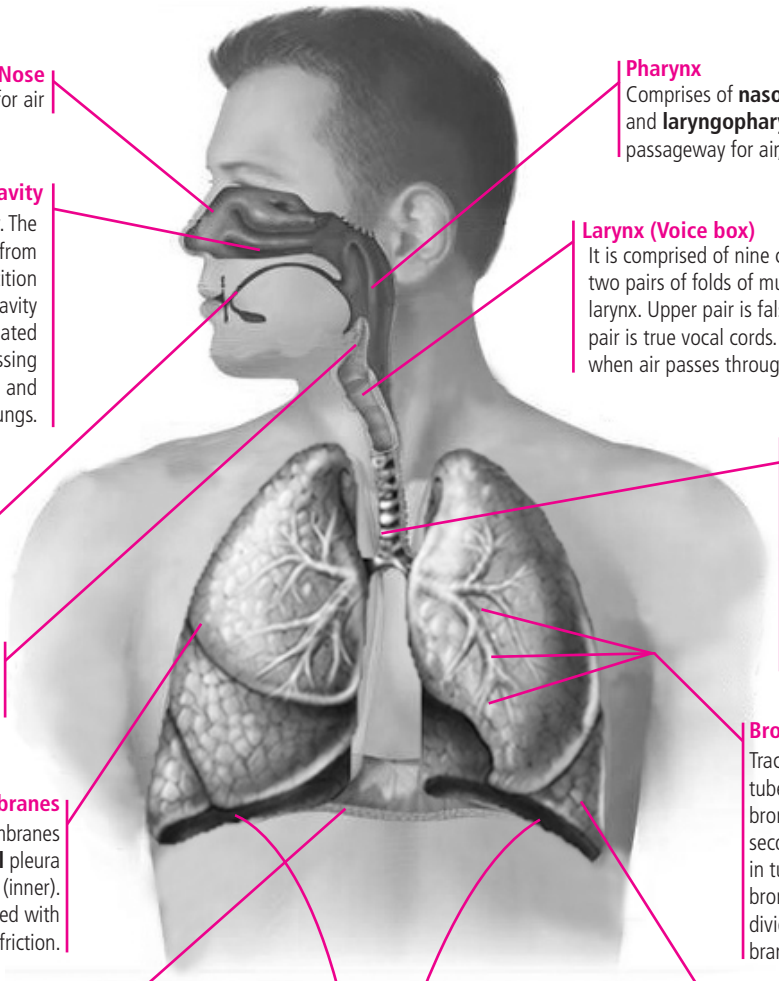


Different respiratory structures in different animals

Organs for exchange of gases in different animal groups

Protozoans	Cnidarians	Nemathelminthes	Arthropods	Echinoderms	Chordates
Plasma membrane	Body surface	Body surface	Gills, Tracheae, Book lungs, Book gills	Tube feet	Pharyngeal wall, Lungs, Gills, Skin
Sponges: Plasma membrane of each cell	Platyhelminthes (free living): Body surface	Annelids: Skin	Molluscs: Gills	Hemichordates: Pharyngeal wall	

HUMAN RESPIRATORY SYSTEM



Nose
Passageway for air

Nasal cavity
Nostrils open into nasal cavity. The two nasal cavities are separated from each other by cartilagenous partition called nasal septum. Nasal cavity is lined by pseudostratified ciliated epithelium due to which air passing over it is moistened, warmed and filtered before it enters lungs.

Mouth
Passageway for food and air

Epiglottis
Leaf shaped cartilage that covers glottis during swallowing.

Pleural membranes
Each lung is enclosed by two membranes called **pleurae** *viz.* **parietal** pleura (outer) and **visceral** pleura (inner). Space between two pleurae is filled with pleural fluid which reduces friction.

Diaphragm
Muscular shelf at the base of lungs that separates thoracic and abdominal cavity and aids in breathing.

Pharynx
Comprises of **nasopharynx, oropharynx** and **laryngopharynx.** Common passageway for air, food and liquid.

Larynx (Voice box)
It is comprised of nine cartilages. Vocal cords are two pairs of folds of mucous membrane present in larynx. Upper pair is false vocal cords and lower pair is true vocal cords. Vocal cords produce sound when air passes through them.

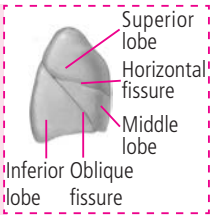
Trachea (Windpipe)
It bears C shaped cartilagenous rings which prevent it from collapsing during inspiration lined by ciliated epithelium bearing mucous glands which trap dust particles entering with air.

Bronchi
Trachea divides into two tubes called bronchi. Primary bronchus divides into secondary bronchus which in turn divides into tertiary bronchus. Tertiary bronchi divides further into smaller branches called bronchioles.

Alveoli
Sites of gaseous exchange.
These are thin walled, lobulated structures surrounded by capillary network.

Right Lung

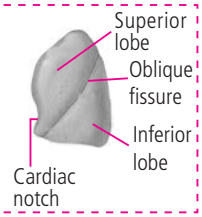
- Three lobes: superior, middle and inferior.
- Lobes are separated by horizontal and oblique fissures.



Lungs
Paired composite organs that flank mediastinum in thorax and composed primarily of alveoli

Left Lung

- Two lobes: superior and inferior, separated by oblique fissure.
- Has cardiac notch, where the heart lies.



Pulmonary surfactant

Surfactant is a mixture of both lipids and proteins, but its major component is a phospholipid. Surfactant is secreted by type II alveolar cells. It lowers the surface tension of the water layer at the alveolar surface, which increases lung compliance, thereby making it easier for the lungs to expand. Surfactant production in the fetal lung occurs in late gestation.

The airway beyond larynx can be divided into two zones:

Conducting zone

- Extends from top of trachea to the beginning of respiratory bronchioles.
- Contains no alveoli and thus no gaseous exchange takes place.

Respiratory zone

- Extends from respiratory bronchioles.
- Contains alveoli hence gases are exchanged with the blood.

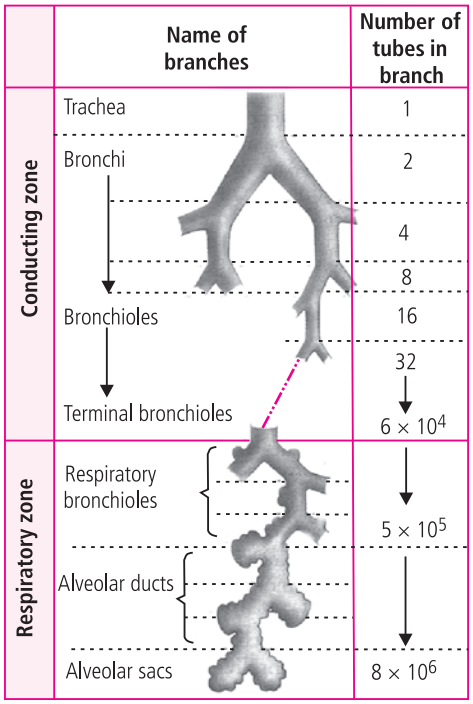


Fig.: Airway branching

MECHANISM OF BREATHING

Inspiration

Sequence of events

- Inspiratory intercostal muscles contract (diaphragm descends; rib cage rises).
- Thoracic cavity volume increases.
- Lungs are stretched; intrapulmonary volume increases.
- Intrapulmonary pressure drops to - 1 mm Hg.
- Air flows into lungs down its pressure gradient until intrapulmonary pressure is 0 (equal to atmospheric pressure).

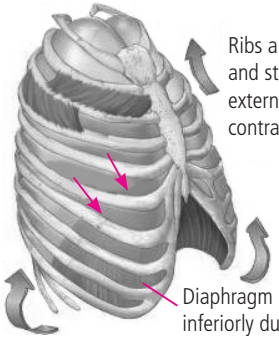


Fig: Changes in anterior-posterior and superior-inferior dimensions

Mechanism of breathing

Expiration

Sequence of events

- Inspiratory intercostal muscles relax (diaphragm rises; rib cage descends.
- Thoracic cavity volume decreases.
- Elastic lungs recoil passively; intrapulmonary volume decreases.
- Intrapulmonary pressure rises to + 1 mm Hg.
- Air flows out of lungs down its pressure gradient until intrapulmonary pressure is 0.

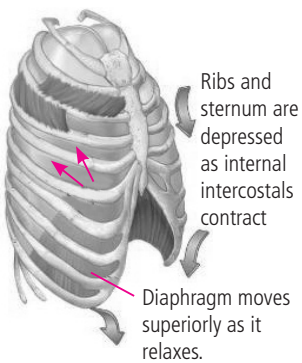


Fig: Changes in anterior-posterior and superior-inferior dimensions

PULMONARY VOLUMES AND CAPACITIES

- **Spirometry** is the process of recording the changes in the volume of air moving in and out of lungs and the instrument used for this purpose is called **spirometer** or **respirometer**. The quantities of air the lungs can receive, hold or expel under different conditions are called **pulmonary volumes**. Combinations of two or more pulmonary volumes are called **pulmonary capacities**.

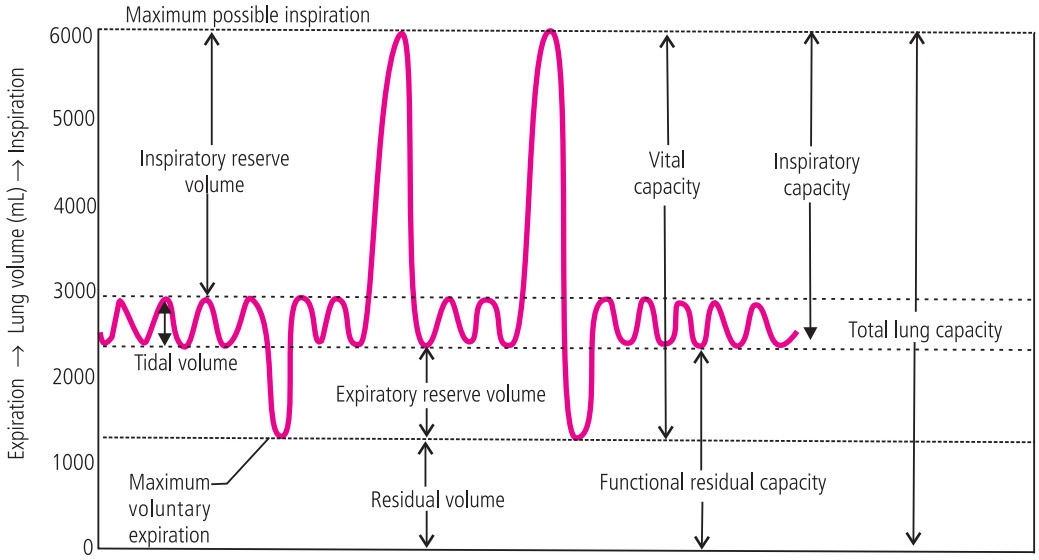


Fig.: Lung volumes and capacities recorded on a spirometer

Respiratory volumes

Tidal Volume (TV)

- It is the volume of air inspired and expired during normal breathing.
- It is about 500 mL and has lowest value among all respiratory volumes.

Inspiratory Reserve Volume (IRV)

- It is an extra amount of air that can be inspired forcibly after a normal inspiration.
- It is about 2500-3000 mL.

Residual Volume (RV)

- It is the volume of air that always remains in the lungs after forcible expiration. It enables the lungs to continue exchange of gases even after maximum exhalation or on holding the breath.
- It is about 1100-1200 mL.

Expiratory Reserve Volume (ERV)

- It is an extra amount of air that can be expelled after a normal expiration.
- It is about 1000 -1100 mL.

Pulmonary capacities

Inspiratory Capacity (IC)

- It is the maximum volume of air that can be inhaled after a normal expiration.
- It includes tidal volume and inspiratory reserve volume (IC = TV + IRV).
- It is about 3000 - 3500 mL.

Functional Residual Capacity (FRC)

- It is the volume of air that remains in lungs after normal expiration.
- It includes residual volume and expiratory reserve volume (FRC = RV + ERV).
- It is about 2400 mL.

Total Lung Capacity (TLC)

- It is the total amount of air present in the lungs and the respiratory passage after a maximum inspiration.
- It is the sum total of vital capacity and the residual volume. TLC = VC + RV or TLC = TV + IRV + ERV + RV.
- It is about 4900 - 5900 mL.

Expiratory Capacity (EC)

- It is the total volume of air a person can expire after normal inspiration.
- It includes tidal volume and expiratory reserve volume (EC = TV + ERV).
- It is about 1500-1600 mL.

Vital Capacity (VC)

- It is the maximum volume of air a person can breathe in after a forced expiration or maximum volume of air a person can breathe out after a forced inspiration.
- It is the sum total of tidal volume, inspiratory reserve volume and expiratory reserve volume. (VC = TV + IRV + ERV)
- It is about 3500 - 4700 mL.

- The vital capacity is higher in athletes, mountaineers or mountain-dwellers and lower in non-athletes, people living in plains, women, old individuals and cigarette smokers.

RESPIRATORY QUOTIENT

- The ratio of volume of CO_2 produced to the volume of O_2 consumed in a unit time is called **respiratory quotient.**

$$R.Q = \frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ absorbed}}$$

- Value of R.Q varies with different foods utilised in the respiration. Glucose has R.Q = 1, fats has about 0.7 and proteins have R.Q about 0.85. R.Q is determined by **Ganong's respirometer.**

EXCHANGE OF GASES

(i) Exchange of gases between alveoli and blood:

- Gaseous exchange between alveoli and blood capillaries takes place across respiratory membrane.
- Respiratory membrane consists of following layers:
  (i) Alveolar epithelium
  (ii) Epithelial basement membrane
  (iii) Thin interstitial space
  (iv) Capillary basement membrane
  (v) Capillary endothelium
- The partial pressure of oxygen (pO_2) in the alveoli is higher (105 mmHg) than that in the deoxygenated blood in the capillaries of the pulmonary arteries (40 mmHg.). As the gases diffuse from a higher to a lower concentration, the movement of oxygen is from the alveoli to the blood. The pCO_2 in alveoli is lower (40 mmHg) as compared to pCO_2 in impure blood (46 mmHg). As a result CO_2 diffuses out of the blood into the alveoli.

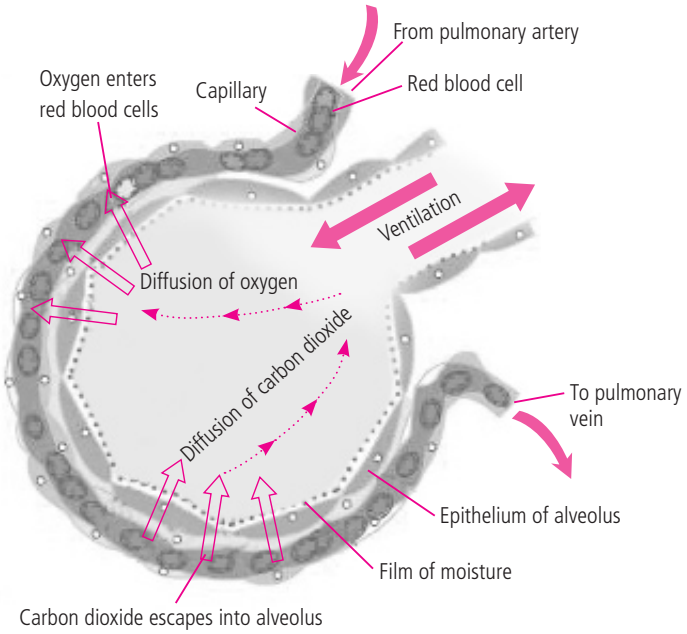


Fig.: Gaseous exchange along alveolar surface

(ii) Exchange of gases between blood and tissue cells:

- In the tissues, exchange of gases occurs between the blood and the tissue cells through tissue fluids that surround the tissue cells. Blood that reaches the tissues has more partial pressure of O_2 (pO_2 = 100 mmHg), than that in the tissues (pO_2 = 20 mmHg). Similarly partial pressure of CO_2 is more in tissues (= 52 mmHg) than in the blood (= 40 mmHg).
- Due to these differences in partial pressure of gases, O_2 from blood diffuses in the tissues and CO_2 from tissues diffuses into the blood. The blood becomes deoxygenated and then goes to the right side of the heart that sends it to lungs *via* pulmonary artery for reoxygenation.

TRANSPORT OF GASES IN BLOOD

Transport of oxygen
Oxygen is carried by blood in two forms: as dissolved gas and as oxyhaemoglobin.

As oxyhaemoglobin

About 97% of oxygen is carried in combination with haemoglobin of RBCs. Haemoglobin has four polypeptide chains and four haem groups attached to it. Thus, it can react with 4 molecules of oxygen to form Hb_4O_8. This is called **oxyhaemoglobin**.

$$\underset{\text{Haemoglobin}}{Hb_4} + \underset{\text{Oxygen}}{4O_2} \underset{\text{Low in tissues}}{\overset{\text{High } pO_2 \text{ in lungs}}{\rightleftharpoons}} \underset{\text{Oxyhaemoglobin}}{Hb_4O_8}$$

As dissolved gas

About **3%** of oxygen is transported by blood in dissolved form. Oxygen is soluble in blood plasma to a small extent under normal conditions of temperature and pressure. Hence, most of it is carried by red blood cells.

Oxygen-haemoglobin dissociation curve

- The relationship between the partial pressure of oxygen (pO_2) and percentage saturation of the haemoglobin with oxygen (O_2) is graphically illustrated by a curve called **oxygen haemoglobin dissociation curve** (also called oxygen dissociation curve).
- Under normal conditions, the oxygen haemoglobin dissociation curve is **sigmoid shaped** or **'S' shaped.** The lower part of the curve indicates dissociation of oxygen from haemoglobin. The upper part of the curve indicates the acceptance of oxygen by haemoglobin.
- The pO_2 of the air within alveoli is approximately 105 mmHg. The pO_2 of the blood leaving the alveoli is about 100 mmHg. This is because the blood plasma is not completely saturated with oxygen. The percentage of haemoglobin that is bound with O_2 is called **percentage saturation of haemoglobin**.

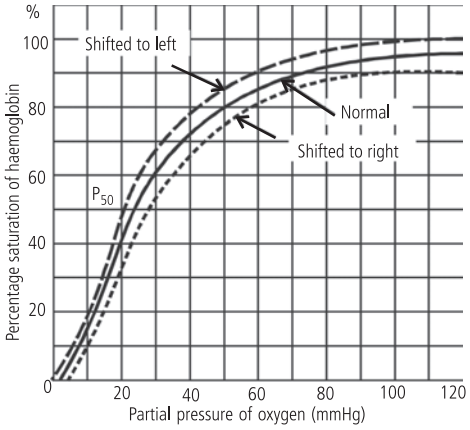


Fig.: Oxygen-haemoglobin dissociation curve.

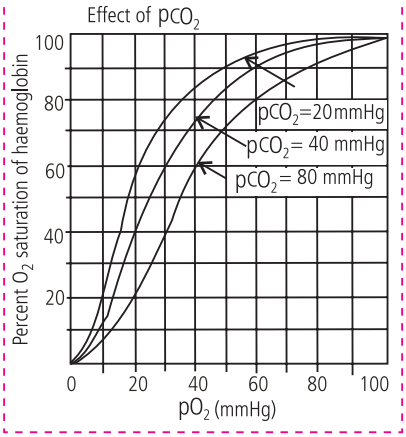
- At blood pO_2 of 100 mmHg, 97% of haemoglobin with RBCs is in oxyhaemoglobin form. As blood moves through capillaries, oxygen leaves blood and diffuses into the tissues. The blood that leaves the tissue in veins has pO_2 to about 40 mmHg. At this lower pO_2, the percentage saturation of haemoglobin accounts for only 75%.

Factors affecting oxygen dissociation curve

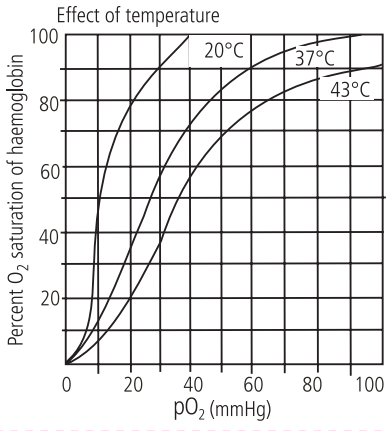
2, 3-diphosphoglyceric acid (2, 3 – DPG) is present in the red blood cells, formed from 3-phosphoglyceric acid (a product of glycolysis). It competes for oxygen binding sites in the haemoglobin molecule. As it binds to the β-chain of HbA (especially deoxy HbA), it causes the right shift of dissociation curve *i.e.*, more unloading of O_2 in tissues.

$$HbO_2 + 2, 3\text{-DPG} \rightleftharpoons Hb - 2, 3\text{-DPG} + O_2$$

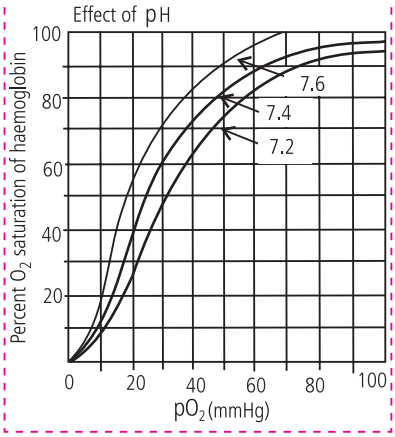
pCO_2 : CO_2 lowers the oxygen affinity of haemoglobin even if the pH is kept constant. Oxygen dissociation curve shifts to the right and releases more O_2 with increase in pCO_2.



Temperature : At higher temperature haemoglobin gives up oxygen more readily and the dissociation curve shifts to the right. This is of physiological importance because increased temperature means higher metabolic rate or higher oxygen requirement.



pH : Increase in CO_2 or other acids lowers the pH of plasma and shifts the dissociation curve to the right. At high CO_2 concentration more O_2 is given up at any given oxygen pressure.



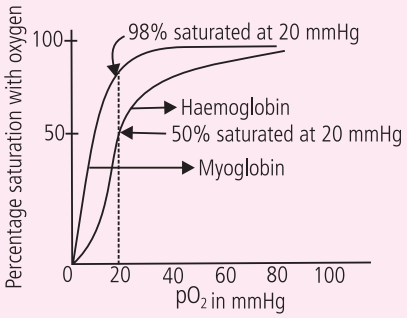
Bohr's effect

It is named after the Danish physiologist **Christian Bohr** (1855-1911). An increase in carbon dioxide in the blood causes oxygen to be displaced from the haemoglobin. This is Bohr's effect. This is an important factor increasing oxygen transport.

The presence of carbon dioxide decreases the affinity of haemoglobin for oxygen and increases release of oxygen to the tissue. The pH of the blood falls as its CO_2 content increases so that when the pCO_2 rises the curve shifts to the right.

Oxygen dissociation curve for myoglobin of muscle

The shape of oxygen dissociation curve for myoglobin is hyperbolic. It clearly shows that it has great affinity for oxygen and binding of oxygen to the single polypeptide chain is non-cooperative. The shape of its dissociation is hyperbolic because its curve is to the left of the haemoglobin curve. It takes up O_2 from the haemoglobin in the blood and releases it only at low pO_2 values. Since pO_2 in the lung capillary bed is 100 mmHg, myoglobin could effectively load oxygen in the lungs. However, the pO_2 of venous blood is 40 mmHg. Since myoglobin cannot deliver a large fraction of its bound oxygen even at 20 mm Hg, it cannot serve as an effective vehicle for delivery of oxygen from lungs to peripheral tissues.



Myoglobin in diving mammals

The diving mammals can store oxygen in the blood and muscles. They have comparatively more blood and more oxygen-storing protein, myoglobin, in the muscles per kg body weight than other mammals. They also have a large spleen that releases blood when a dive begins. Their heart rate and oxygen consumption decrease during dive to conserve oxygen.

Foetal haemoglobin

The haemoglobin of a foetus has a higher affinity for oxygen than the mother's haemoglobin. This enables the foetal haemoglobin to pick up oxygen at oxygen pressures low enough to cause the mother's haemoglobin to release oxygen. If foetal and maternal haemoglobins had the same affinity for oxygen, the foetus would not pick up much of the oxygen released by the mother's blood. After birth, the foetal haemoglobin gets gradually replaced by adult haemoglobin.

Transport of carbon dioxide

In form of bicarbonate

The largest fraction of carbon dioxide **(about 65-70%)** is converted to bicarbonate ions (HCO^-_3) and transported in plasma.

When carbon dioxide diffuses into the RBCs, it combines with water, forming carbonic acid (H_2CO_3). H_2CO_3 is unstable and quickly dissociates into hydrogen ions and bicarbonate ions.

This reaction is very slow in blood plasma, but occurs very rapidly inside RBCs because of a zinc containing enzyme, the **carbonic anhydrase**.

$$\underset{\text{Carbon dioxide}}{CO_2} + \underset{\text{Water}}{H_2O} \overset{\text{Carbonic anhydrase}}{\rightleftharpoons} \underset{\text{Carbonic acid}}{H_2CO_3}$$

$$H_2CO_3 \rightleftharpoons \underset{\text{Hydrogen ion}}{H^+} + \underset{\text{Bicarbonate}}{HCO^-_3}$$

In form of carbaminohaemoglobin

Another **20-25%** of carbon dioxide molecules entering the blood react directly with amine radicals (NH_2) of haemoglobin to form an unstable compound **carbaminohaemoglobin**. A small amount of carbon dioxide also reacts in this same way with the plasma proteins.

$$\underset{\text{Reduced haemoglobin}}{HHbNH_2} + CO_2 \rightleftharpoons \underset{\text{Carbamino haemoglobin}}{HbNHCOOH} + H^+$$

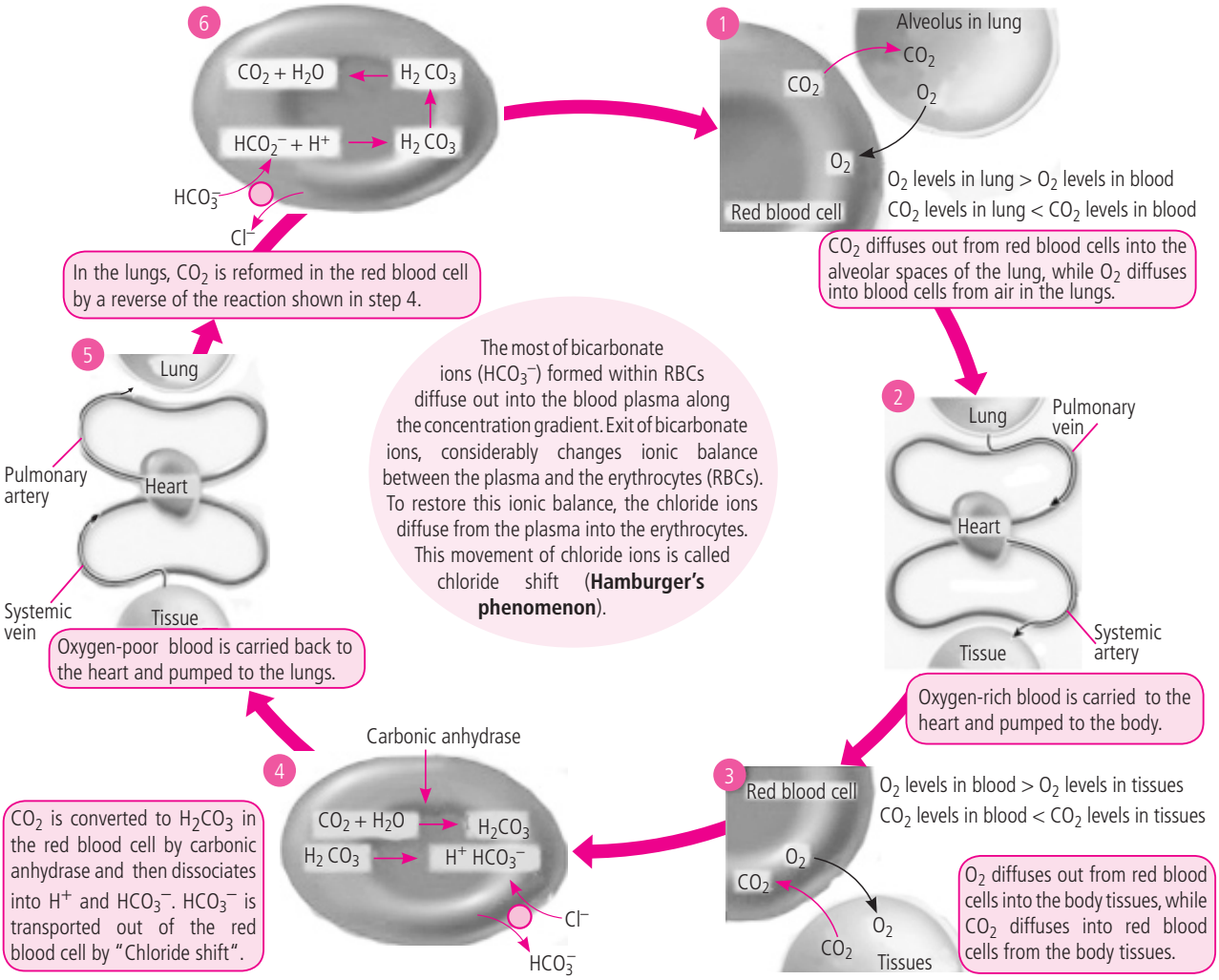
In dissolved state

Because of its high solubility, about **10%** carbon dioxide gets dissolved in the blood plasma and is carried in solution to the lungs.

INTEXT PRACTICE QUESTIONS

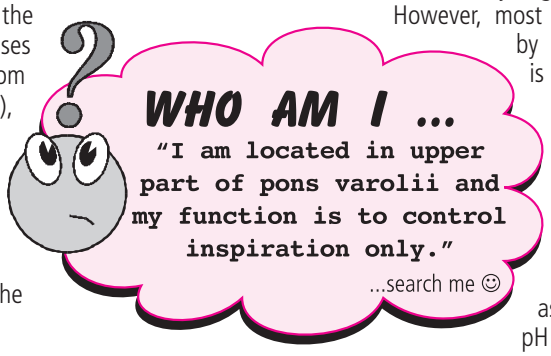
1. What is the effect of increasing CO_2 concentration on oxygen-haemoglobin dissociation curve?
2. Why CO_2 transport occurs more rapidly in RBCs as compared to blood plasma?
3. What is the maximum volume of air a person can breathe in after forced expiration?

CHLORIDE SHIFT



HALDANE EFFECT

- It was proposed by **J.B.S. Haldane.** It is based on the fact that combination of oxygen with haemoglobin causes the haemoglobin to become a strong acid.
- Binding of oxygen with haemoglobin tends to displace carbon dioxide from the blood. This is called **Haldane effect**. It is far more important in promoting carbon dioxide than is the Bohr effect which promotes oxygen transport.
- As carbon dioxide enters the systemic bloodstream, it causes more oxygen to dissociate from haemoglobin (Bohr effect), which in turn allows more carbon dioxide to combine with haemoglobin and more bicarbonate ions to be formed (Haldane effect).
- In the pulmonary circulation, the situation is reversed.



- Uptake of oxygen facilitates the release of carbon dioxide . As haemoglobin becomes saturated with oxygen, the hydrogen ions released combine with HCO_3^-, helping to unload CO_2 from the pulmonary blood.
- The Haldane effect encourages CO_2 exchange in both the tissues and lungs.

Haemoglobin acts as a buffer

- Addition of hydrogen ions would make the blood acidic. However, most of the hydrogen ions are neutralised by combination with haemoglobin, which is negatively charged, forming acid haemoglobin. This reduces the acidity of the blood, and also releases additional oxygen. If the blood becomes too basic, acid haemoglobin dissociates, releasing hydrogen ions.

  $HHb \rightarrow H^+ + Hb$.

- Thus, the haemoglobin also acts as a buffer, a substance that prevents the pH from fluctuating.

CELLULAR RESPIRATION

- It occurs inside the cells. Organic substances are catabolised to liberate energy inside the living cells.

Aerobic Respiration		
1.	Glycolysis	It is the first step, common to both aerobic and anaerobic respiration. It occurs in cytoplasm.
2.	Krebs' cycle	It is the second step, operates inside mitochondria and uses oxygen. It occurs only in aerobic respiration.
3.	Electron Transport Chain (ETC)	Components of ETC are present in inner mitochondrial membrane, thus occurs in mitochondria.
4.	Oxidative phosphorylation	It is the synthesis of energy rich ATP molecules. It occurs in inner mitochondrial membrane.

REGULATION OF RESPIRATION

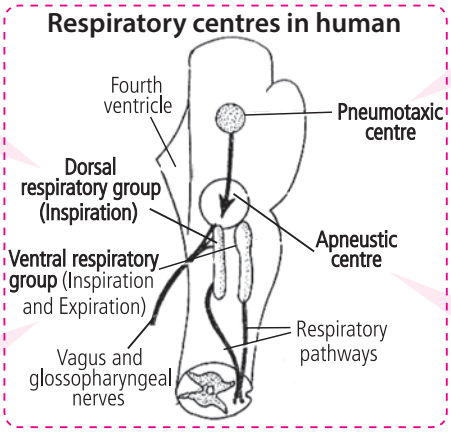
- Respiration is under both neural and chemical regulation.

Nervous regulation

- The respiratory centre is composed of several widely dispersed groups of neurons located in the **medulla oblongata** and **pons varolii**.
- The voluntary control / system is located in the cerebral cortex and send impulses to the respiratory motor neurons *via* the corticospinal tracts.
- The automatic system is located in the pons and medulla and the efferent output from this system to the respiratory motor neurons is located in the lateral and ventral portion of spinal cord.

(i) **Dorsal respiratory group of neurons:** These are located in the dorsal portion of the medulla oblongata. This group of neurons mainly causes inspiration and controls the contraction of intercostal muscles and muscles that flatten the diaphragm to cause inspiration. The neurons of inspiratory centre are active for 2 seconds and then rest for 3 seconds.

(ii) **Ventral respiratory group of neurons:** These are located in the ventro-lateral part of the medualla oblongata. These send signals for both inspiration and expiration.



(iii) **Pneumotaxic centre :** It is located in the upper part of pons varolii. It sends signals to all the neurons of dorsal respiratory group and only to inspiratory neurons of ventral respiratory group. Its main job is to primarily limit inspiration.

(iv) **Apneustic centre :** It lies in the lower part of pons varolii and works in collaboration with pneumotaxic centre to control the depth of inspiration.

Chemical control

- The peripheral chemoreceptors located in the neck at the bifurcation of the common carotid arteries and in the thorax on the arch of aorta are called **carotid bodies** and **aortic bodies** respectively. They respond to changes in arterial blood. Peripheral chemoreceptors are stimulated by:
  - Significantly decreased pO_2 (hypoxia)
  - Increased H^+ concentration (metabolic acidosis)
  - Increased pCO_2 (respiratory acidosis)

  They send appropriate nerve impulses in respiratory muscles, which quicken or slow down breathing as required till normal CO_2 and O_2 levels are regained.
- **Central chemoreceptors** located in the medulla oblongata, respond to changes in the brain extracellular fluid. They are stimulated by increased p_{CO_2} *via* associated changes in H^+ concentration.

CO_2 level has more effect on breathing

The level of CO_2 has more effect on breathing than does the level of oxygen. If the CO_2 content of the blood drops below a certain critical level, breathing stops. If we hold our breath by closing the nostrils, CO_2 level in the blood rises, and breathing is accelerated on reopening the nostrils. If we resort to repeated deep inhalations and exhalations in rapid successions, the CO_2 level of the blood falls so much that we can hold breath longer. Oxygen does not seem to have a significant effect on the respiratory centres.

Hering-Breuer Inflation Reflex

- Stretch receptors are located in the walls of the bronchi and bronchioles of the lungs. When the lungs become overstretched, these receptors send signals to the dorsal respiratory group of neurons through vagi cranial nerves. In response, the inhibitory area is inhibited (prevents further inspiration). This response to the stimulation of stretch receptors is called Hering-Breuer inflation reflex. This reflex is mainly a protective mechanism for preventing excess lung inflation rather than an important component in the regulation of respiration.

Disorders of respiratory system

Asthma

Bronchial asthma is generally caused due to the **hypersensitivity of the bronchioles** to the foreign substances (allergens) present in the air that passes through them. Allergens stimulate release of histamines from mast cells. The goblet (mucous) cells lining the respiratory passage start secreting excess mucus which may clog the bronchi and bronchioles. Symptoms include coughing, or difficulty in breathing mainly during expiration.

Asphyxia

It is a life-threatening condition in which oxygen is prevented from reaching the tissues by obstruction of or damage to any part of the respiratory system. Drowning, choking, and breathing poisonous gas all lead to asphyxia.

Pneumonia

It is an acute infection or inflammation of alveoli of the lung. Pneumonia is caused mainly due to **infection by** *Streptococcus pneumoniae* bacteria. In such patients, the uptake of oxygen is adversely affected due to inflammed alveoli filled with excess mucus and dead WBCs.

Occupational Respiratory Disorders

Such diseases are common in persons who work in an environment where they are constantly exposed to potentially harmful substances such as gas, fumes or dusts. Persons working in industries involving grinding or stone breaking etc., suffer from these diseases. **Silicosis** and **asbestosis** are the common occupational lung diseases. These are characterised by proliferation of fibrous connective tissue of upper part of lung., causing inflammation.

SARS (Severe Acute Respiratory Syndrome)

It is caused by **Human Corona Virus (HCV)**. Incubation period is of 2 – 10 days. Initially, there is fever, chills, headache, muscle soreness, discomfort etc. A dry cough develops accompanied by hypoxia (reduced O_2 in blood). It is diagnosed by ELISA.

Influenza

It is also caused by *Influenzae* virus. Its symptoms include chills, fever, headache and muscular pain. Cold like symptoms appear as the fever subsides.

Emphysema

This respiratory disorder is due to the **inflation or abnormal distension of the alveolar sacs** resulting in the loss of their elasticity. Cigarette smoking and chronic bronchitis are the causes of this disease. The alveolar sac remains filled with air even after expiration.

Pulmonary tuberculosis (TB)

It is caused by *Mycobacterium tuberculosis*. It most often affects the lungs and the pleura. The bacteria destory parts of the lung tissue and the tissue is replaced by fibrous connective tissue. Gases do not diffuse easily through the fibrous tissue. Its symptoms include fatigue, weight loss, lethargy, a low grade fever, night sweats, cough and chest pain. Tuberculosis bacteria are spread by inhalation.

Bronchitis

Infectious microbes present in the air result in the **hypertrophy** (overgrowth) and **hyperplasia** (an increase in number of cells leading to hypertrophy) **of sero-mucous gland** and **goblet cells** (mucous cells) lining the bronchi. The bronchial lining swells and produces excess mucus. Symptom is regular coughing with thick greenish yellow sputum.

Intext Practice Questions

4. What is Haldane effect?
5. What is Hering-Breuer inflation relfex?
6. Which respiratory disorder causes hypertrophy and hyperplasia of sero-mucous gland and goblet cells lining the bronchi?

Hiccups, Sneezing and Coughing

A **hiccup** is an **involuntary contraction of diaphragm** that may repeat several times in a minute. It involves a reflex arc, once triggered, causes strong contractions of diaphragm followed by closure of vocal cords. At the same time normal peristalsis of oesophagus is suppressed.

A **sneeze is a semi autonomous expulsion of air** from lungs through nose and mouth, usually caused by foreign particles irritating the nasal mucosa. It is linked to sudden exposure to bright light, sudden change in temperature, breeze of cold air or viral infection. The brain, in response to signal, activates the pharyngeal and tracheal muscles and creates a large opening of nasal and oral cavities, resulting in a powerful release of air and particles.

Coughing is preceded by a long-drawn and deep inspiration that is followed by a complete closure of the glottis, resulting a forcible expiration that suddenly pushes glottis open and sends a blast of air through the upper respiratory passages. Stimulus for this reflex act could be a foreign body lodged in the larynx, trachea, or epiglottis.

POWER EXERCISE

1. The exchange of gases in the alveoli of the lungs takes place by
(a) passive transport (b) active transport
(c) osmosis (d) simple diffusion.

2. After deep inspiration capacity of maximum expiration of lungs is called
(a) total lung capacity (b) functional residual capacity
(c) vital capacity (d) inspiratory capacity.

3. R.Q (respiratory quotient) is less than 1 in
(a) fructose (b) fat
(c) organic acid (d) glucose.

4. Match the columns and select the correct option from the codes given below.

(A) TV + ERV	(i) Expiratory capacity
(B) RV + ERV + TV + IRV	(ii) Total lung capacity
(C) ERV + RV	(iii) Functional residual capacity

(a) A-(i), B-(ii), C-(iii) (b) A-(iii), B-(i), C-(ii)
(c) A-(iii), B-(ii), C-(i) (d) A-(ii), B-(iii), C-(i)

5. Tachypnea is
(a) normal breathing (b) slow breathing
(c) rapid shallow breathing
(d) no breathing.

6. Increase in body temperature makes oxygen haemoglobin dissociation curve
(a) shift to left (b) shift to right
(c) hyperbolic (d) parabolic.

7. Inspiration occurs when there is a negative pressure in the lungs with respect to atmospheric pressure. This negative pressure is achieved when
(a) intrapulmonary pressure is less than the atmospheric pressure
(b) intrapulmonary pressure is greater than the atmospheric pressure
(c) intrapulmonary pressure is equal to the atmospheric pressure
(d) intrapleural pressure becomes more than the intra-alveolar pressure.

8. Asthma is characterised by
(a) spasm in bronchial muscle
(b) alveolar wall degradation
(c) pain in lungs
(d) damage in diaphragm.

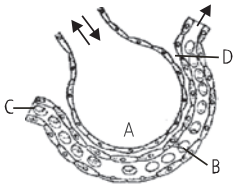
9. About 1000 mL of air is always known to remain inside the human lungs. It is described as _____.
(a) inspiratory reserve volume
(b) expiratory reserve volume
(c) residual volume
(d) tidal volume

10. Hamburger's phenomenon explains
(a) formation of HCO_3^-
(b) chloride shift
(c) oxygen saturation of haemoglobin
(d) breathing mechanism.

11. Chemosensitive area of respiratory centre in medulla is affected by
(a) less CO_2 and H^+ ions
(b) less O_2 and H^+ ions
(c) excess CO_2 and H^+ ions
(d) excess O_2 and H^+ ions.

12. Between breaths the intrapleural pressure is approximately _____ mm Hg less than atmospheric pressure.
(a) 1 (b) 4
(c) 8 (d) 10

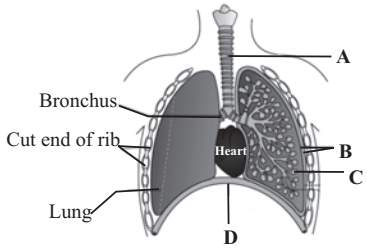
13. The figure given below shows a small part of human lung where exchange of gases takes place. Select the option which represents labelled part (A, B, C or D) correctly identified along with its function.



(a) C : arterial capillary - passes oxygen to tissues
(b) A : alveolar cavity - main site of exchange of respiratory gases
(c) D : capillary wall - exchange of O_2 and CO_2 takes place here
(d) B : red blood cells - transport of CO_2 mainly.

14. Surfactant
(a) is a polysaccharide produced by type I alveolar cells
(b) is excessive in many premature infants resulting in difficulties in breathing
(c) decreases the surface tension of the fluid lining the alveoli
(d) secretion is decreased when a deep breath is taken.

15. The figure shows a diagrammatic view of human respiratory system with labels A, B, C and D. Select the option which gives correct identification and main function and / or characteristic.



(a) C - Alveoli - Thin walled vascular bag like structures for exchange of gases.
(b) D - Lower end of lungs - Diaphragm pulls it down during inspiration.
(c) A - Trachea - Long tube supported by complete cartilaginous rings for conducting inspired air.
(d) B - Pleural membrane - Surrounds ribs on both sides to provide cushion against rubbing.

16. During the transportation of gases, to maintain the ionic balance, chloride ions shift from
(a) RBCs to plasma (b) plasma to RBCs
(c) lungs to blood (d) blood to lungs.

17. Haldane effect plays important role in promoting carbon dioxide transport than the Bohr's effect in promoting oxygen transport because
(a) oxyhaemoglobin is a stronger acid which donates hydrogen ion (H^+) which in turn displace carbon dioxide from blood.
(b) carbaminohaemoglobin is a stronger acid which splits into hydrogen ion (H^+) and bicarbonate (HCO_3^-)
(c) carbon dioxide reacts with water to form carbonic acid that lowers the pH in tissue.
(d) carbon dioxide is less soluble in venous blood than in arterial blood.

18. When diaphragm of man is completely dome shaped it shows
(a) end of expiration and beginning of inspiration
(b) beginning of expiration and end of inspiration
(c) increased rate of breathing
(d) decreased rate of breathing.

19. In the tissues, high concentrations of carbon dioxide
(a) increases the affinity of haemoglobin to both oxygen and hydrogen
(b) increases the affinity of haemoglobin to oxygen but decreases its affinity to hydrogen
(c) decreases the affinity of haemoglobin to oxygen but increases its affinity to hydrogen
(d) decreases the affinity of haemoglobin to both oxygen and hydrogen.

20. Dead space air in man is
(a) 500 mL (b) 150 mL
(c) 250 mL (d) 1.5 L.

ANSWER KEY

1.	(d)	**2.**	(c)	**3.**	(b)	**4.**	(a)	**5.**	(c)
6.	(b)	**7.**	(a)	**8.**	(a)	**9.**	(c)	**10.**	(b)
11.	(c)	**12.**	(b)	**13.**	(b)	**14.**	(c)	**15.**	(a)
16.	(b)	**17.**	(a)	**18.**	(a)	**19.**	(c)	**20.**	(b)

☺☺

Spellathon

1. Make as many biological terms as possible using the given letters. Each word should contain the letter given in circle.
2. Minimum 4 letter word should be made.
3. In making a word, a letter can be used as many times as it appears in the box.
4. Make at least 1 seven letter word.

A	R	Y	S	P	B	E	T	O	D	N
O	H	C	G	U		I	M	F	L	X

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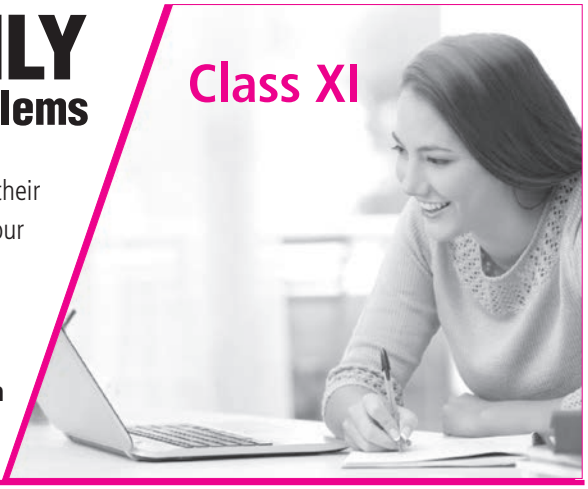
MPP-1 MONTHLY Practice Problems

Class XI



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer.

Self check table given at the end will help you to check your readiness.

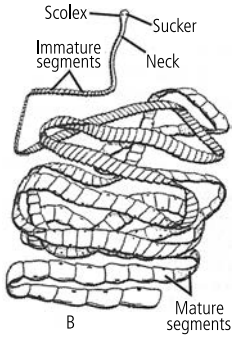
- **The Living World**
- **Biological Classification**
- **Plant Kingdom**
- **Animal Kingdom**

Total Marks : 160 **Time Taken : 40 Min.**

1. Which rank of taxonomic hierarchy shows maximum similar characteristics?
(a) Genus (b) Order
(c) Class (d) Family

2. Consider the following statements regarding gymnosperms and choose the correct option.
I. In gymnosperms, the male and female gametophytes have an independent existence.
II. In gymnosperms, the multicellular female gametophyte is retained within the megasporangium.
III. The gymnosperms are heterosporous.
Of these statements
(a) I and II are true, but III is false
(b) I and III are true, but II is false
(c) II and III are false, but I is true
(d) II and III are true, but I is false.

3. Identify the given figure. Which animals are its primary and secondary hosts?



	Organism	Primary Host	Secondary Host
(a)	*Taenia solium*	Man	Pig
(b)	*Taenia saginata*	Human being	Pig
(c)	*Taenia solium*	Man	Cattle
(d)	*Taenia saginata*	Cattle	Sheep

4. Zygotic meiosis is present in
(a) *Ceratium* (b) *Gymnodinium*
(c) *Noctiluca* (d) both (a) and (b).

5. Dinoflagellates include
(a) Diatoms (b) Desmids
(c) *Euglena* (d) *Noctiluca.*

6. From which of the following algae, agar-agar is commercially extracted?
I. *Sargassum* II. *Gelidium*
III. *Gracilaria* IV. *Polysiphonia*
V. *Volvox*
(a) III and V (b) II and III
(c) IV and V (d) I and II

7. Scorpion possess
(a) 3 pairs of legs (b) 4 pairs of legs
(c) 5 pairs of legs (d) 6 pairs of legs.

8. In flowering plants meiosis occurs at the time of
(a) formation of buds (b) germination of seed
(c) formation of root primordia
(d) formation of pollen grains.

9. Fill in the given blanks and select the correct option.
I. Loose mucilage sheath of non-cellulosic polysaccharide in bacteria is _A_.
II. Plasma membrane in monerans is _B_.
III. Episomes are formed by temporary association of _C_ with nucleoid.
IV. _D_ is the absorption of DNA segment from surrounding medium by a living bacterium.
(a) A-slime layer, B-selectively permeable, C- plasmid, D-Transformation
(b) A-capsule, B-permeable, C-ribosome, D-Transduction
(c) A-glycocalyx, B-impermeable, C-mesosome, D-Transduction
(d) A-slime layer, B-permeable, C-ribosome, D-Conjugation

10. Booklet containing list of characters and their alternates for identification of various taxa is
(a) flora (b) key
(c) manual (d) catalogue.

11. Which of the following statements is incorrect for lysogenic phase of a virus?
(a) The virus is non-virulent.
(b) The host cell does not get lysed.
(c) The host DNA gets hydrolysed.
(d) The viral genome gets integrated with the host DNA.

12. In pteridophytes spore germinates to give rise to
(a) thalloid gametophyte called prothallus
(b) thalloid sporophyte called prothallus
(c) sporophytic protonema
(d) thalloid, photosynthetic sporophyte.

13. Match column I with column II and select the correct option from codes given below.

	Column I		**Column II**
A.	Psilopsida	1.	*Dryopteris*
B.	Lycopsida	2.	*Equisetum*
C.	Sphenopsida	3.	*Selaginella*
D.	Pteropsida	4.	*Rhynia*

	A	**B**	**C**	**D**
(a)	4	3	2	1
(b)	3	2	1	4
(c)	2	1	4	3
(d)	1	4	3	2

14. Eye spot or stigma of *Euglena* occurs at the attachment of the membranes of
(a) contractile vacuole (b) cytopharynx
(c) reservoir (d) cytostome.

15. How plant specimens in herbarium can be prevented from fungal attack?
(a) By keeping the specimen in airtight vasculum
(b) By keeping naphthalene balls with herbarium sheets
(c) By keeping herbarium sheets in polythene packets
(d) By treating specimens with 0.1% mercuric chloride

16. Identify the given figure X and select the correct option regarding it.

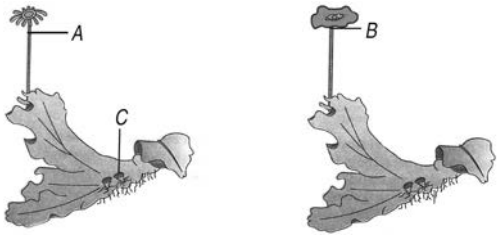
X
(a) X belongs to Class Phycomycetes.
(b) X is edible.
(c) X contains umbrella like basidiocarp.
(d) Both (b) and (c)

17. The tube within tube body plan is shown by
(a) sponges
(b) cnidarians and flatworms
(c) flatworms and roundworms
(d) earthworms and sea cucumber.

18. Read the followings statements and select the incorrect one.
(a) Slime moulds are saprophytic protists.
(b) Mycoplasma are the organisms that completely lack cell wall.
(c) Cyanobacteria are unicellular, colonial or filamentous fresh or marine water or terrestrial algae.
(d) In ascomycetes and phycomycetes, dikaryon condition is present.

19. Interspecific hybrid "Tigon" is
(i) Sterile hybrid (ii) Fertile hybrid
(iii) Male lion and female tiger
(iv) Male tiger and female lion.
Choose the correct statements.
(a) (i) and (iv) (b) (ii) and (iii)
(c) (ii) and (iv) (d) (i) and (iii)

20. Refer to the given figures and select the correct option in which all the three parts A, B and C are correctly labelled.



(a) A-Antheridiophore, B-Archegoniophore, C-Endospore
(b) A-Archegoniophore, B-Antheridiophore, C-Gemma cup
(c) A-Antheridiophore, B-Archegoniophore, C-Gemma cup
(d) A-Archegoniophore, B-Antheridiophore, C-Seta

21. Match column I with column II and select the correct option.

	Column I		**Column II**
A.	Mammals	(i)	Scales
B.	Aves	(ii)	Heterocercal
C.	Reptilia	(iii)	Mammary Glands
D.	Osteichthyes	(iv)	Homocercal
E.	Chondrichthyes	(v)	Pneumatic bones

(a) A-(i), B-(ii), C-(iii), D-(iv), E-(v)
(b) A-(iii), B-(v), C-(i), D-(ii), E-(iv)
(c) A-(iii), B-(v), C-(i), D-(iv), E-(ii)
(d) A-(i), B-(iii), C-(v), D-(ii), E-(iv)

22. According to Whittaker, producers belong to which kingdom?
(a) Plantae only
(b) Monera and Plantae only
(c) Protista, Monera and Plantae
(d) All the five kingdoms

23. Third moulting in the life cycle of *Ascaris* takes place in
(a) soil (b) lungs
(c) water (d) intestine.

24. Match the column I with column II and choose the correct option from the codes given below.

Column I	Column II
A. Truffels	(i) Deuteromycetes
B. Rusts	(ii) Ascomycetes
C. Bread mould	(iii) Basidiomycetes
D. Imperfect fungi	(iv) Phycomycetes

(a) A-(iii), B-(iv),C-(i), D-(ii)
(b) A-(ii), B-(iii),C-(iv),D-(i)
(c) A-(iii), B-(iv),C-(ii), D-(i)
(d) A-(ii), B-(iv), C-(iii),D-(i)

25. Match the column I with column II.

Column I	Column II
A. *Nitrobacter*	(i) Cyanobacteria
B. *Spirulina*	(ii) Saprophytic bacteria
C. *Methanobacterium*	(iii) Chemoautotrophic bacteria
D. *Pseudomonas*	(iv) Fermentation of cellulose
	(v) Nitrifying bacteria
	(vi) Food supplement
	(vii) Anaerobe
	(viii) Nature's scavengers

(a) A-(iii), (v); B-(i), (iv); C-(vi), (viii); D-(ii), (vii)
(b) A-(iii), (v); B-(i), (vi); C-(iv), (vii); D-(ii), (viii)
(c) A-(i), (vi); B-(ii), (vii); C-(iii), (iv); D-(v), (viii)
(d) A-(iii), (v); B-(ii), (vi); C-(iv), (vii); D-(i), (viii)

26. Sago starch is obtained from
(a) *Picea* (b) *Taxus*
(c) *Pinus* (d) *Cycas.*

27. Read the given statements and select the correct option.
Statement A : An *Amoeba* is an immortal organism.
Statement B : Natural death is absent in *Amoeba* as fully grown *Amoeba* divides into two new daughter cells.
(a) Both statements A and B are correct and B is the correct explanation of A.
(b) Both statements A and B are correct but B is not the correct explanation of A.
(c) Statement A is incorrect but B is correct.
(d) Both statement A and B are incorrect.

28. The branch of taxonomy based on similarity of characters due to common phylogeny is called as
(a) numerical taxonomy (b) chemotaxonomy
(c) cladistic taxonomy (d) cytotaxonomy.

29. Leech belongs to the Class
(a) Polychaeta (b) Oligochaeta
(c) Hirudinea (d) Archiannelida.

30. Fill in the blank spaces in the table given below by selecting the correct option.

Kingdom	Cell wall	Nutrition
Monera	A	Chemosynthetic
B	Either absent or cellulosic	Photosynthetic and heterotrophic
Fungi	C	Saprophytic
D	Absent	Heterotrophic

	A	B	C	D
(a)	Non-cellulosic	Protista	Non-cellulosic	Animalia
(b)	Absent	Plantae	Cellulosic	Animalia
(c)	Polysaccharide	Plantae	Cellulosic	Portista
(d)	Cellulosic	Animalia	Non-cellulosic	Protista

31. Haplo-diplontic life cycle pattern is found in
(a) bryophytes and pteridophytes
(b) algae and bryophytes
(c) bryophytes and gymnosperms
(d) bryophytes and angiosperms.

32. Match the column I with column II and select the correct option.

Column I	Column II
(i) Central National Herbarium	(p) London
(ii) Royal Botanical Garden	(q) Delhi
(iii) National Museum of Natural History	(r) Kolkata
(iv) Rajiv Gandhi Zoological Park	(s) Pune

(a) (i)-(r), (ii)-(s), (iii)-(p), (iv)-(q)
(b) (i)-(r), (ii)-(p), (iii)-(q), (iv)-(s)
(c) (i)-(p), (ii)-(s), (iii)-(q), (iv)-(r)
(d) (i)-(q), (ii)-(r), (iii)-(p), (iv)-(s)

33. Select the incorrect match amongst the following.
(a) Monoplacophora - *Neopilina*
(b) Amphineura - *Chiton*
(c) Cephalopoda - *Pila*
(d) Gastropoda - *Doris*

34. Read the following statements and select the incorrect one.
(a) *Pavo*, *Anas* and *Corvus* are flying birds.
(b) Ammocoete is the larva of cyclostomes.
(c) Bombay duck is a cartilaginous fish.
(d) Hedgehog and *Macropus* are eutherians.

35. Which of the following is not matched correctly?
(a) *Nostoc* – Cyanobacteria
(b) *Monocystis* – Sporozoans
(c) *Noctiliuca* – Dinoflagellates
(d) *Aspergillus* – Chrysophytes

36. Consider the following statements.
I. Asexual reproduction in *Chlamydomonas* is mainly by non-flagellated zoospores produced in zoosporangia.
II. In Class Chlorophyceae the sexual reproduction can occur by isogamy, anisogamy and oogamy.
Which of the statements given above is/are correct?
(a) Only I (b) Only II
(c) I and II (d) None of these

37. The principal cell types present in the body wall of *Sycon* are the
(a) pinacocytes, porocytes, choanocytes, amoebocytes
(b) pinacocytes, choanocytes, amoebocytes, nephrocytes
(c) choanocytes, solenocytes, amoebocytes, nephrocytes
(d) choanocytes, porocytes, nephrocytes, stinging cells.

38. Select the incorrect statement about mosses.
(a) Sex organs are multicellular and jacketed.
(b) Sporophyte is differentiated into foot, seta and capsule.
(c) Seta and capsule bear spores, which give rise to gametophyte after meiosis.
(d) Capsule contains a sterile columella.

39. Gastrozooid with a mouth is found in
(a) *Physalia* (b) *Obelia*
(c) *Cliona* (d) Both (a) and (b)

40. *Albugo candida* causes
(a) white rust of crucifer
(b) late blight of potato
(c) green ear of bajra
(d) yellow rust of wheat.

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SELF CHECK

No. of questions attempted	.....
No. of questions correct	.....
Marks scored in percentage	.....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

HIGH YIELD FACTS

Class XII

Principles of Inheritance and Variation

- The term **genetics** was coined and used for the first time by **W. Bateson** (1905). Genetics includes both **'heredity** and **variations'. 'Heredity'** is the transmission of characteristics, structural, functional and behaviouristic, from the parents to the offspring or from one generation to another. **Variations** tell us about differences in characteristics between two individuals.

PRE-MENDELIAN IDEAS ABOUT INHERITANCE

- A number of theories were put forward prior to Mendel to explain the transmission of characters from parents to offspring. They are often called **theories of blending inheritance**.

Theories of blending inheritance

Moist vapour theory

Pythagoras (580–500 B.C.) believed that each organ of the body of male produces moist vapours during coitus which form the body parts of the embryo.

Humoral theory

The Hippocratic treatise, *On the Seed* argues that active "**humors**" are the bearers of hereditary traits and are drawn from various parts of the body into the semen. These humors could be healthy or diseased. These humors could be altered in individuals and, in their new form, could be passed on to offspring. In this way, newborns could "inherit" traits that their parents had "acquired" because of their environment.

Reproductive blood theory

Aristotle, proposed that male semen was formed from blood, rather than from each organ, and its generative power resided in its "vital heat" which had the capacity to produce offspring of the same "form" as the parent. Aristotle believed that the vital heat cooked and shaped the menstrual blood produced by the female, and the embryo developed because of the shaping power of the vital heat.

Preformation theory

Preformation theory was given by **Swammerdam** (1679) and advocated by **Malpighi** (1673). This theory believed that the organism is already present, *i.e.*, preformed in the sperm or egg in a miniature form called **homunculus**. Fertilisation is required to stimulate its growth. It was believed by a number of workers of that period like Hartsoeker (1694) and Dalepatius (1694).

Theory of pangenesis

Darwin (1868) proposed that every somatic cell and tissue of the body produces a tiny particle called **gemmule** or **pangene**. It contains both the parental and the acquired characters. All the gemmules or pangenes of the body cells collect in the gametes and are passed on to the zygote where they guide the growth of different parts of the embryo to form an offspring.

Analysis of various PMTs from 2012-2016

	2012	2013	2014	2015	2016
AIPMT/NEET	4	5	3	5	6
AIIMS	1	–	2	1	–
AMU	7	4	6	7	–
Kerala	6	–	6	5	6
K.CET	3	4	3	3	4
J & K	2	–	4	6	3

MENDELIAN GENETICS

- Gregor Mendel, through his work on pea plants, discovered the fundamental laws of inheritance. Mendel is therefore, called **Father of Genetics**. He wrote about his work in his paper **"Experiments on Plant Hybridisation"** which was published in the fourth volume of **"Annual Proceedings of Natural History Society of Brunn"** in 1866. However, Mendel's work remained unnoticed and unappreciated for some 34 years.
- It was in 1900 that three workers independently rediscovered the principles of heredity already worked out by Mendel. They were **Hugo de Vries** of Holland, **Carl Correns** of Germany and **Erich von Tschermak** of Austria.

Terminologies and Symbols

- **Character** is a well defined morphological or physiological feature of an organism and **trait** is its distinguishing feature.
- **Gene** is the inherited factor that determines the biological character of an organism.
- **Allelomorphs** or **alleles** refer to the two Mendelian factors which occur on the same locus on the two homologous chromosomes of an individual and control the expression of a character, *e.g.*, T and t, Y and y, R and r are pairs of alleles.
- **Dominant allele** is one of the factor of an allelic pair which can express itself whether present in homozygous or heterozygous state, *e.g.*, T (tallness in pea), R (round seed in pea).
- **Recessive allele** is the factor of an allelic pair which is unable to express its effect in the presence of its contrasting alternative form in a heterozygote, *e.g.*, t in Tt.
- **Wild allele** is the one which was originally present in the population and is dominant and widespread.
- The diploid condition in which the alleles at a given locus are identical is called **homozygous** or pure.
- Organism containing two different alleles or individual containing both dominant and recessive genes of an allelic pair, *e.g.*, **Tt**, is known as **heterozygous** or **hybrid.**
- Second stage of Mendel's experiment is called **F_1 generation** or **first filial generation.**
- Third stage of Mendel's experiment is called **second filial** or **F_2 generation.**
- **Hybrid vigour** or **heterosis** is the superiority of hybrid over either of its parents in one or more traits.
- **Genotype** is the gene complement or genetic constitution of an individual with regard to one or more characters irrespective of whether the genes are expressed or not.
- **Phenotype** is the observable characteristic of an organism which is determined by its genes.
- The portion or region on chromosome representing a single gene is called **gene locus.**
- All the genotypes of all organisms in a population form the **gene pool.**
- **Pure line** or **pure breeding line** is a strain of individuals homozygous for all genes considered. The term was coined by **Johannsen.**
- **Punnett square** is a checker board which was devised by **R.C. Punnett** and used to show the result of a cross between two organisms.
- **Genome** is a constitution of all the genes contained in a single set of chromosomes, *i.e.*, in a haploid nucleus. Each parent, through its reproductive cells, contributes its genome to its offspring. A single genome is present in **haploid cells,** two in **diploid cells** and many in **polyploid cells.**

Reasons for Mendel's success

- He chose garden pea that was easy to grow and to hybridise artificially. It is **self-fertilising** in nature, but it is easy to cross-breed experimentally. The plant reproduces well and grows to maturity in a single season.
- He was fortunate in choosing a **diploid plant** because diploid organisms contain only two sets of chromosomes. If he had chosen a polyploid organism, an organism with more than two sets of chromosomes, he would not have obtained simple, understandable results.
- He chose to follow **seven visible features** (unit characters), each represented by two contrasting forms or traits.
- He restricted his examination to **very few pairs of contrasting traits** in each experiment.
- He also kept **accurate quantitative records**, a necessity in genetic experiments. From the analysis of his data, Mendel derived certain postulates that have become the principles of transmission genetics.

MENDEL'S EXPERIMENTS

- Mendel studied the inheritance of **seven different pairs of contrasting characters** of garden pea (*Pisum sativum*) plant but considered only one pair at a time.
- He crossed two plants with alternate characters by artificial pollination. Due to self-fertilising nature of garden pea, its anthers require removal before maturity for cross fertilisation. This operation of removal of anthers is called **emasculation**. The stigma is protected against any foreign pollen. The pollen of other plant (to be used as male parent) is dusted on the feathery stigma of emasculated flower. The result of such a procedure is, infact, the **cross fertilisation.**

Monohybrid cross

- Monohybrid cross is a cross made to study simultaneous inheritance of a single pair of Mendelian factors. In other words, the cross in which only alternate forms of a single character are taken into consideration is called monohybrid cross.

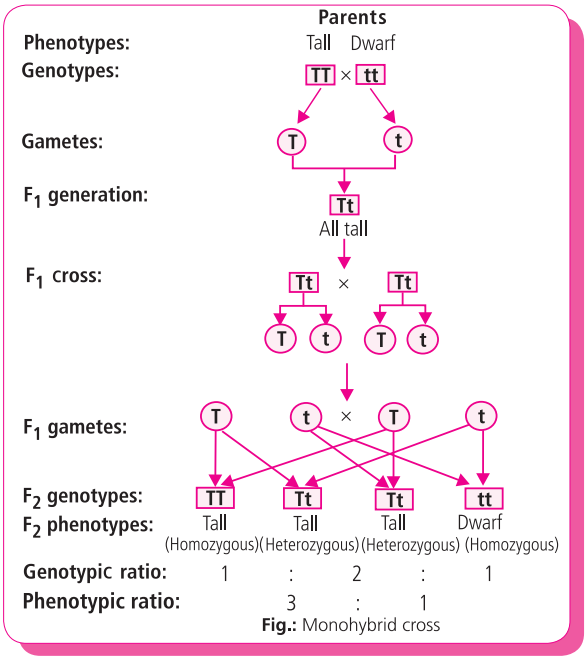


Fig.: Monohybrid cross

LAWS OF INHERITANCE
(Based on monohybrid cross)

Law of Dominance

When two homozygous individuals with contrasting characters are crossed, the character that appears in the F_1 hybrids is dominant character and that does not appear in F_1 hybrids is recessive character.

Law of Segregation

When a pair of contrasting factors or genes or allelomorphs are brought together in a heterozygote (hybrid) the two members of the allelic pair remain together without being contaminated and when gametes are formed from the hybrid, the two alleles separate out from each other and only one allele enters each gamete. It is also known as **"law of purity of gametes"** because each gamete is pure in itself *i.e.*, having either dominant or recessive allele.

Table: A summary of the seven pairs of contrasting traits and the results of Mendel's seven monohybrid crosses of the garden pea (*Pisum sativum*)

Character	Contrasting traits (dominant/recessive)		F_1 results	F_2 results	F_2 ratio
Seed shape	Round/Wrinkled		All round	5474 Round, 1850 Wrinkled	2.96:1
Seed colour	Yellow/Green		All yellow	6022 Yellow, 2001 Green	3.01:1
Pod shape	Full/Constricted		All full	882 Full, 299 Constricted	2.95:1
Pod colour	Green/Yellow		All green	428 Green, 152 Yellow	2.82:1
Flower colour	Violet/White		All violet	705 Violet, 224 White	3.15:1
Flower position	Axial/Terminal		All axial	651 Axial, 207 Terminal	3.14:1
Stem height	Tall/Dwarf		All tall	787 Tall, 277 Dwarf	2.84:1

Test cross

Tall plant produced in the F_2 generation are predicted to have either the TT or the Tt genotypes. Mendel devised a rather simple method that is still used today in breeding procedures of plants and animals, the **test cross**. The organism of the dominant phenotype, but unknown genotype, is crossed to a homozygous recessive individual. For example, if a tall plant of genotype TT is test crossed to a dwarf plant, which must have the tt genotype, all offspring will be tall phenotypically and Tt genotypically. However, if a tall plant is Tt and is crossed to a dwarf plant (tt), then one-half of the offspring will be tall (Tt) and the other half will be dwarf (tt). Therefore, a 1:1 ratio of tall/dwarf phenotypes demonstrates the heterozygous nature of the tall plant of unknown genotype.

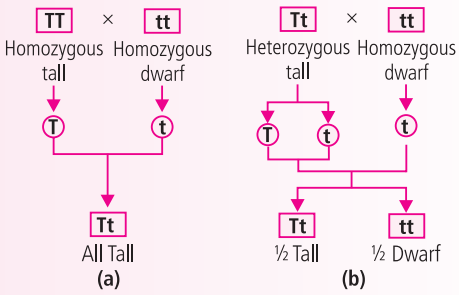


Fig.: Test cross for a single character

Dihybrid cross

- Mendel also crossed pea plants differing in two characters (dihybrid cross). This helped him to understand inheritance of two genes (*i.e.*, two pairs of alleles) at a time.
- It was found that inheritance of one pair of allele (one trait) does not interfere with the inheritance of other pair of allele (second trait).

Law of independent assortment (Based on dihybrid cross)

- The law states that "when two pairs of characters are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters."
- Independent assortment is not applicable for the genes located on the same chromosome, i.e., linked genes. It is applicable to only those factors or genes which are present on different chromosomes. Mendel's gene pairs did not show linkage.
- The genes controlling the seven pea characters studied by Mendel are now known to be located on **four chromosomes (1, 4, 5, 7).**
- Mendelian recombinations were mainly due to independent assortment. Mendel's 9:3:3:1 dihybrid ratio is an ideal ratio based on probability events involving segregation, independent assortment, and random fertilisation.

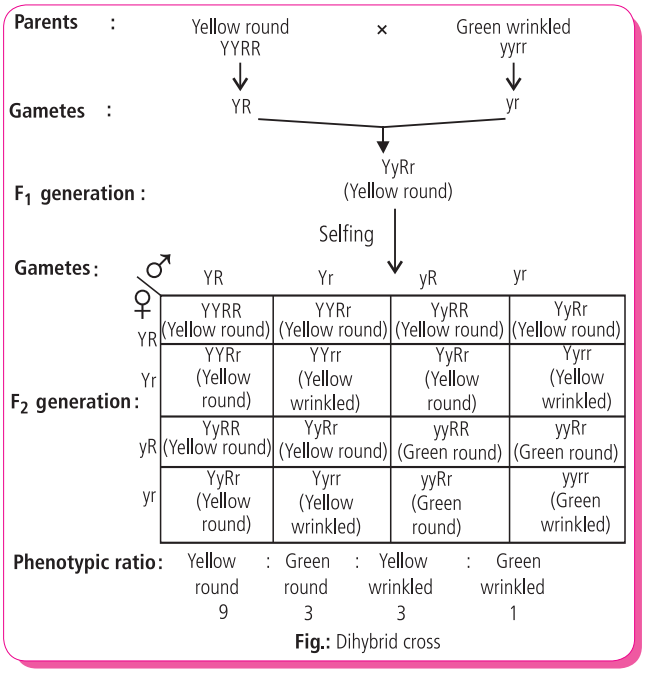


Fig.: Dihybrid cross

Trihybrid cross

- Mendel demonstrated that the identical processes of segregation and independent assortment apply to three pairs of contrasting traits in a **trihybrid cross**, also referred to as a **three-factor cross**.

Table: Simple mathematical rules useful in solving genetics problems

Number of heterozygous gene pairs	Number of different types of gametes formed	Number of different genotypes produced	Number of different phenotypes produced
n	2^n	3^n	2^n
E.g., if n = 1	2	3	2

FOUNDATION OF MODERN GENETICS

- **Walter Flemming** discovered chromosomes in 1879. As a result of the findings of Flemming and many other cytologists, the presence of a nuclear component soon became an integral part of ideas surrounding inheritance. It was in this setting that

scientists were able to re- examine Mendel's findings. In the early 20th century, hybridisation experiments similar to Mendel's were independently performed by three botanists, **Hugo deVries**, **Karl Correns**, and **Erich Tschermak**.

- In 1902, two cytologists, **Walter Sutton** and **Theodor Boveri**, independently published papers linking their discoveries of the behaviour of chromosomes during meiosis to the Mendelian principles of segregation and independent assortment. They pointed out that the separation of chromosomes during meiosis could serve as the cytological basis of these two postulates. Although they thought that Mendel's unit factors were probably chromosomes, rather than genes on chromosomes, their finding re-established the importance of Mendel's work, which served as the foundation of ensuing genetic investigations. Based on their studies, Sutton and Boveri are credited with initiating the chromosomal theory of heredity. Work by **Thomas H. Morgan**, **Alfred H. Sturtevant, Calvin Bridges,** and others using fruit flies established beyond a reasonable doubt that Sutton and Boveri's hypothesis was correct.

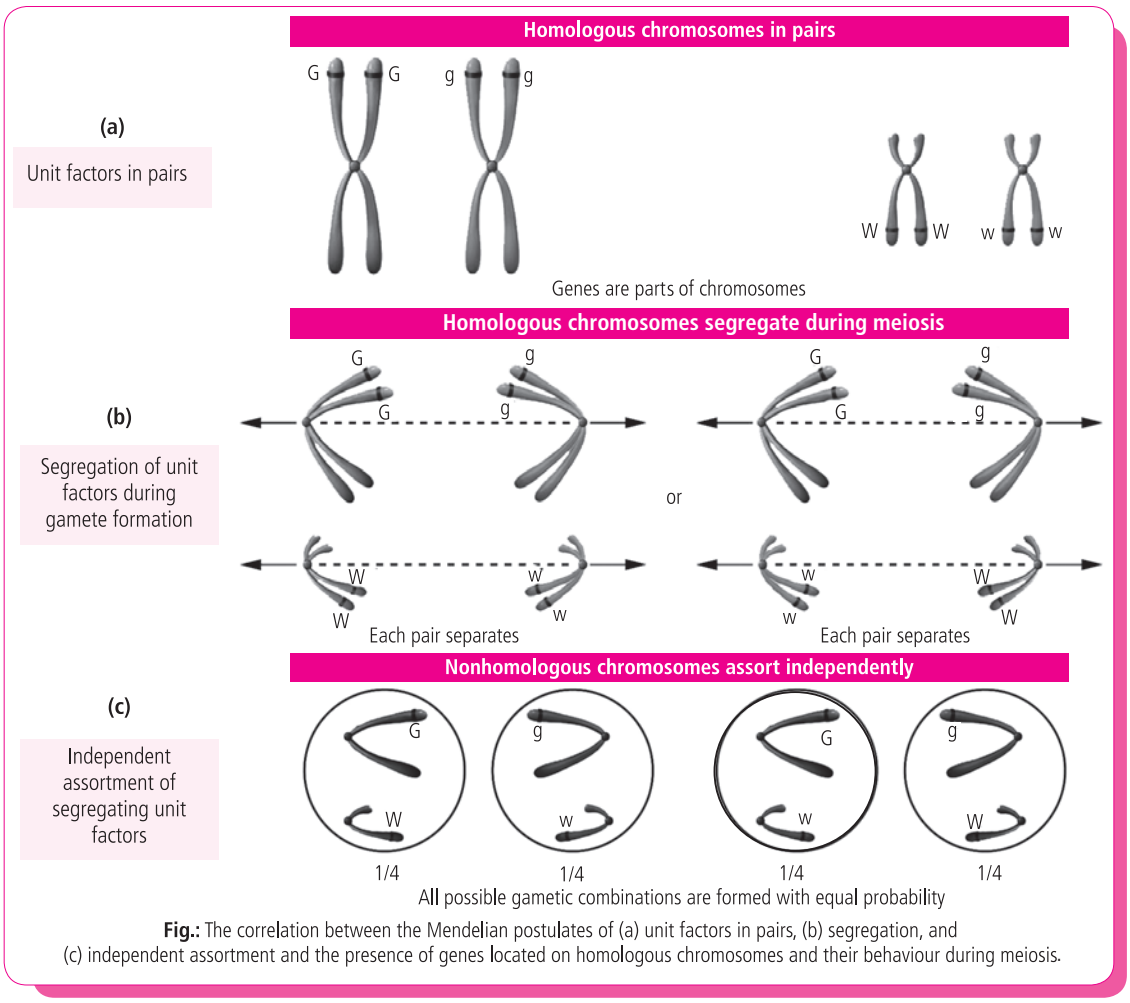


Fig.: The correlation between the Mendelian postulates of (a) unit factors in pairs, (b) segregation, and (c) independent assortment and the presence of genes located on homologous chromosomes and their behaviour during meiosis.

GENE INTERACTION

- Gene interaction is the influence of alleles and non-alleles on the normal phenotypic expression of genes.

Gene interaction

Intragenic gene interaction

In the intragenic or interallelic interactions, the two alleles of a gene which are present on the same gene locus on the two homologous chromosomes, react with each other in such a way as to produce an expression different from the normal dominant-recessive phenotype, *e.g.*, incomplete dominance, codominance, multiple alleles.

Intergenic gene interaction

In intergenic or nonallelic interactions, two or more independent genes present on same or different chromosomes interact to produce a different expression, *e.g.*, epistasis, duplicate genes, complementary genes, supplementary genes, inhibitory genes, etc.

Intragenic interactions

Incomplete dominance

- It is the phenomenon where dominant gene in heterozygous condition has reduced expression so that each allele expressess itself partially. This is also called **blending inheritance.**

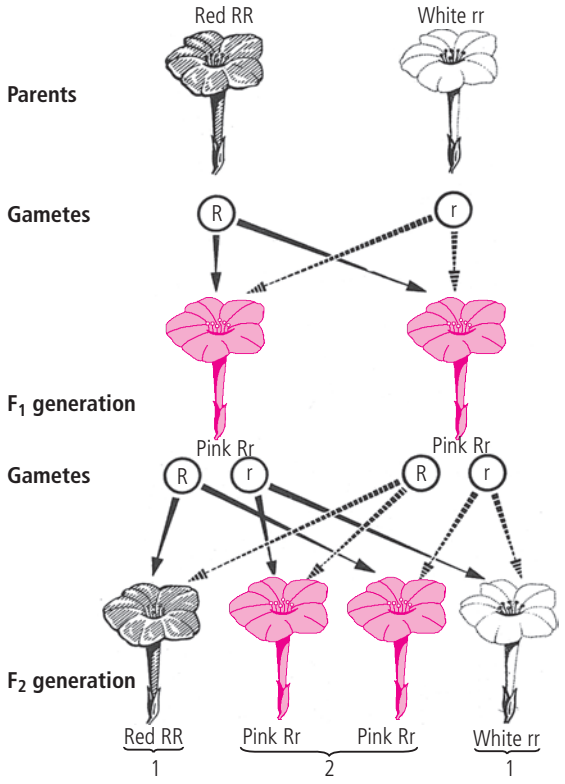


Fig.: Incomplete dominance in *Mirabilis jalapa*

Codominance

- If two alleles of a single gene are responsible for producing two distinct and detectable gene products, a situation different from incomplete dominance or dominance-recessiveness arises. In such a case, the joint expression of both alleles in a heterozygote is called **codominance.**

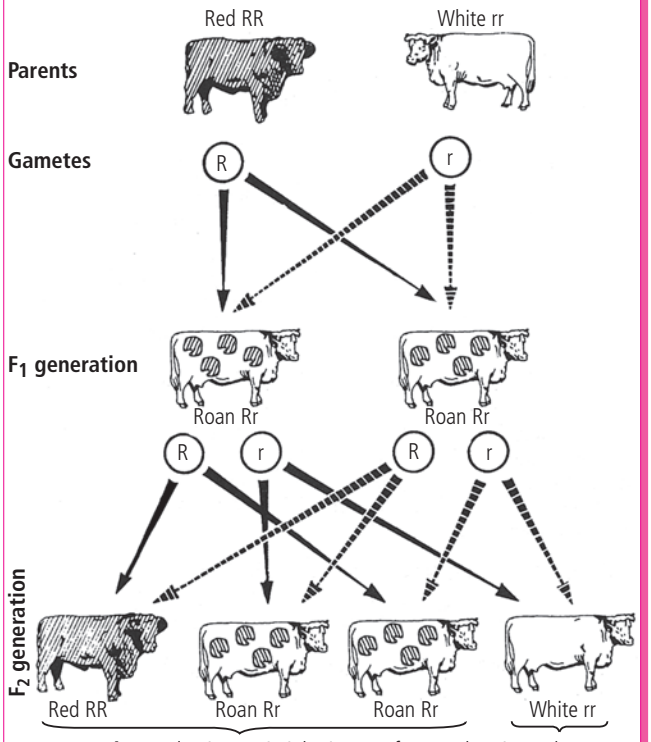


Fig.: Codominance in inheritance of coat colour in cattle

Multiple alleles

- When three or more alleles of the same gene are found within members of a population multiple alleles are said to be present, creating a characteristic mode of inheritance. The multiple alleles can be studied only in populations. A diploid organism has, at most, two homologous gene loci that may be occupied by different alleles of the same gene. However, among members of a species, many alternative forms of the same gene can exist.
- **ABO blood type** alleles in humans form an example of multiple alleles. The ABO locus has three common alleles : I^A, I^B and *i*. I^A and I^B are codominant (I^AI^B heterozygotes have both A and B antigens on their red blood cells) and *i* is recessive (*ii* homozygotes have no antigens on their red blood cells; I^Ai and I^Bi heterozygotes have A and B antigens, respectively, on their red blood cells).

Phenotype (Blood group)	Genotypes	Antibodies present in blood serum	Antigens on RBC
A	I^AI^A or I^Ai	B	A
B	I^BI^B or I^Bi	A	B
AB	I^AI^B	None	A and B
O	*ii*	A and B	None

Lethal genes

A lethal gene can be defined as a gene whose phenotypic effect is sufficiently drastic to kill the bearer. The normal segregation ratio is modified into 2 : 1.

Dominant lethal genes

The dominant lethal genes are lethal in homozygous condition and produce some defective or abnormal phenotype in heterozygous condition. Dominant lethal genes cannot be transmitted to next generation, because the individuals carrying these genes die, *e.g.*, Huntington's chorea in man .

Recessive lethal genes

The recessive lethal genes produce lethal effect only in homozygous condition. Their heterozygotes are normal *e.g.*, Tay Sach's disease.

Intergenic interactions

Complementary genes

Complementary genes may be defined as, two or more dominant genes present on **separate gene loci** (non-allelic pair), which interact to produce a particular phenotypic trait, but neither of them produces the phenotypic trait in the absence of other. There is **complementation** between two genes implying that both genes are necessary for the production of a particular phenotype. Complementary genes were first studied by **Bateson** and **Punnett** (1906) in case of flower colour of sweet pea (*Lathyrus odoratus*).

Parents: White flower (○) CCpp × White flower (○) ccPP

Gametes: Cp, cP

F_1 generation: CcPp — Purple flower (●) — Selfing

♂ \ ♀	CP	Cp	cP	cp
CP	CCPP ●	CCPp ●	CcPP ●	CcPp ●
Cp	CCPp ●	CCpp ○	CcPp ●	Ccpp ○
cP	CcPP ●	CcPp ●	ccPP ○	ccPp ○
cp	CcPp ●	Ccpp ○	ccPp ○	ccpp ○

F_2 generation: Purple flower : White flower
9 ● 7 ○

Fig.: Complementary gene action in sweet pea

Supplementary genes

Supplementary genes are two non-allelic dominant genes, which interact in such a way that one dominant gene will produce its effect whether the other is present or not. The second dominant, gene produces its effect only in the presence of first gene, usually forming a new trait. *E.g.*, coat colour in mice.

Parents: Agouti CCAA × Albino ccaa

Gametes: CA, ca

F_1 generation: Agouti CcAa — Selfing

Gametes:

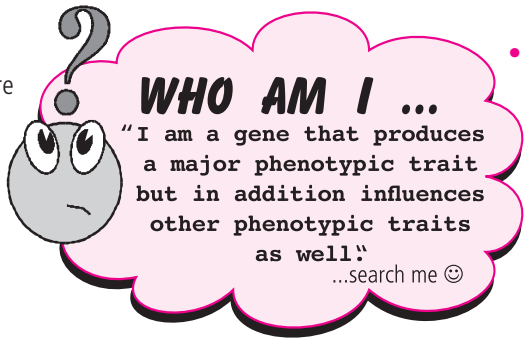
♂ \ ♀	CA	cA	Ca	ca
CA	CCAA agouti	CcAA agouti	CCAa agouti	CcAa agouti
cA	CcAA agouti	ccAA albino	CcAa agouti	ccAa albino
Ca	CCAa agouti	CcAa agouti	CCaa black	Ccaa black
ca	CcAa agouti	ccAa albino	Ccaa black	ccaa albino

F_2 generation: 9 Agouti : 3 Black : 4 Albino

Fig.: Interaction of supplementary genes in mice for coat colour

Duplicate genes

- Duplicate genes or factors are two or more independent genes present on different chromosomes which determine the same or nearly same phenotype so that either of them can produce the same character.



- The independent genes do not have cumulative effect. They produce the same phenotype whether present in homozygous or heterozygous state. As a result, dominant phenotype is more abundant. F_2 ratio is **15:1**., *e.g.*, seed shape in Shepherd's purse.

Epistasis

Epistasis is the interaction between genes present at two separate loci in which one gene suppresses or masks the expression of other gene. The gene that masks the effect of other gene is known as **inhibiting** or **epistatic gene/factor** and the one which is being prevented from expressing itself is known as **hypostatic gene/factor.** It is similar to dominance and recessiveness but the two factors occupy two different loci.

Dominant epistasis

In dominant epistasis, out of two pairs of alleles the dominant allele of one gene masks the activity of other non-allelic pair *e.g.*, fruit colour in summer squash (*Cucurbita pepo*).

Parents : WWYY (White fruit) × wwyy (Green fruit)

Gametes : WY, wy

F_1 generation : WwYy (White fruit)

Selfing

Gametes:

♀ \ ♂	WY	Wy	wY	wy
WY	WWYY white	WWYy white	WwYY white	WwYy white
Wy	WWYy white	WWyy white	WwYy white	Wwyy white
wY	WwYY white	WwYy white	wwYY yellow	wwYy yellow
wy	WwYy white	Wwyy white	wwYy yellow	wwyy green

F_2 generation : 12 White : 3 Yellow : 1 Green

Fig.: Inheritance of fruit colour in *Cucurbita pepo* due to dominant epistasis

Recessive epistasis

Epistasis due to recessive gene is known as recessive epistasis, *i.e.*, the recessive epistatic gene masks the activity of the dominant gene at the other gene locus *e.g.*, pigmentation in onion bulb.

Parents: IIRR Red bulb × iirr White bulb

Gametes: IR, ir

F_1 generation: IiRr (Hybrid red)

Selfing

Gametes:

♀ \ ♂	IR	Ir	iR	ir
IR	IIRR red	IIRr red	IiRR red	IiRr red
Ir	IIRr red	IIrr yellow	IiRr red	Iirr yellow
iR	IiRR red	IiRr red	iiRR white	iiRr white
ir	IiRr red	Iirr yellow	iiRr white	iirr white

F_2 generation: 9 Red : 3 Yellow : 4 White

Fig.: Inheritance of pigmentation in onion bulbs indicating recessive epistasis

Pleiotropy

- According to Mendel, a specific gene produces only one specific phenotypic character. But cases have been studied in which one gene may produce several side effects, *i.e.*, a gene produces a major phenotypic trait but in addition to that influences some other phenotypic traits also. This phenomenon of a single major gene influencing more than one character (multiple expression) is known as **pleiotropism** and such genes are known as **pleiotropic genes.**

  Example: In man, gene producing the disease phenylketonuria also produces a number of abnormal phenotypic traits, which are collectively known as syndrome. This gene results in short stature, mental retardation, widely spaced incisors, pigmented patches on the skin and excessive sweating.

Intext Practice Questions

1. Differentiate between incomplete dominance and codominance.
2. What were reasons for Mendel's success in figuring out the pattern of inheritance?
3. Explain the significance of test cross.
4. Name the type of intergenic interaction in which two dominant genes interact to produce a particular phenotypic trait, but neither of them produces the phenotypic trait in the absence of other.
5. How is recessive epistasis different from dominant epistasis?

QUANTITATIVE OR POLYGENIC INHERITANCE

- It is a type of inheritance controlled by generally three or more genes in which the dominant alleles have cumulative effect with each dominant allele expressing a part or unit of the trait, the full trait being shown only when all the dominant alleles are present. The genes involved in quantitative inheritance are called **polygenes.** Quantitative inheritance is , therefore, also called **polygenic inheritance.** It is also named as **multiple factor inheritance**.

Examples of quantitative inheritance

Kernel colour in wheat

- **Nilsson Ehle (1909)** and **East (1910, 1916)** gave first significant clue of quantitative inheritance by their individual works on wheat.
- **Two pairs of genes** controlling production of red pigment are operating in this cross. Each gene contains two alleles. One allele produces a given quantity of the red pigment, while its counterpart does not produce any pigment. All alleles are equally potent in the production or lack of production of pigment.
- When **three pairs of genes are** involved , the F_2 ratio is 1 : 6 : 15 : 20 : 15 : 6 : 1.

Parents : Red kernel AABB × White kernel aabb

Gametes : AB, ab

F_1 generation : Intermediate red AaBb

F_1 gametes : Selfing

♀ / ♂	AB	Ab	aB	ab
AB	AABB Dark red	AABb Medium	AaBB Medium	AaBb Intermediate
Ab	AABb Medium	AAbb Intermediate	AaBb Intermediate	Aabb Light
aB	AaBB Medium	AaBb Intermediate	aaBB Intermediate	aaBb Light
ab	AaBb Intermediate	Aabb Light	aaBb Light	aabb White

F_2 generation :
Dark red : 1/16 Light red : 4/16
Medium red : 4/16 White : 1/16
Intermediate red : 6/16

Fig.: Results of polygenic inheritance of kernel colour in wheat

Height in man

- The inheritance of height in man is a more complex phenomenon involving perhaps **ten or more pairs** of genes. The character of tallness is recessive to shortness, thus, an individual having the genotype of more dominant genes will have the phenotype of shortness. Because, this quantitative trait is controlled by multiple pairs of genes and is variously influenced by a variety of environmental conditions, the heights of adults range from 140 cm to 203 cm.

LINKAGE

- Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosome.
- Linkage was first suggested by **Sutton and Boveri** (1902-1903) when they propounded the famous "chromosomal theory of inheritance".
- **Bateson and Punnett** (1906) while working on sweet pea (*Lathyrus odoratus*) found that the factors for certain characters do not show independent assortment. They suggested that the alleles coming from the same parent tend to enter the same gamete and get inherited together **(coupling).** Similarly, the same genes coming from two different parents, tend to enter different gametes and get inherited separately and independently **(repulsion).**
- Morgan (1910) while working on *Drosophila* stated that coupling and repulsion are two aspects of the same phenomenon, which he described as 'linkage'. In 1911, Morgan and Castle proposed 'the chromosome theory of linkage'**.** It states that :
  (i) Linked genes occur in the same chromosome. (ii) They lie in a linear sequence in the chromosome.
  (iii) There is a tendency to maintain the parental combination of genes except for occasional crossovers.
  (iv) Strength of the linkage between two genes is inversely proportional to the distance between the two, *i.e.*, two linked genes show higher frequency of crossing over if the distance between them is higher and low frequency if the distance is small.
- Genes that are present on the same chromosome make one **linkage group**.

Arrangement of linked genes
(In heterozygous individual)

Cis-arrangement

The dominant genes of both pairs are located in one member of the chromosome pair and their recessive alleles are located in the other chromosome of the pair. This arrangement is known as ***cis*-arrangement.**

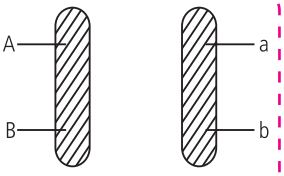


Fig.: *Cis*-arrangement of genes

Trans-arrangement

The dominant gene of one pair and the recessive gene of other pair are located in one chromosome of the pair and the recessive gene of the first pair and dominant gene of the second pair are located in the second chromosome of the pair. This arrangement is known as ***trans*-arrangement.**

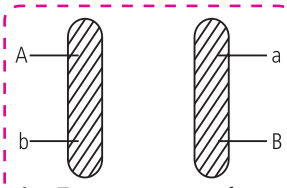


Fig.: *Trans*-arrangement of genes

Complete linkage

Complete linkage is a linkage or grouping of genes on a chromosome which is not altered and is inherited as such from generation to generation without any cross-over. In such cases, linked genes do not separate to form new or non-parental combinations.

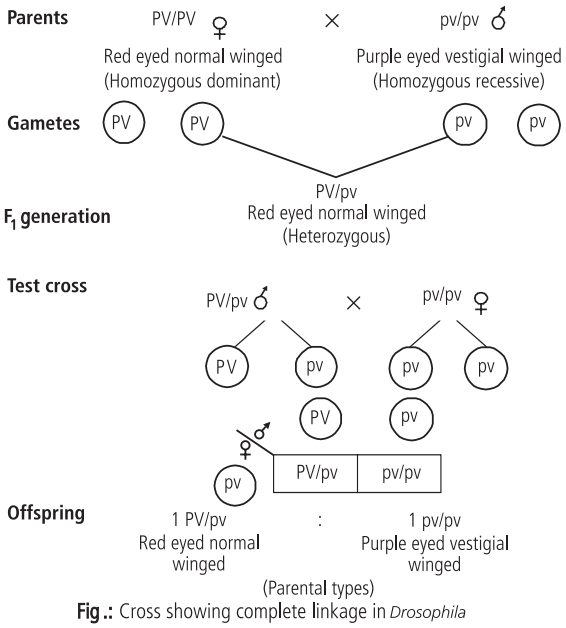


Fig.: Cross showing complete linkage in *Drosophila*

Types of linkage

Incomplete linkage

Incomplete linkage is the phenomenon of an occasional crossing over between two homologous chromosomes so that one or more alleles present in a linkage group are replaced by other alleles.

It produces both parental and recombinant individuals. The percentage of each parental type is more than 25% while that of each recombinant type is less than 25%, *i.e.*, parental types are more than 50% of population while recombinant types are less than 50%.

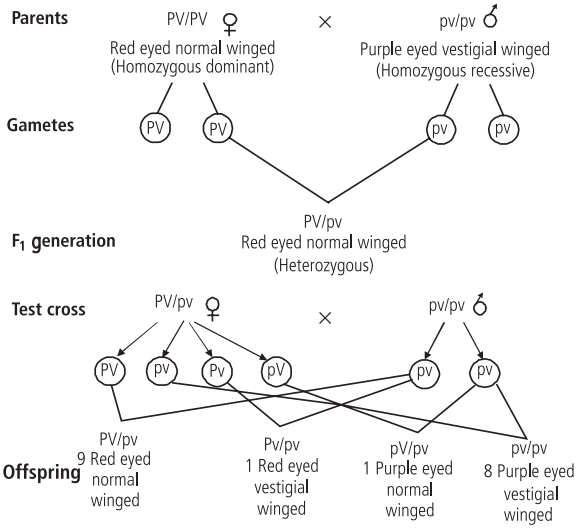


Fig.: Cross showing incomplete linkage in *Drosophila*

Linkage map

- A linkage or genetic or chromosome map is a linear graphic representation of the sequence and relative distances of the various genes present in a chromosome. It is constructed by making crosses and observing whether certain characteristics tend to be inherited together.
- The first chromosome maps were prepared by **Sturtevant** in 1911 for two chromosomes and in 1913 for all the four chromosomes of *Drosophila*.
- Construction of linkage map is based on the following facts:
  (i) Genes present in a chromosome are arranged in a linear sequence.
  (ii) The frequency of crossing over and hence recombination between two genes is directly proportional to the physical distance between the two.
- **Map unit** is a unit for measuring distance between genes (or other loci) on a chromosome according to the frequency of recombination between them due to crossing over.
- 1% crossing over between two linked genes is known as 1 map unit or centiMorgan (cM). 100% crossing over is termed as Morgan (M) and 10% crossing over as deciMorgan (dM; after T. H. Morgan who is considered to be the father of experimental genetics).

X-linkage

- In humans, males contain an X and Y chromosome, whereas females contain two X chromosomes. While the Y chromosome must contain a region of pairing homology with the X chromosome if the two are to synapse and segregate during meiosis, the remainder of the Y chromosome in humans as well as other species is considered to be relatively inert genetically. Thus, it lacks most genes present on the X chromosome.
- As a result, genes present on the X chromosome exhibit unique patterns of inheritance in comparison with autosomal genes. The term X-linkage is used to describe such situations. One of the first cases of X-linkage was documented in 1910 by **Thomas H. Morgan** during his studies of the white eye mutation in *Drosophila*.

Characteristics of X-linked inheritance

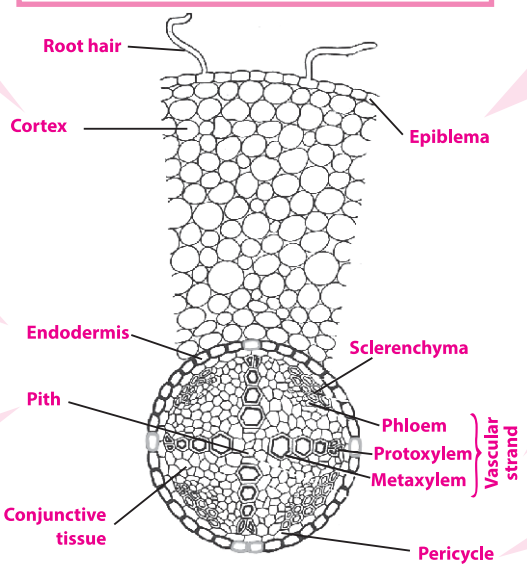
- It shows criss-cross pattern of inheritance. Father does not pass the X-linked allele of a trait to his son. The same is passed to the daughter, from where it reaches to grandson.
- Mother passes the alleles of a X-linked trait to both sons and daughters.
- X-linked traits are more apparent in males than in females. As many sex-linked traits are harmful, males suffer more from X-linked disorders.
- Females generally function as carriers of X-linked disorders because recessive genes can express themselves in females only in the homozygous state.
- Majority of the X-linked traits are recessive.

CONCEPT MAP

ANATOMY OF DICOTS

Anatomy is the study of internal structures of various parts of a living organism. Anatomy of dicot plants deals with the internal structures of stem, root and leaves of plants.

ANATOMY OF DICOT ROOT



T.S. of dicot root

- It is situated below epiblema and is made up of thin-walled parenchyma cells with intercellular spaces.
- Cortical cells store starch.

- Innermost layer of cortex is called **endodermis**. It is made up of single layer of barrel-shaped cells lacking intercellular spaces.
- Young endodermal cells possess **Casparian strips** (bands of thickening which run along their radial and tangential wall).
- Casparian strips prevent plasmolysis of endodermal cells and do not allow wall to wall movement of substances between cortex and pericycle.
- Endodermal cells opposite to protoxylem point lack Casparian strips and are called **passage cells**.

- It is found in the centre and is often reduced or absent in dicot root.
- If present, it consists of parenchyma cells without intercellular spaces.

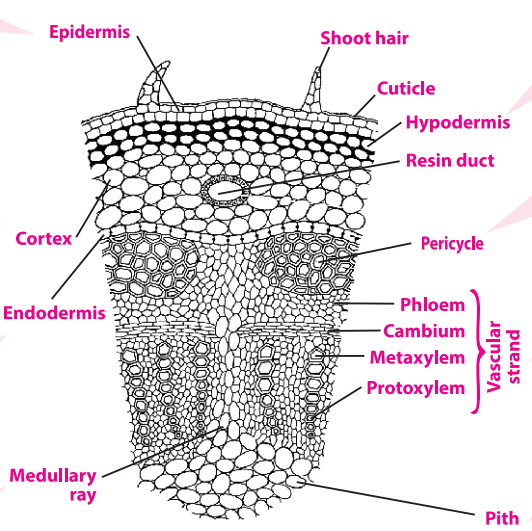
- Xylem and phloem bundles are separated from each other by one or more layers of small thin-walled cells called conjunctive parenchyma.
- It becomes meristematic to form vascular cambium.

- It is the outermost layer of root.
- Made up of compactly arranged, thin-walled, parenchymatous cells.
- Distinct cuticle and stomata are absent.
- Some cells of epiblema give rise to thin-walled tubular outgrowths called **root hairs**. These absorb water and mineral salts from the soil.
- Due to presence of root hairs, the epiblema is also called **piliferous layer**.

- Vascular bundles are **radial**, *i.e.,* xylem and phloem are situated on different radii and **exarch**, *i.e.,* protoxylem away from the centre and metaxylem towards the centre.
- Roots may be **diarch** (2 xylem bundles), **triarch** (3 xylem bundles), **tetrach** (4 xylem bundles), **pentarch** (5 xylem bundles) or **hexarch** (6 xylem bundles).

- It is usually a single layered structure found below the endodermis and represents the outer boundary of stele.
- All lateral roots originate from pericycle.

ANATOMY OF DICOT STEM



T.S. of dicot stem

- It is the outermost layer of stem and is protective in function.
- Made up of compactly arranged, parenchymatous cells devoid of chloroplasts (except guard cells).
- The outer walls of epidermal cells are cuticularised.
- Stomata and multicellular hair are present in epidermis.

- Consists of thin-walled parenchymatous cells with inter-cellular spaces.
- Major function of cortex is food storage.

- It is the innermost boundary of cortex made up of compactly arranged barrel-shaped cells without Casparian strips.
- Endodermal cells of stem store starch grain and are often referred to as **starch sheath**.

- They are radial strips of parenchyma which are present between adjacent vascular bundles.
- They connect pith with pericycle and cortex.
- Ray cells are larger than cortical cells.

- Hypodermis lies just below epidermis and consists of 3-5 layers of collenchymatous cells.
- The intercellular spaces are absent and corners of cells are thickened due to deposition of extra cellulose impregnated with pectic substances.
- These cells often possess chloroplasts.

- Pericycle is **heterogenous**, *i.e.,* made up of alternating bands of parenchymatous and sclerenchymatous cells.
- Sclerenchymatous cells are situated in between endodermis and phloem cells of vascular bundles whereas parenchymatous cells are present above the medullary rays.

- Vascular bundles are arranged in a ring and are **conjoint** (with both phloem and xylem), **collateral** (phloem and xylem on same radius) and **open** (with a strip of cambium between phloem and xylem). Xylem is situated towards the inner side of each vascular bundle whereas phloem lies towards the pericycle on the outer side of vascular bundle.
- Xylem is **endarch** (protoxylem towards the centre).

- It is extensively developed central portion of ground tissue, made up of large thin-walled polygonal parenchymatous cells with intercellular spaces.

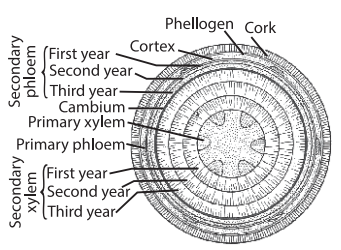
Secondary growth in dicots

Secondary growth in dicot stem

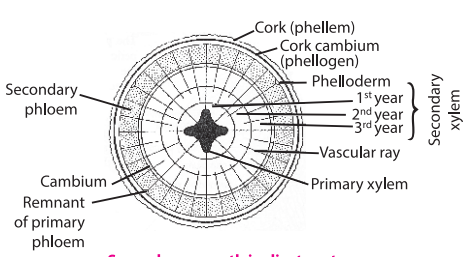
In a typical dicot stem the cambium is present in between the xylem and phloem. It is called **fascicular** or **intrafascicular** cambium. Along with this cambium, some medullary ray cells also become active forming **interfascicular** cambium. Interfascicular and intrafascicular cambia together form a ring of cambium. Cambial cells give rise to secondary phloem on the outer side and secondary xylem on the inner side. **Phellogen** or cork cambium arises from permanent living cells of hypodermis or outer cortex. It divides to give rise to phellem (cork) on the outerside and phelloderm (secondary cortex) on the inner side.

Secondary growth in dicot root

In dicot roots cambium develops at the time of secondary growth. First of all parenchyma cells interior to the phloem become meristematic, and strips of cambia are formed. Later, these strips divide tangentially again and again and produce secondary tissues. The cells of pericycle lying opposite to each protoxylem divide and form a few layers of cell. Thus, a wavy continuous cambium ring is produced which cuts-off secondary xylem internally at all places and secondary phloem at all places externally. Cork cambium arises as a result of the tangential division of the outer cells of pericycle. The activity of cork cambium is similar to that found in dicot stem so it produces cork cells on the outer side and parenchyma on the inner side.

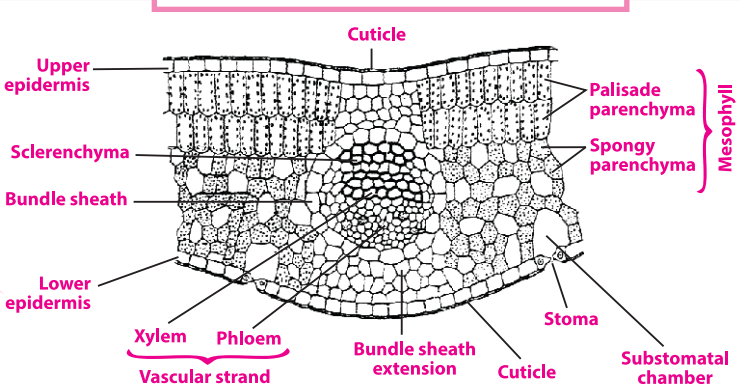


Secondary growth in dicot stem



Secondary growth in dicot root

ANATOMY OF DICOT LEAF



V.S. of dicot leaf

- Consists of a single layer of tightly packed rectangular barrel-shaped parenchymatous cells usually devoid of stomata and chloroplasts.
- Outer walls of epidermal cells are cuticularised.

- This is like upper epidermis but with stomata and chloroplasts (in guard cells only).
- Outer walls of cells are cuticularised.

- The tissue between upper and lower epidermis is called mesophyll.
- It is differentiated into 2 regions:
  (i) **Palisade parenchyma:** It lies below upper epidermis and consists of 1-3 layers of vertically elongated closely placed, columnar or cylindrical cells. These cells have numerous chloroplasts and take part in photosynthesis.
  (ii) **Spongy parenchyma:** It is found below palisade tissue. The cells are almost spherical and irregularly arranged with intercellular spaces. They also possess chloroplasts but fewer than present in palisade parenchyma and take part in photosynthesis.

- Vascular bundles are generally found at the boundary between the palisade and spongy regions.
- Vascular bundles are **conjoint** and **collateral.**
- Around each vascular bundle a sheath of parenchymatous cells called **bundle sheath** is present.
- The midrib contains a number of vascular bundles which are embedded in parenchymatous ground tissue.

- Substomatal chamber is present below the stomata which helps in exchange of gases and is also called **respiratory cavity**.

Table: **Some X-linked disorders in humans with their causes and symptoms**

Disorders	Causes	Symptoms
Haemophilia A/B	Absence of antihaemophiliac globulin factor VIII and plasma thromboplastin factor IX	Absence of natural phenomenon of blood clotting
Colour blindness	Defect in either red or green cone cells of retina	Failure to discriminate between red and green colour
Duchenne type muscular dystrophy	Mutation in certain genes involved in making protein dystrophin that protects muscle fibres from damage	Muscular deterioration that progresses rapidly during the early teen years. Muscles of the legs and shoulders become stiff, and the children usually become paralysed and crippled during their middle or late teens. Virtually all die before the age of 21.

Sex influenced genes

The sex influenced genes are present in the autosomes whose dominance is influenced by the sex of the bearer. These are expressed more frequently in one sex than in the other. For example, pattern of baldness is dominant in male and recessive in female. This is because the gene for baldness (B) in heterozygous state (Bb) expresses itself in male but not in female. It means gene B for baldness behaves as a dominant in male and as a recessive in female.

Sex limited genes

Sex limited genes are present in the autosomes but their expression is determined by the presence or absence of one of the sex hormones. Therefore, these express themselves only in one sex. The sex limited genes control the expression of primary and secondary sexual characters. For example, beard development in human beings is a sex-limited character.

SEX DETERMINATION

- It is a biological system that determines the development of sexual characteristics in an organism.

Types of sex determination

Chromosomal sex determination

- It is based on **heterogamety** or occurrence of two types of gametes in one of the two sexes.
- **XX-XY method** (XX - ♀ and XY - ♂). *E.g.*, mammals, some insects etc.
- **XX-XO method** (XX - ♀ and XO - ♂). *E.g.*, roundworm, some insects etc.
- **ZZ-ZW method** (ZW - ♀ and ZZ - ♂). *E.g.*, birds, some reptiles, etc.
- **ZZ-ZO method** (ZO - ♀ and ZZ - ♂). *E.g.*, moths, butterfly, etc.

Cytoplasmic sex determination

- Cytoplasmic or **F-factor** located in plasmid determines the sex. Male or donor cell's fertility factor is designated as F^+ while that of female or recipient cell's fertility factor is designated as F^-.

Environmental sex determination

- Determination of sex depends on environmental conditions.
- Environmental factors like temperature, etc. determine whether fertilised eggs will develop into a male or a female. *E.g.*, crocodiles, lizards, etc.

Genic balance mechanism

- Ratio of X chromosome and autosome decides the sex of individual.

  If ratio = 1, individual is female

  > 1, infertile metafemale

  = 0.5 normal male

  < 0.5, infertile metamales

  Between 0.5 to 1, is intersex.
- Found in *Drosophila*.

MUTATIONS

Mutations are new sudden inheritable discontinuous variations which appear in the organisms due to permanent change in their genotypes. The term "mutation" was coined by **Hugo de Vries** (1901).

Depending upon cause:

- **Genomic mutations** – Changes in number of chromosomes
- **Chromosomal mutations** – Changes in number and arrangment of genes in chromosomes. They are also called as **chromosomal aberrations**.
- **Gene mutations** – Changes in the form and expression of gene

Depending upon site of occurrence:

- **Somatic mutations** – Mutations appearing in the body cells (other than germ cells) are known as somatic mutations. They are not passed on to offspring.
- **Germinal mutations** – Mutations appearing in germinal cells are called germinal mutations. They are passed on the offspring.

Genomic mutations
(Changes in number of chromosomes)

Euploidy

The organisms having one or more complete sets of chromosomes or organisms having chromosome number which is whole number multiple of basic chromosome number, are called **euploids** and this phenomenon is called euploidy.

Haploidy

Haploids are the individuals, which are having half the chromosome number (somatic) as compared to its diploid or normal individual, *e.g.*, wheat.

Monoploidy

Monoploids on the other hand are the individuals having single basic set of chromosomes, *e.g.* in **barley,** $2n = x = 7$ (Monoploid) in **maize,** $2n = x = 10$ (Monoploid) ($x \rightarrow$ basic chromosome number).

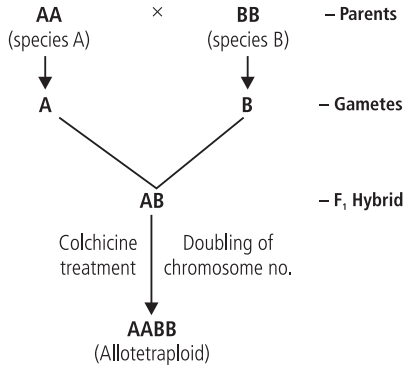
Polyploidy

A plant or animal that has more than two haploid sets of chromosomes is called a polyploid. Polyploids may originate either by reduplication of the chromosome number in somatic tissue with suppression of cytokinesis or by formation of gametes with an unreduced number of chromosomes.

Polyploids can be **triploid** (three sets; $3x$), **tetraploid** (four sets; $4x$), **pentaploid** (five sets; $5x$), **hexaploid** (six sets; $6x$), **octaploid** (eight sets; $8x$), **decaploid** (ten sets; $10x$), **dodecaploid** (twelve sets; $12x$).

Allopolyploidy

This is a chromosomal variation produced in crosses between two species having different sets of chromosomes. The resulting hybrid has a different number of chromosomes than the parents.



Autoallopolyploidy

Polyploids where different genomes show homoeologous relationship are called autoallopolyploids or segmental polyploids. **Three genomes in wheat** A, B and D are not fully distinct from each other and they have some portions common in them (*i.e.*, only segments are homologous). Hence A, B and D show **homoeologous** relationship.

Autopolyploidy

Here, there is multiplication of same basic set of chromosomes. For example :
Organism with single genome, *i.e.*, 'A' – haploid.
Organism with two similar genomes, *i.e.*, 'AA' – autodiploid.
Organism with three similar genomes, *i.e.*, 'AAA' – autotriploid.
Organism with four similar genomes, *i.e.*, 'AAAA' – autotetraploid and so on.

Aneuploidy

If the number of chromosomes in an organism is not whole number multiple of basic chromosome number, it is called **aneuploidy** and such organisms are called **aneuploids**, *e.g.*, if x (basic chromosomes no.) = 7 and $2n$ (diploid no.) = 14 then $2n = 15$, $2n = 16$, $2n = 13$, $2n = 12$ are the **aneuploids**.
Aneuploidy is produced by a failure in the separation of chromosomes during meiosis, called nondisjunction.

Hyperploidy
Addition of chromosomes

Trisomic
(2n + 1) Results in
- Down's syndrome (trisomy of 21)
- Klinefelter's syndrome (due to additional chromosomes)

Tetrasomic (2n + 2)

Pentasomic (2n + 3)

Hypoploidy
Loss of chromosomes

Monosomic
(2n – 1)
Results in Turner's syndrome

Nullisomic
(2n – 2)
Lethal in diploid organism but survival in polyploidy.

Table: Aneuploidy resulting from nondisjunction in the human population

Chromosome nomenclature	Chromosome formula	Clinical syndrome	Estimated frequency at birth	Main phenotypic characteristics
47, + 21	$2n + 1$	Down	1/700	Short broad hands with Simian-type palmar crease, short stature, hyperflexibility of joints, mental retardation, broad head with round face, open mouth with large tongue, epicanthal fold.
47,+ 13	$2n + 1$	Patau	1/20,000	Mental deficiency and deafness, minor muscle seizures, cleft lip and/or palate, polydactyly, cardiac anomalies, posterior heel prominence.

47, + 18	$2n + 1$	Edward	1/8000	Multiple congenital malformation of many organs; low-set, malformed ears; receding mandible, small mouth and nose with general elfin appearance; mental deficiency; horseshoe or double kidney; short sternum, 90% die in the first 6 months.
45, X	$2n - 1$	Turner	1/2500 female births	Female with retarded sexual development, usually sterile, short stature, webbing of skin in neck region, cardiovascular abnormalities, hearing impairment.
47, XXY 48, XXXY 48, XXYY 49, XXXXY 50, XXXXXY	$2n + 1$ $2n + 2$ $2n + 2$ $2n + 3$ $2n + 4$	Klinefelter	1/500 male births	Male, subfertile with small testes, developed breasts, feminine pitched voice, long limbs, knock knees, rambling talkativeness.
47, XXX	$2n + 1$	Triple X	1/700	Female with usually normal genitalia and limited fertility. Slight mental retardation.

Chromosomal aberrations

The chromosomal mutations are the visible changes in the structure of chromosomes, involving changes either in the total number of genes or gene loci in a chromosome or their rearrangement. These are also known as chromosomal rearrangements or **chromosomal aberrations.**

Interchromosomal aberrations

Duplication

Duplication occurs when a segment of the chromosome is represented two or more times. The duplicated fragment may be free, with a kinetochore of its own, or it may be incorporated into a chromosomal segment of the normal complement. Duplication increases the number of genes in the genotype. It increases **genetic redundancy,** protects the organism against **harmful mutations** and allows development of **new traits.**

Translocation

Translocation is the separation of a chromosome segment and its union to a nonhomologous chromosome.In **simple translocation** one chromosome shows deletion or deficiency while a nonhomologous chromosome comes to have an additional segment. It is called **reciprocal** when segments are exchanged between nonhomologous chromosomes. Translocations may be **homozygotic,** if involving segments of two chromosomes of a pair, or **heterozygotic** if only one chromosome of a pair is translocated. When both chromosomes are broken near the kinetochore, a new chromosome may originate by **centric fusion** or **Robertsonian translocation.** The fusion creates a **metacentric chromosome** with two arms in the form of a V, and a small fragment, which tends to be eliminated.

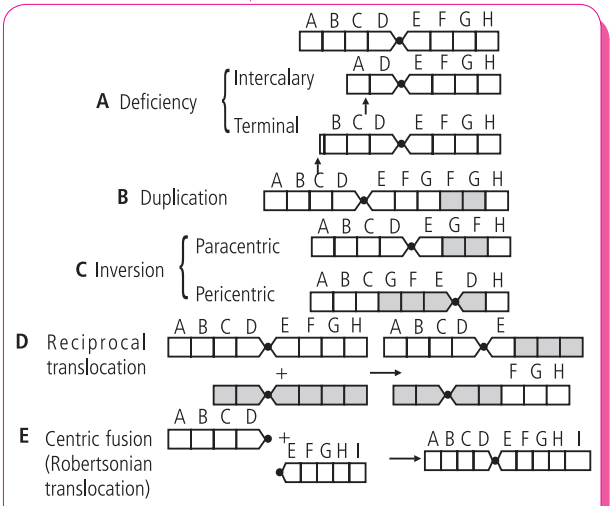


Fig.: Diagram showing some of the most frequent chromosomal aberrations.

Intrachromosomal aberrations

Deficiency or deletion

This aberration involves the loss of chromosomal material and may be either terminal (at the end of a chromosome) or intercalary (within the chromosome). The former aberration originates from a single break at the G_1 phase and the latter from two breaks. **Cri-du-chat syndrome** in humans is caused by deletion of a part of short arm of **chromosome 5.**

Inversion

An inversion is a chromosomal aberration in which a segment is inverted 180°. Inversions are called **pericentric** when the segment includes the kinetochore, and **paracentric** if the kinetochore is located outside the segment. In these aberrations there is a typical configuration at **pachynema** consisting of a loop that allows the pairing of the inverted segment. In the paracentric inversion, acentric and dicentric chromatids are formed.

Gene mutation

- **Inversion** — The base sequence of a cistron is reversed.
- **Substitution** — One base is substituted by other.
  - **Transition** — One purine is replaced by other purine and one pyrimidine is replaced by other pyrimidine.
  - **Transversion** — Purine is replaced by pyrimidine.
- **Frame shift** — Reading of the frame of base sequences shift laterally.
  - **Insertion** — One or more nucleotides are added in the segment of DNA representing cistron.
  - **Deletion** — One or more nucleotides are lost from a segment of DNA representing a cistron.

Intext Practice Questions

6. What are sex-influenced traits?
7. Differentiate between euploidy and aneuploidy.
8. How is simple translocation different from reciprocal translocation?

POWER EXERCISE

1. How many different types of genetically different gametes will be produced by a heterozygous plant having the genotype AABbCc?
   (a) Six (b) Nine
   (c) Two (d) Four
2. According to Mendelism which character shows dominance in *Pisum sativum*?
   (a) Terminal position of flower
   (b) Green colour in seed coat
   (c) Wrinkled seeds
   (d) Green pod colour
3. Mendel was lucky to work on pea plants for his experiments because
   (a) pea flowers are normally cross pollinated but can be readily self pollinated
   (b) there is no variety in pea with observable alternative form of a trait
   (c) the selected seven characters in the experiment are located on the same chromosome
   (d) the selected seven characters were located on different chromosomes.
4. Mendel's principle of segregation means that the germ cells always receive
   (a) one pair of alleles
   (b) one quarter of the genes
   (c) one of the paired alleles
   (d) any pair of alleles.
5. If round seed shape (RR) is dominant over wrinkled seed shape (rr), and yellow cotyledon is dominant (YY) over green cotyledon (yy), then in a Mendelian dihybrid cross when heterozygous round yellow seeds (RrYy) are self crossed, round green offsprings are represented by the genotype
   (a) RrYy, RrYY, RRYy (b) Rryy, RRyy, rryy
   (c) rrYy, rrYY (d) Rryy, RRyy
6. From a cross AABb × aaBb, the genotypes AaBB : AaBb : Aabb : aabb will be obtained in which of the following ratio?
   (a) 0 : 3 : 1 : 0 (b) 1 : 2 : 1 : 0
   (c) 1 : 1 : 1 : 1 (d) 1 : 1 : 1 : 0
7. In garden pea, round shape of seeds is dominant over wrinkled shape. A pea plant heterozygous for round shape of seed is selfed and 1600 seeds produced during the cross are subsequently germinated. How many seedlings would have the parental phenotype?
   (a) 400 (b) 1600
   (c) 1200 (d) 800
8. A test cross is carried out to
   (a) determine the genotype of a plant at F_2
   (b) predict whether two traits are linked
   (c) assess the number of alleles of a gene
   (d) determine whether two species or varieties will breed successfully.
9. The colour based contrasting traits in seven contrasting pairs, studied by Mendel in pea plant were
   (a) 1 (b) 2
   (c) 3 (d) 4.
10. A man having the genotype EEFfGgHH can produce P number of genetically different sperms, and a woman of genotype liLLMmNn can generate Q number of genetically different eggs. Determine the values of P and Q.
    (a) P = 4, Q = 4 (b) P = 4, Q = 8
    (c) P = 8, Q = 4 (d) P = 8, Q = 8

INFO SHOTS

Deinococcus radiodurans has been listed as world's toughest bacterium in 'The Guinness Book of World Records' because of its extra-ordinary resistance to extreme environments. It is the most radiation resistant known organism and has the ability to rapidly repair its genome if damage occurs somehow. Its evolution on Earth is a debate for scientists and some even believe it to be of Martian origin.

11. When both alleles express their effect on being present together, the phenomenon is called
(a) dominance
(b) codominance
(c) pseudodominance
(d) amphidominance.

12. Complementary genes were first studied by _____, in 1906, in case of flower colour of _____.
(a) Bateson and Punnet, *Lathyrus odoratus*
(b) Bateson and Punnet, *Pisum sativum*
(c) Morgan, *Drosophila*
(d) Sturtevant, *Drosphila*

13. In *Mirabilis jalapa*, when red colour flowers were crossed with white flowers, pink colour flowers were obtained. It was due to
(a) epistasis
(b) complete dominance
(c) crossing over
(d) incomplete dominance.

14. Pleiotropy occurs when a gene has
(a) a complementary gene elsewhere
(b) a small effect on one trait
(c) reversible effects on the phenotype, depending on age
(d) many effects on the phenotype.

15. Haemophilia is more commonly seen in human males than in human females because
(a) a greater proportion of girls die in infancy
(b) this disease is due to a Y-linked recessive mutation
(c) this disease is due to an X-linked recessive mutation
(d) this disease is due to an X-linked dominant mutation.

16. Which of the following shows linkage group in coupling phase?
(a) $\frac{A}{a}\frac{B}{b}$ (b) $\frac{A}{a}\frac{b}{B}$
(c) $\frac{A}{a}\frac{b}{b}$ (d) $\frac{a}{a}\frac{B}{b}$

17. The ABO blood grouping in human beings is an example of
(i) Dominance (ii) Incomplete dominance
(iii) Co-dominance (iv) Multiple alleles
(a) (i) and (ii) only (b) (ii), (iii) and (iv)
(c) (i), (iii) and (iv) (d) (ii) and (iii) only

18. Trisomy and monosomy is represented respectively by
(a) $2n-1$ and $2n+1$ (b) $2n+1$ and $2n-1$
(c) $2n$ and $2n+1$ (d) $2n$ and $2n-1$

19. The mutation of the type in which a part or the complete gene is removed from the genome is called
(a) deletion (b) inversion
(c) duplication (d) translocation.

20. Due to nondisjunction of chromosomes during spermatogenesis, some sperms carry both sex chromosomes (22A + XY) and some sperms do not carry any sex chromosome (22A + O). If these sperms fertilise normal eggs (22A + X), what types of genetic disorders appear among the offsprings?
(a) Turner's syndrome and Klinefelter's syndrome
(b) Down's syndrome and Klinefelter's syndrome
(c) Down's syndrome and Turner's syndrome
(d) Down's syndrome and Cri-du-chat syndrome

ANSWER KEY

1.	(d)	**2.**	(d)	**3.**	(d)	**4.**	(c)	**5.**	(d)
6.	(b)	**7.**	(c)	**8.**	(a)	**9.**	(c)	**10.**	(b)
11.	(b)	**12.**	(a)	**13.**	(d)	**14.**	(d)	**15.**	(c)
16.	(a)	**17.**	(c)	**18.**	(b)	**19.**	(a)	**20.**	(a)

☺☺

UNSCRAMBLED WORDS

MAY 2016

1. RAMENTA	2. NONDISJUNCTION
3. INVOLUTION	4. OPSONINS
5. KINESIOLOGY	6. THELYTOKY
7. ARYTENOID	8. ANAMORPH
9. BIOLISTIC	10. PROLINE

Winners : *Debasrija Mondal (West Bengal), Soumyajit Sahoo (Odisha), Sandra Sanjana (Kerala), Jeevan Jose Kalan (Kerala), Swarnendu Acharjee*

ANSWERS — WHO AM I ...

1. Pneumotaxic centre — Pg. 26
2. Pleiotropic gene — Pg. 42

NEET ESSENTIAL

The syllabus for NEET is very vast which impedes students from acquiring indepth knowledge and covering the entire syllabus at the same time. An *essential topic for NEET* is therefore presented here to enable students grasp the topic, analyse the type of questions and SCORE HIGH.

REPRODUCTION IN PLANTS AND ANIMALS

■ REPRODUCTION IN ORGANISMS ■ SEXUAL REPRODUCTION IN FLOWERING PLANTS

The period from birth to the death of an organism is called its life span. Life span of an organism may be few minutes to several thousand years.

Life span of an organism usually includes four stages – (i) **Juvenility :** During this stage organism develops the capacity to reproduce. (ii) **Maturity :** Reproduction begins during this stage. (iii) **Ageing** and **senescence :** Ageing is progressive deterioration in the body of the organisms. The terminal irreversible stage of ageing is called senescence. (iv) **Death :** Senescence finally leads to death.

REPRODUCTION

Reproduction is one of the fundamental characteristics of living organisms. Reproduction is defined as a biological process in which an organism gives rise to young ones (offspring) similar to itself. The offspring grow, mature and in turn produce new offspring. Thus, there is a cycle of birth, growth and death.

Reproduction is essential for the continuation of the line of succession and maintenance of a particular species in the biosphere. The reproduction methods are broadly categorised into 2 types namely – **asexual reproduction** and **sexual reproduction**.

ASEXUAL REPRODUCTION

Asexual reproduction is the production of offspring by a single parent without the formation and fusion of gametes. The offspring receive all their genes from one parent, so are identical to each other as well as to the parent. Asexual reproduction involves only mitotic division. Types of asexual reproduction have been discussed in the flow chart given on next page.

Types of asexual reproduction

Budding

Daughter individual is formed from a small part or bud, arising from parent body. In animals it is of three types:

(i) **Exogenous budding :** The bud grows externally on the surface of parent body. It may split away from the parent, *e.g., Hydra* or remain attached to it, *e.g., Sycon*. In yeast, bud is formed on one side of the parent cell and soon it separates and grows into a new individual.

(ii) **Endogenous budding :** The buds are formed within the parent's body. They are called **gemmules** which consist of small group of cells in a protective covering, *e.g., Spongilla*.

(iii) **Strobilation :** The repeated formation of similar segments by the process of budding is called strobilation. The segmented body is called a **strobila** larva and each segment is called an **ephyra** larva, *e.g., Aurelia*.

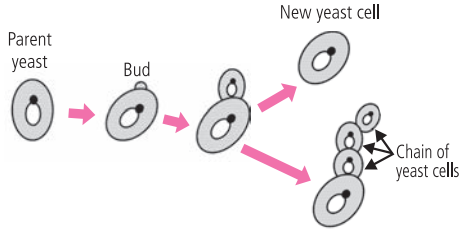


Fig.: Budding in yeast

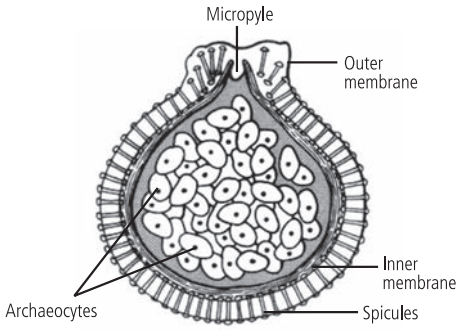


Fig.: Gemmule of *Spongilla*

Gemmae

These are unicellular or multicellular propagules which develop in small receptacles called gemma cups. They detach from the parent and grow into new individuals, *e.g., Marchantia*.

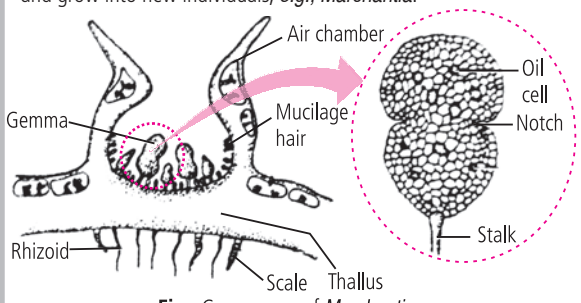


Fig.: Gemma cup of *Marchantia*

Fission

It is the division of the parent body into two or more daughter individuals identical to the parent. It is of 3 types: **binary fission**, *e.g., Amoeba*, **multiple fission**, *e.g., Plasmodium* and **plasmotomy**, *e.g., Opalina*.

Fragmentation

In this, the parent body breaks into two or more fragments. Each fragment develops into a new organism. Examples: - *Spirogyra*, sponges, echinoderms, etc.

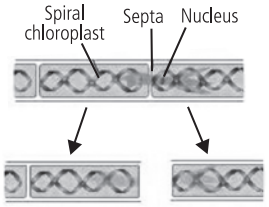


Fig.: Fragmentation in *Spirogyra*

Regeneration

Regeneration is the regrowth in the injured region. It is of two types: (i) **Morphallaxis :** The whole body is formed from a small fragment, *e.g., Hydra*. (ii) **Epimorphosis :** It is the replacement of lost body part. It can be **reparative** (only certain damaged tissues regenerate) or **restorative** (several body parts can redevelop, *e.g.,* broken tail of wall lizard).

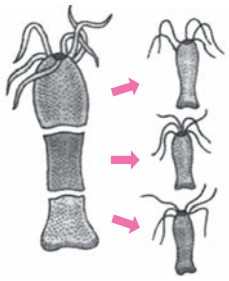


Fig.: Regeneration in *Hydra*

Spore formation

Spores are microscopic, single-celled, thin or thick walled propagules which develop asexually on the parent body. Spores can be of various types *viz.* **zoospores** (motile and flagellated, *e.g., Chlamydomonas*), **conidia** (non-motile and produced exogenously *e.g., Penicillium*), **chlamydospores** (thick-walled and non-motile *e.g., Rhizopus*), **oidia** (small, thin-walled fragments, *e.g., Agaricus*) and **sporangiospores** (non-motile endospores *e.g., Mucor*).

Vegetative propagation

The formation of new plants from vegetative plant parts is known as vegetative propagation. Methods of vegetative propagation have been summarised in the flow chart given on next page.

Methods of vegetative propagation

Natural methods

Propagation by roots

Tap roots of some plants develop adventitious buds to form new plants, *e.g., Dalbergia*. In some plants like sweet potato and *Dahlia*, root tubers develop adventitious buds which develop into new plants.

Propagation by stems

Certain stem modifications take part in vegetative propagation such as **tubers** (have buds over their nodes or eyes which produce new plantlets when placed in the soil, *e.g.*, potato), **bulbs** (underground condensed shoots with buds which form new plants, *e.g.*, onion), **corms** (unbranched swollen underground stems with circular nodes having buds which germinate into new plants, *e.g.*, *Colocasia*), **rhizomes** (main underground stems with buds which give rise to new aerial shoots during favourable conditions, *e.g.*, ginger), **suckers** (slender subaerial branches which develop from base of aerial shoot, breaking forms new plants, *e.g.*, mint), **runners** (narrow horizontal branches which develop at the base of crown and root at intervals, breaking helps in vegetative propagation, *e.g.*, *Cynodon*), **stolons** (arched horizontal branches which develop at the base of crown, breaking results in formation of new plant, *e.g.*, strawberry) and **offsets** (one internode long runners breaking helps in propagation, *e.g.*, *Eichhornia*).

Propagation by leaves

Leaves of many plants have adventitious buds. Such leaves when fall on the ground, their buds develop root and mature into individual plants, *e.g.*, *Bryophyllum*, *Begonia* etc.

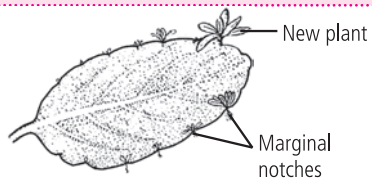


Fig.: Leaf of *Bryophyllum*

Propagation by turions and bulbils

A **turion** is a swollen bud which contains stored food. It detaches from the parent plant and germinates under favourable conditions *e.g.*, *Utricularia*.

Bulbils are multicellular fleshy buds that take part in vegetative propagation, *e.g.*, *Oxalis*, *Agave* etc.

Fig.: Bulbil of *Agave*

Artificial methods

Cuttings

These are cut pieces of plant parts which are planted in the nurseries. These can be:

(i) **Root cuttings –** The pieces of roots are used to artificially propagate new plants, *e.g.*, lemon, orange etc.

(ii) **Stem cuttings –** 20-30 cm long pieces of one year old stems are cut and planted. Before planting they are treated with root promoting chemicals like IBA, *e.g.*, rose, sugarcane etc.

(iii) **Leaf cuttings –** Leaves are cut transversely into 2-3 parts and planted in vertical position in the soil, *e.g.*, *Sansevieria* and *Saintpaulia*.

Layering

In this method, adventitious roots are induced to develop on a soft stem by defoliating the soft basal branch and a small injury or cut is given. The injured defoliated part is pegged in the soil to develop adventitious roots. The pegged down branch of the plant is called layer. Once the roots develop, the layer is separated and planted. It can be of following types: **mound** layering, **gootee** or **air** layering, **simple** layering, **serpentine** layering and **trench** layering.

Fig.: Propagation by layering

Grafting

Grafting is a technique of connecting two plant parts, usually a root system and a shoot system of two different plants in such a way that they unite and later develop as a composite plant. A small shoot of plant with superior characters is employed as graft or **scion**. The root system of the other plant which is disease resistant and has good root system is used as **stock** (not successful in monocots). It is done in mango, apple etc. The various techniques of grafting are **tongue** grafting, **crown** grafting, **wedge** grafting, **side** grafting, **approach** grafting and **bud** grafting.

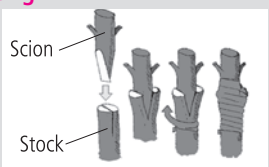


Fig.: Grafting process

Micropropagation

This method includes propagation of plants by culturing the cells, tissues and organs. This is known as tissue culture. The culturing results in formation of callus, an undifferentiated mass of cells which later differentiates to form a large number of plantlets. It is useful in obtaining virus free plants, disease free plants, homozygous diploids and quick commercial production of orchids, *Carnation*, *Gladiolus* etc.

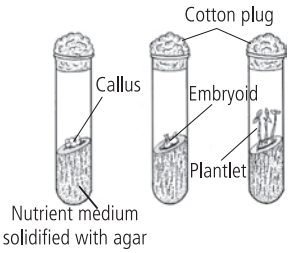


Fig.: Micropropagation

Special modes of reproduction

Parthenogenesis

Development of an egg (ovum) into a complete individual without fertilisation by a sperm is known as **parthenogenesis**. It occurs in its natural course in many invertebrates. Natural parthenogenesis may be complete or incomplete.

Complete parthenogenesis occurs in those animals which breed exclusively by parthenogenesis and sexual reproduction is not known in them. **Incomplete parthenogenesis** occurs in those animals which reproduce both sexually as well as parthenogenetically.

Based on the sex of offspring, parthenogenesis can be of following three types: (i) **Arrhenotoky** (only males are produced by parthenogenesis) (ii) **Thelytoky** (only females are produced by parthenogenesis) (iii) **Amphitoky** (parthenogenetic egg may develop into individual of any sex *i.e.*, male or female).

In artificial parthenogenesis the egg (ovum) is induced to develop into a complete individual by artificial stimuli which may be physical or chemical.

Neoteny

When the larva retains adult characters such as gonads and starts producing young ones by sexual reproduction, it is called **neoteny.** It occurs in the **axolotl** larva of *Ambystoma* - tiger salamander.

SEXUAL REPRODUCTION

Sexual reproduction is the process of development of new individuals through the formation and fusion of gametes. It is also called **amphimixis**.

Types

Syngamy

It is the complete and permanent fusion of male and female gametes to form the zygote .

On the basis of source of fusing gametes

Endogamy

It is the fusion of male and female gametes of the same parent, hence, uniparental *e.g.*, *Taenia*.

Exogamy

It is the fusion of two gametes produced by different parents, hence, biparental*e.g.*, Rabbit.

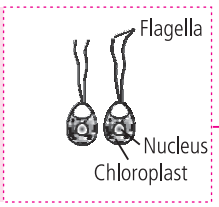
Conjugation

A process of sexual reproduction in which organisms of the same species temporarily couple and exchange or in some cases transfer their genetic material. It takes place in *Paramoecium*, *Spirogyra*, bacteria etc.

On the basis of structure of fusing gametes

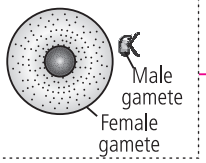
Isogamy

It involves the fusion of gametes which do not differ morphologically but may be different physiologically. It takes place in *Chlamydomonas.*



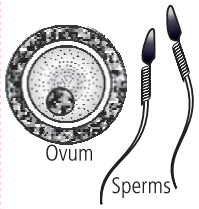
Anisogamy

It involves the fusion of gametes which differ in size or form. It takes place in *Chlamydomonas*, red algae etc.



Oogamy

It involves the fusion of large non-motile female gamete and a small motile male gamete. It takes place in some algae, vertebrates including human beings and higher invertebrates.



Hologamy

It involves the fusion of two organisms. It occurs in yeasts.

MPP-1 CLASS XI ANSWER KEY

1.	(a)	2.	(d)	3.	(a)	4.	(d)	5.	(d)	6.	(b)	7.	(b)	8.	(d)	9.	(a)	10.	(b)
11.	(c)	12.	(a)	13.	(a)	14.	(c)	15.	(d)	16.	(d)	17.	(d)	18.	(d)	19.	(c)	20.	(b)
21.	(c)	22.	(c)	23.	(b)	24.	(b)	25.	(b)	26.	(d)	27.	(a)	28.	(c)	29.	(c)	30.	(a)
31.	(a)	32.	(b)	33.	(c)	34.	(c)	35.	(d)	36.	(b)	37.	(a)	38.	(c)	39.	(d)	40.	(a)

Events in sexual reproduction

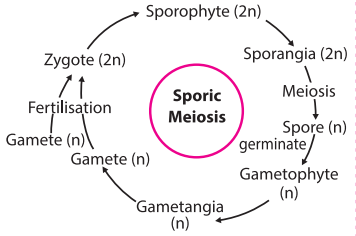
Pre-fertilisation events

These events of sexual reproduction take place before the fusion of gametes. These include :

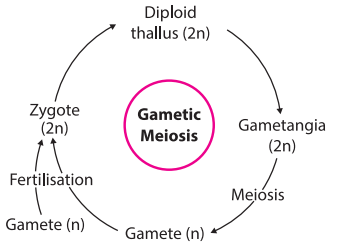
Gametogenesis

It is the formation of gametes. Gametes can be **isogametes** (morphologically similar) or **heterogametes** (morphologically dissimilar). Gametes are formed as a result of meiosis which can be of three types:

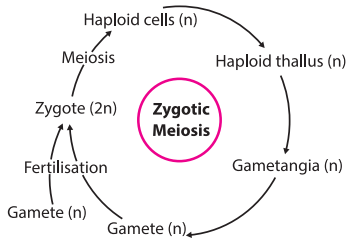
Sporic meiosis occurring inside the sporangia



Gametic meiosis occurring in the germinal cell



Zygotic meiosis occurring in the zygote



Gamete transfer

It is the transfer of gametes to bring them together for fertilisation. In algae, bryophytes and pteridophytes water serves as the medium. In flowering plants it is done by pollination. Animals have copulatory organs to transfer male gametes.

Fertilisation

It is the complete and permanent fusion of two gametes from different or same parent to form a diploid zygote (syngamy). It can be of two types.

External fertilisation

When fertilisation occurs outside the body of the organism, it is called external fertilisation or external syngamy. It requires an external medium such as water, *e.g.*, bony fish and amphibians.

Internal fertilisation

When egg is retained inside female body where it fuses with the male gamete, the process is called internal fertilisation or internal syngamy, *e.g.*, reptiles, birds, mammals, etc.

Embryogenesis

During embryogenesis zygote undergoes mitotic cell division and cell differentiation. On the basis of development of zygote, animals can be **oviparous** (egg- laying; zygote develops outside the female body) *e.g.*, all birds, most reptiles etc., **viviparous** (zygote develops inside the female body) *e.g.*, mammals (except egg laying mammals) or **ovoviviparous** (retains egg inside; zygote development is internal) *e.g.*, shark.

In flowering plants, zygote is formed inside the ovule.

After fertilisation the ripened ovary forms the fruit. The ovules mature and get converted into seeds. The ovary wall produces pericarp which protects the seeds.

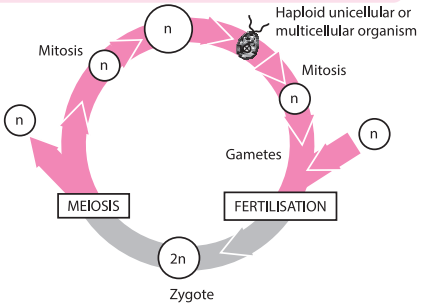
Post-fertilisation events

It includes development of zygote and embryogenesis.

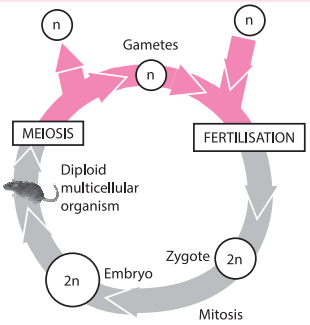
Development of zygote

The zygote formed by fusion of two gametes is always diploid. It is a link between one generation and next generation. The development of zygote depends upon the type of life cycle of the organisms and environmental conditions. There are three types of life cycles:

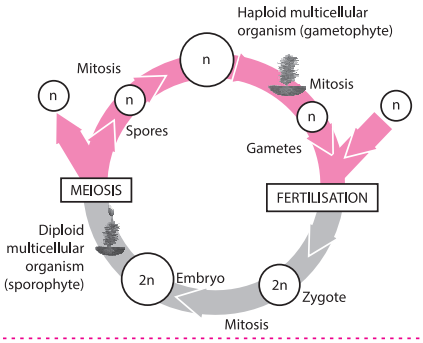
Haplontic life cycle occurs in many algae and fungi



Diplontic life cycle occurs in higher animals and seed bearing plants



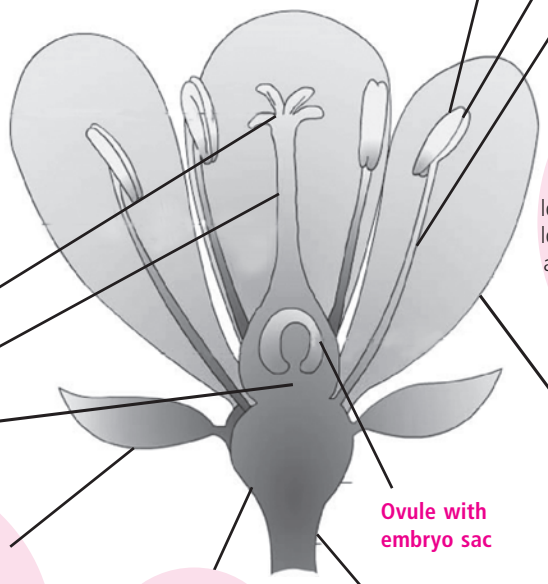
Diplohaplontic life cycle occurs in bryophytes, pteridophytes and some algae.



SEXUAL REPRODUCTION IN FLOWERING PLANTS

In angiosperms, the main sporophytic plant body (2n) bears flowers during reproductive phase. **Flower** is concerned with sexual reproduction. It is a modified shoot (shoot of determinate growth) with highly condensed internodes and leaves specialised variously to act as different floral parts or organs. A complete flower consists of four whorls of floral appendages attached on receptacle - **calyx, corolla, androecium** and **gynoecium**.

Parts of a typical flower



Carpel / Pistil
Carpels constitute the fourth and the innermost floral whorl, **gynoecium**. Carpel is the female reproductive organ of a flower. A typical carpel comprises a basal swollen **ovary** with a terminal **style** surmounted with **stigma**. Ovary contains one or more **ovules**, each enclosing embryo sac.

Stamen
Stamens constitute the third floral whorl, **androecium**. Stamen is the male reproductive organ of flower. It consists of long slender sterile filament and upper swollen fertile anther. 2 lobed anther is called **dithecous** while one lobed anther is called **monothecous**. The two anther lobes are attached to each other on back side by **connective** (sterile parenchymatous tissue with vascular strand). Anther bears pollen sacs filled with pollen grains (microspores).

Sepal
Sepals are generally green or inconspicuously coloured and more or less foliaceous in texture serving primarily to protect flower in its bud stage. They constitute the outermost floral whorl, **calyx**. When sepals are fused together calyx is called as **gamosepalous** and when they are free, calyx is called **polysepalous**.

Receptacle
Swollen end of axis to which floral leaves are attached

Pedicel
Stalk of flower

Petal
Petals are mostly brightly coloured and often differentiated into a narrow basal part, **limb** and flat expanded part, **claw**. Their main function is to attract insects for pollination. They constitute the second floral whorl called **corolla**. Corolla with free petals is called **polypetalous** whereas corolla with fused petals is called **gamopetalous**.

Structure of anther

Epidermis
It is the outermost wall layer of anther which is protective in function. In mature anther the epidermal cells are tangentially stretched and flattened.

Middle layers
The cells of these layers are ephemeral and degenerate in the mature anther.

Tapetum
It is the innermost layer of anther wall which completely surrounds the sporogenous tissue. The cells of tapetum are relatively large and centripetally extended having dense cytoplasm and prominent nuclei. Tapetum provides nourishment to the developing microspores, secretes callase enzyme, secretes sporopollenin coated übisch bodies and pollen kitt.

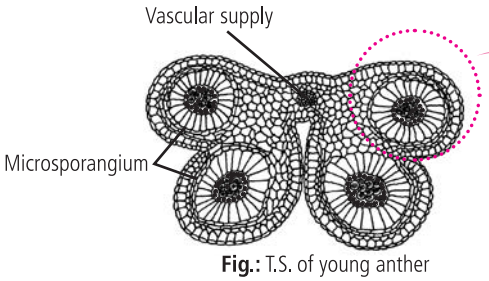


Fig.: T.S. of young anther

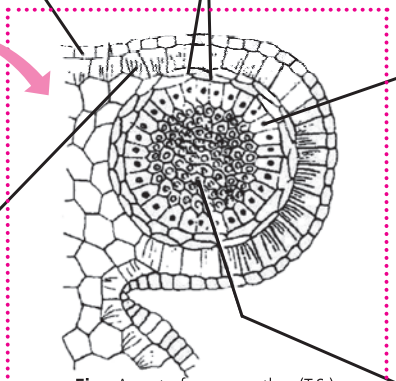


Fig.: A part of young anther (T.S.) magnified to show structural details

Endothecium
Endothecium is sub-epidermal layer of anther wall which is mostly single layered but may become multilayered. The radial and tangential walls of these cells have characteristic thickening bands. The presence of fibrous bands, differential expansion of inner and outer tangential walls and hygroscopic nature of endothecial cells play an important role in the dehiscence of anthers.

Sporogenous tissue
Sporogenous tissue fills the whole interior of microsporangium. The cells of sporogenous tissue transform into pollen mother cells (PMC) and give rise to microspores or pollen grains.

Microsporogenesis

The process of formation of microspores from sporogenous tissue is known as **microsporogenesis**. The sporogenous cells may directly function as **microspore mother cells** (also called **pollen mother cells** or **PMCs**) or they may undergo a few mitosis to add up to their number before entering meiosis. Each PMC, by a meiotic division, gives rise to a group of four haploid microspores. Aggregates of four microspores are referred to as **microspore tetrads**. In some cases, one microspore is formed from one pollen mother cell, *e.g.*, Family Cyperaceae.

Usually the arrangement of microspores in a tetrad is **tetrahedral** or **isobilateral**, however **decussate** (*e.g.*, *Magnolia*, *Atriplex*), **linear** (*e.g.*, *Halophila*) and **T-shaped** (*e.g.*, *Aristolochia*) tetrads are also found.

In members of Asclepiadaceae and Orchidaceae, all the pollens of an anther lobe are packed in a bag like structure called **pollinium**. In certain members of Family Orchidaceae, the pollinium is less compact and comprises smaller loose groups of pollen grains termed as **massulae**. When 4 pollens of a tetrad do not separate and remain attached, they are known as **compound pollen grains** (*e.g.*, *Drimys*, *Jatropha*). **Polyspory** is the occurrence of more than 4 spores in a pollen tetrad, *e.g.*, *Cuscuta reflexa*.

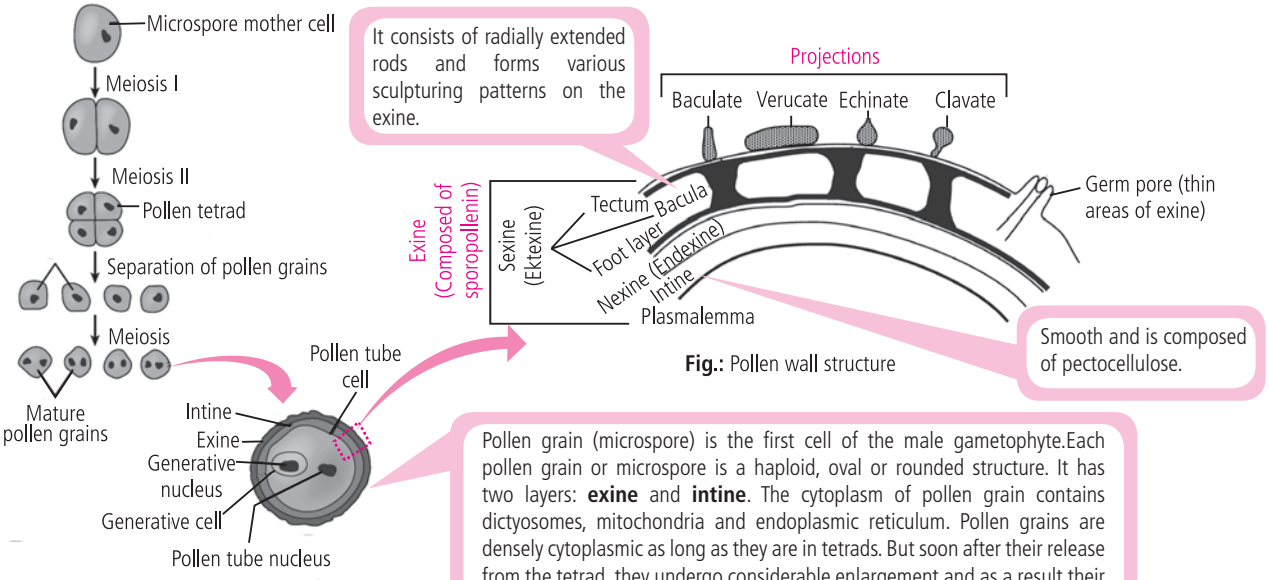


Fig.: Pollen wall structure

Fig.: Microsporogenesis and section of mature pollen grain containing 2-celled male gametophyte

Stages in development of male gametophyte

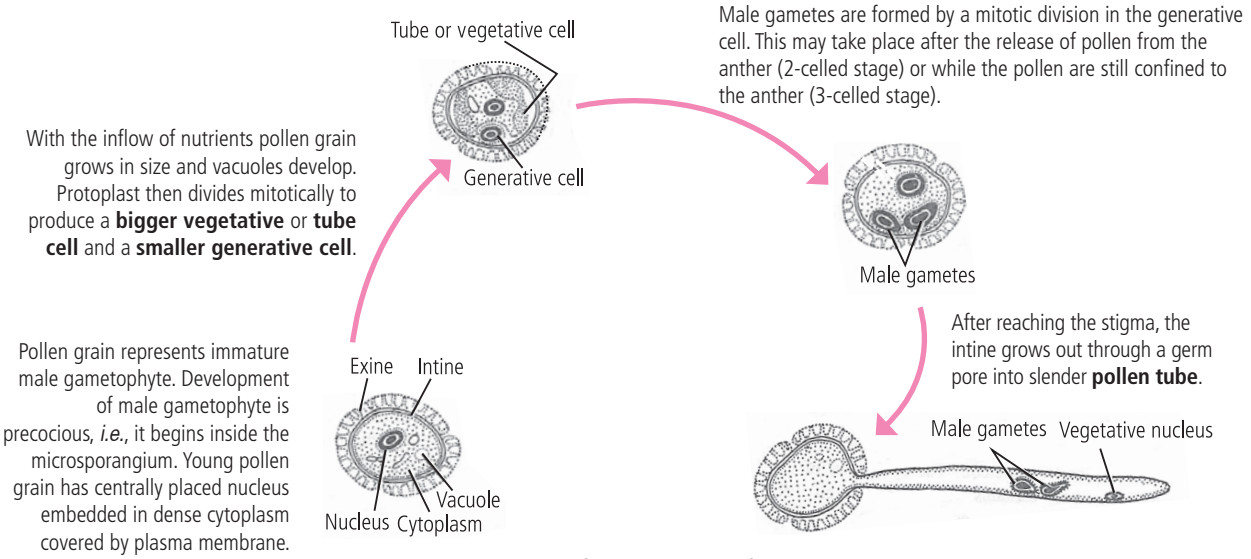


Fig.: Successive stages of the development of male gametophyte

Structure of ovule

The ovary contains one or more round or oval bodies, known as the **ovule**. It is also known as integumented megasporangium and develops from the base or the inner surface of the ovary. Each ovule contains a large oval cell known as the **embryo sac**. The ovary gives rise to the fruit and ovules give rise to the seeds after fertilisation.

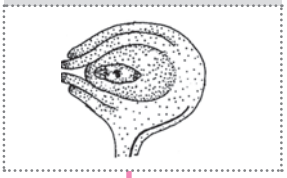
Ovule having single integument is called **unitegmic ovule**. It is common in Gamopetalae. Ovule having 2 integuments is called **bitegmic ovule**, *e.g.*, members of Polypetalae and monocots. When nucellus is not surrounded by integuments, the ovule is called **ategmic**, *e.g.*, *Santalum album*, *Loranthus*.

Types of ovule

Orthotropous ovule
Micropyle, chalaza and funiculus lie in a same straight line, *e.g.*, Family Polygonaceae and Piperaceae.

Anatropous ovule
Most common type of ovule found in angiosperms. Micropyle is on lower side. Further micropyle and funiculus lie side by side and micropyle is close to hilum.

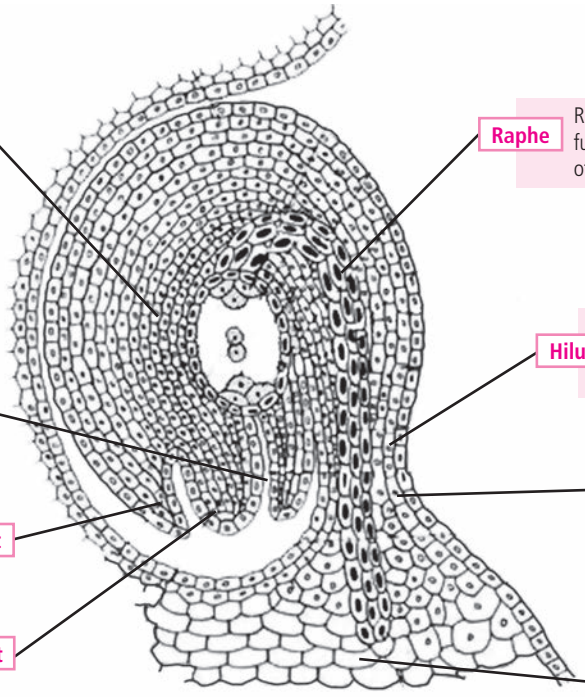
Hemianatropous ovule
Nucellus and integuments (*i.e.*, body of ovule) are at right angle to stalk or funiculus, *e.g.*, Primulaceae and Ranunculaceae.



Campylotropous ovule
Micropyle is not in line with chalaza and funicle lies at right angles to chalaza, *e.g.*, Capparidaceae, Chenopodiaceae, etc.

Amphitropous ovule
Curvature is observed both in the body of ovule and embryo sac. The embryo sac assumes horse shoe-shape, *e.g.*, in Papaveraceae, Alismataceae and Butomaceae, etc.

Circinotropous ovule
The funiculus takes a complete round around the body of ovule. Found in Family Cactaceae, *e.g.*, *Opuntia*.



Nucellus or megasporangium
Mass of parenchymatous cell. Nucellus may be quite massive (crassinucellate ovule) or thin (teninucellate ovule).

Raphe
Ridge formed by fusion of funiculus with the main body of ovule.

Hilum
The place of attachment of funiculus with the main body of ovule.

Small opening at the apex of integuments. **Micropyle**

Funiculus
Stalk through which ovule is attached to placenta.

Integuments
Membranes enclosing the nucellus

Outer integument

Inner integument

Placenta
Parenchymatous cushion

Fig.: L.S. of a typical ovule of angiosperm

Megasporogenesis and development of female gametophyte

(i) Formation of megaspore (n) from megaspore mother cell (2n) inside the ovule is called **megasporogenesis**.

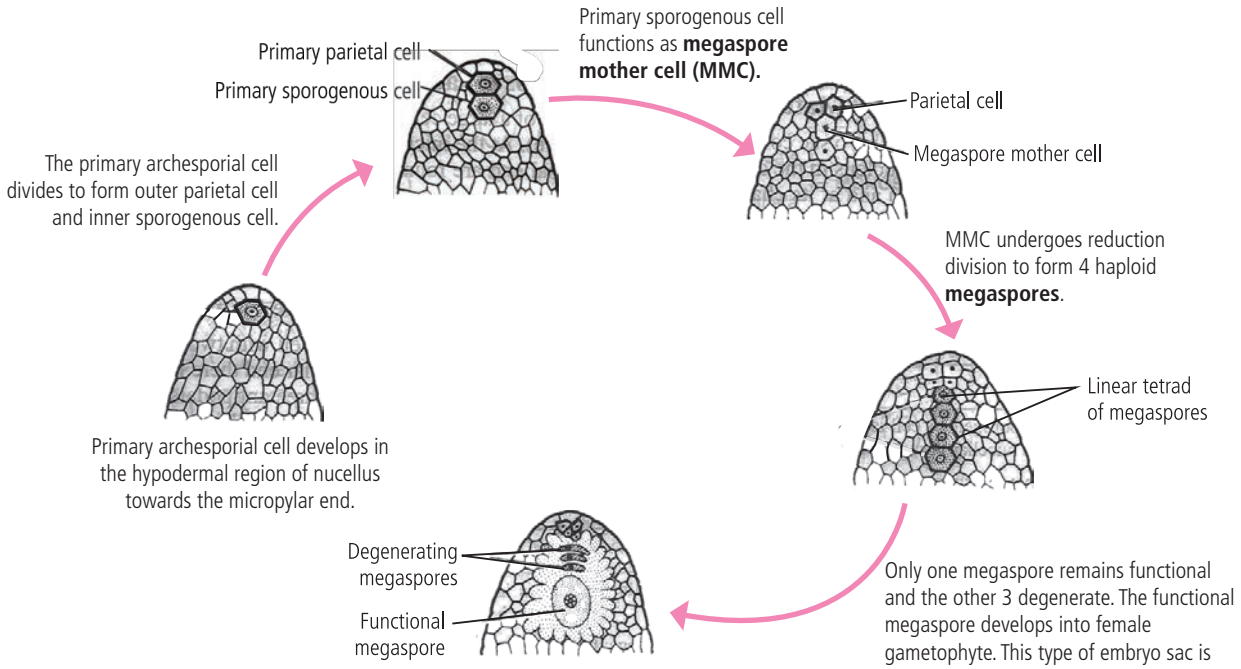


Fig.: Different stages of megasporogenesis

(ii) Development of female gametophyte or embryo sac is as follows:

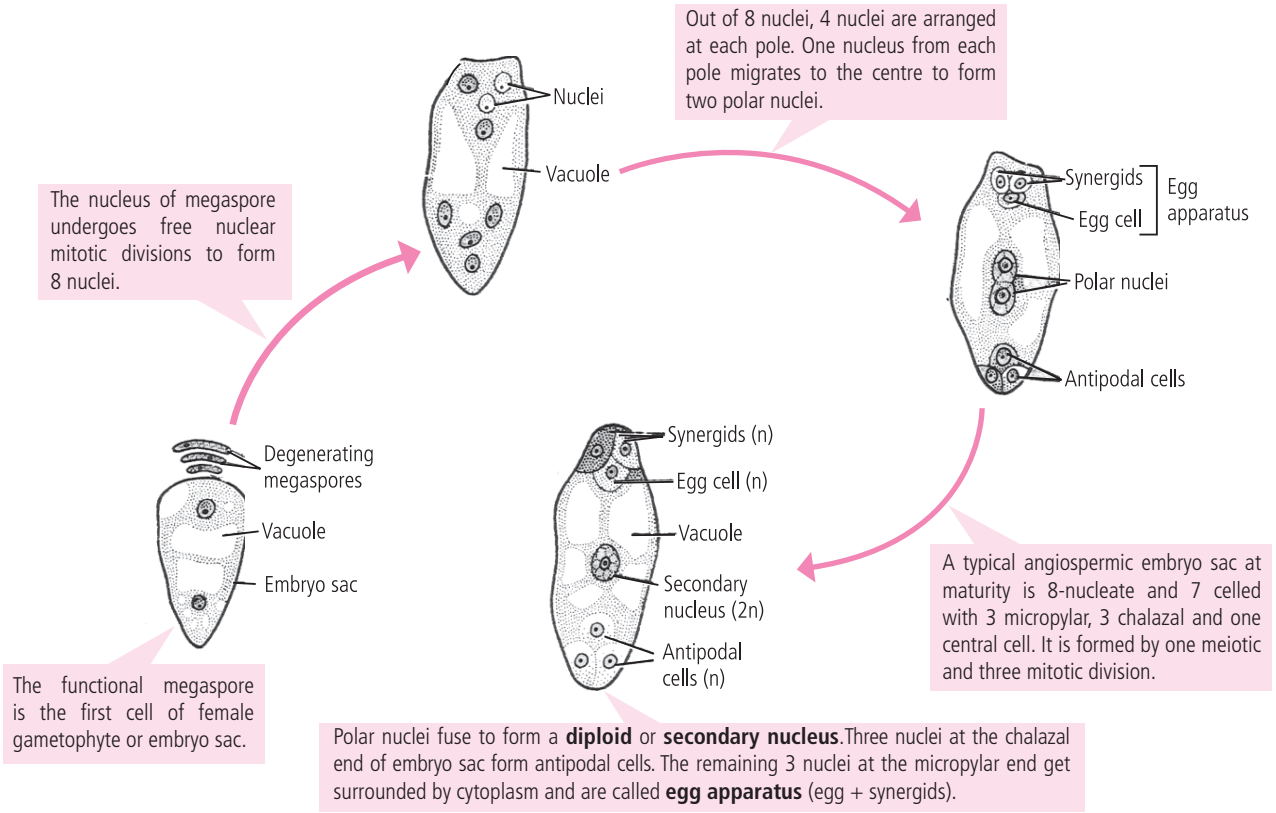


Fig.: Development of embryo sac (female gametophyte)

Typical *Polygonum* type of embryo sac

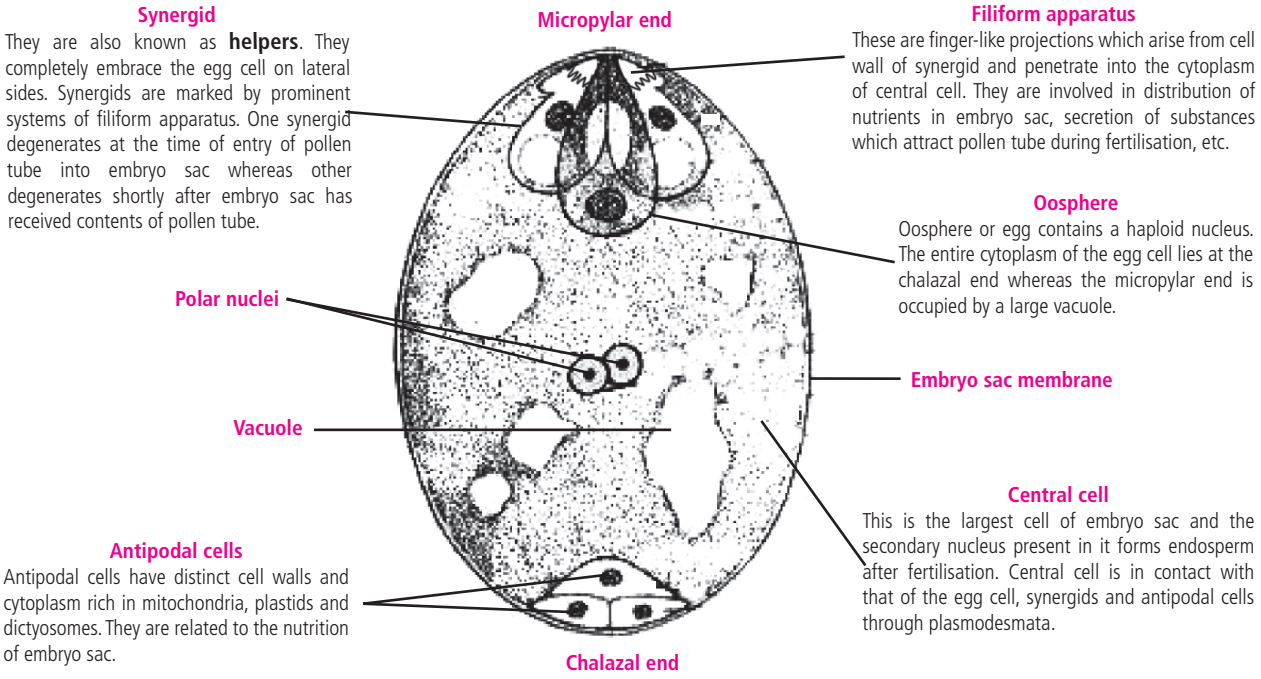


Fig.: *Polygonum* type of embryo sac

Pollination

The transfer of pollen grains from anther to stigma of a flower is called pollination. Pollination in angiosperms generally takes place at **2-celled stage** (rarely 3-celled stage) of microspores or pollen, *i.e.*, pollen having vegetative cell and generative cell.

If the pollen grains are transferred to the micropyle of the ovule directly, the pollination is called **direct pollination**, *e.g.*, gymnosperms. Since the ovules are enclosed in the ovary in angiosperms, the pollination is called **indirect pollination**. Pollination is of 2 types: self pollination (autogamy and geitonogamy) and cross pollination (xenogamy).

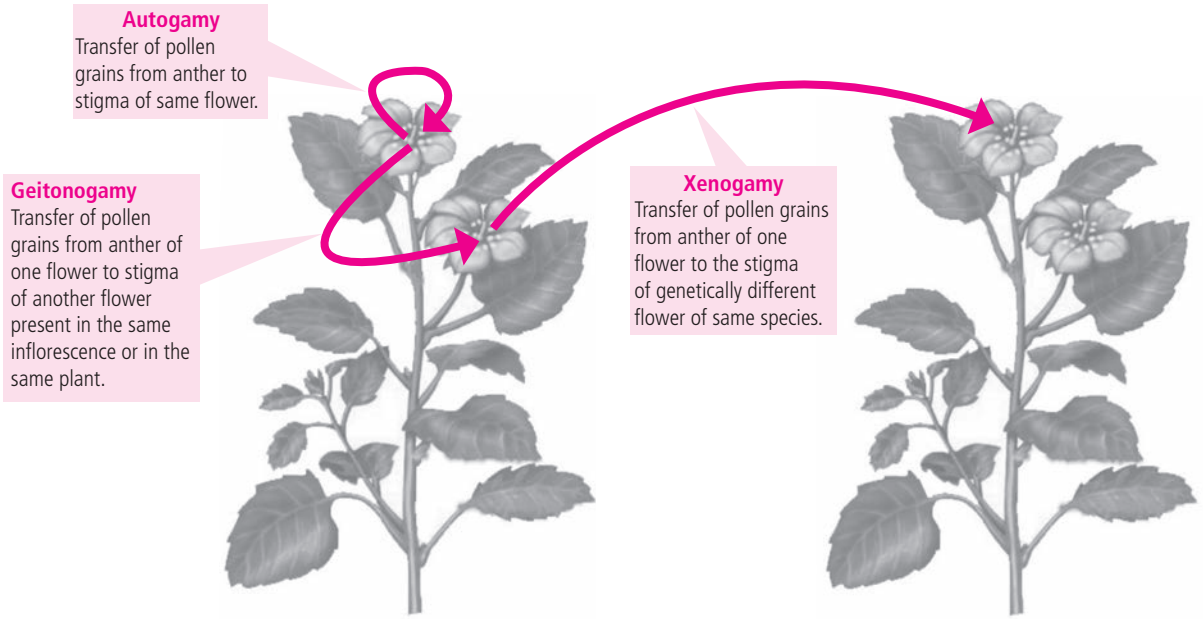


Fig.: Types of pollination

Self pollination

Advantages

- It maintains the parental characters or purity of the race indefinitely.
- It is used to **maintain pure lines** for hybridisation experiments.
- Flowers need not develop devices for attracting insect pollinators.
- It ensures seed production.

Disadvantages

- New useful characters are seldom introduced.
- Vigour and vitality of the race decreases with prolonged self pollination.
- Immunity to diseases decreases.
- Variability and hence adaptability to changed environment is reduced.

Cross pollination

Advantages

- It introduces **genetic recombinations** and hence variations in the progeny.
- It increases the adaptability of the offspring towards changes in the environment.
- The offspring have characters better than the parents due to the phenomenon of **hybrid vigour**.
- The plants produced are more resistant to diseases.
- New and more useful varieties can be produced through cross pollination.
- The defective characters of the race are eliminated and replaced by better characters.

Disadvantages

- It is **highly wasteful** because plants have to produce a large number of pollen grains and other accessory structures in order to suit the various pollinating agencies.
- Some undesirable characters may creep in the race.

Contrivances of self pollination

Homogamy
Condition in which male and female reproductive parts of a bisexual flower mature at the same time.

Bisexuality
It corresponds to occurrence of both male and female sex organs in a flower.

Movement of floral parts
In some flowers with epipetalous stamens, the petals may move to make anthers contact stigma.

Cleistogamy
Condition in which flower never opens thus self pollination takes place, *e.g., Commelina.*

Contrivances of cross pollination

Dichogamy
A condition where male and female sex organs of a flower mature at different times *viz.* **protandry** when anthers mature earlier than gynoecium, *e.g., Helianthus, Tagetes* and **protogyny** when gynoecium matures earlier than the anther, *e.g., Gloriosa, Plantago.*

Self incompatibility
It refers to failure of pollen to germinate on the stigma of same flower due to physiological or genetic reasons, *e.g.,* tobacco.

Herkogamy
It is the presence of natural or physical barriers between androecium and gynoecium of a bisexual flower *e.g.,* in *Calotropis,* pollen grains occur in pollinia which can be lifted by insects only.

Heterostyly
Occurrence of two or more types of flower with regard to length of style and stamens *viz.* **pin eyed** (short stamen and long style), **thrum eyed** (long stamen and short style), *e.g., Primula.*

Table : Agents of cross pollination	
Abiotic agents	**Anemophily**
	The pollination taking place by means of wind is known as **anemophily.** *E.g., Zea mays* (maize), grasses, mulberry, date palm, *Salix, Cannabis* etc. Wind pollinated flowers have following features: – Non-essential whorls such as calyx, corolla, bracts and bracteoles are not showy. – Flowers are devoid of scent and nectar. – Both the stigmas and anthers are exserted. – Pollen grains are dry, very small sized, non-sticky and unwettable, so that they can be carried by wind to long distances. – Stigma is hairy, feathery (grasses) or branched to catch the wind borne pollens.
	Hydrophily
	Pollination which occurs with the help of water is called **hydrophily**. Water pollinated flowers have following features: – Flowers are inconspicuous and small. – Odour, nectar and colour is absent in flowers. – Flower whorls, if present are coated with wax. – Pollen grains are small, light weighted, non-sticky and coated with wax. – Stigma is unwettable but sticky. **Hypohydrophily** occurs below the surface of water, *e.g., Ceratophyllum, Najas, Zostera*. **Epihydrophily** takes place over the surface of water, *e.g., Potamogeton, Vallisneria*, etc.
Biotic agents	**Entomophily**
	Pollination by insects is called **entomophily**. Insect-pollinated flowers produce **nectar** which attracts the pollinators for feeding. Some flowers produce **edible pollen grains.** Flowers are **fragrant** and emit scent and odour. Flowers are **bright coloured.** The pollen grains are spiny, heavy and surrounded by a yellow sticky substance called pollenkitt.
	Ornithophily
	Pollination by birds is called ornithophily. Ornithophilous flowers have tubular (*Nicotiana glauca*), cup-shaped (*Callistemon*) or urn-shaped (some members of Ericaceae) corollas. Ornithophilous flowers are large sized, brightly coloured, usually odourless and they produce a large amount of mucilagenous nectar for birds to drink. *E.g., Strelitzia reginae* is pollinated by sun birds.
	Chiropterophily
	Pollination of flowers performed by bats is called **chiropterophily**. Bat pollinated flowers are dull-coloured with strong fermenting or fruity smell, abundant nectar and pollen grains. Examples of chiropterophilous plants are *Kigelia, Adansonia,* etc.
	Malacophily
	Pollination by snails is called **malacophily**. This type of pollination is seen in some plants such as *Arisaema,* etc.
	Myrmecophily
	It is the pollination of flowers by ants, *e.g.*, some members of Family Rubiaceae.

Pollen pistil interaction

Pollination does not guarantee the transfer of the right type of pollen *i.e.*, compatible pollen on the stigma. Often, pollens of the wrong type either from other species or from the same plant (if it is self incompatible), also land on the stigma. Compatible pollens are identified by stigma through a process known as **pollen-pistil interaction**.

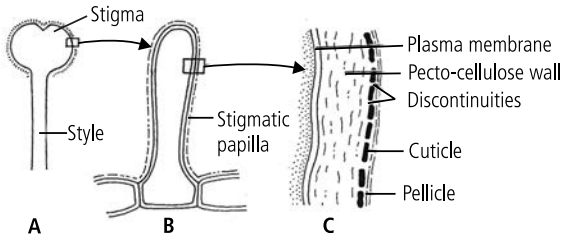


Fig.: A-B. Stigmatic papilla; **C.** Detailed structure of papilla surface showing various layers.

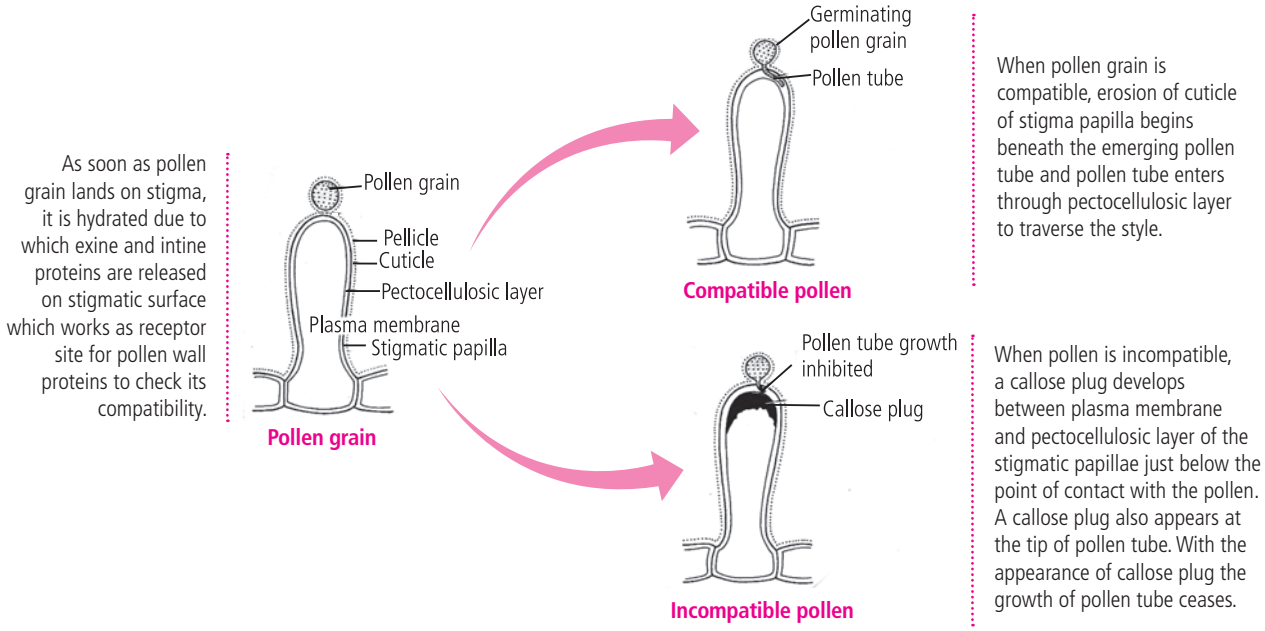
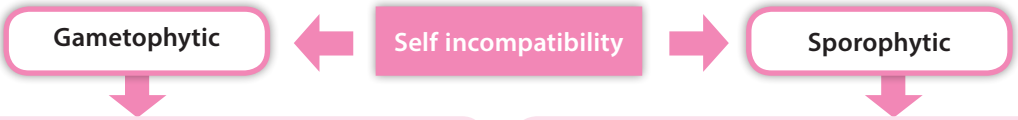


Fig.: Pollen-stigma interaction

Self incompatibility

If a pistil carrying functional female gametes, fails to set seeds following pollination with viable and fertile pollen capable of bringing about fertilisation in another pistil, the two are said to be incompatible and the phenomenon is called sexual incompatibility. Sexual incompatibility between individuals of same species is self-incompatibility. It is gene determined process and incompatibility reactors are by single genes which has several alleles.



Incompatibility process is determined by the genotype of pollen grain. Pollen grains that possess S allele common to any one of the two alleles present in the cells of the pistil will not be functional on that particular pistil.

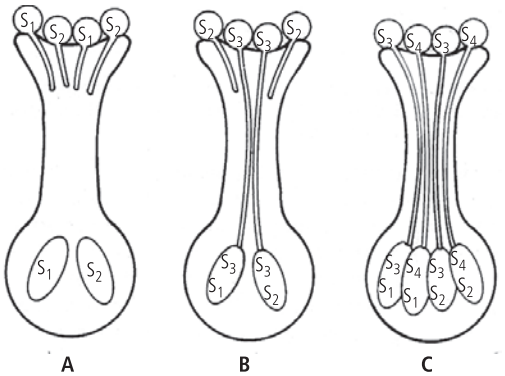


Fig.: Response of pollen on a pistil of S_1S_2 plant, showing gametophytic self-incompatibility. A. None of the pollen from a S_1S_2 plant is able to affect fertilisation. B. From a S_2S_3 plant only S_3 pollen succeed in fertilising the ovules. C. All the pollen from S_3S_4 plants bring about fertilisation.

Incompatibility process is determined by the genotype of the sporophytic tissue of plant from which pollen is derived. The presence of even one of the alleles of the stylar tissue in the sporophytic tissue of the male parent would render all the pollen of that plant non-functional with respect to that particualr style.

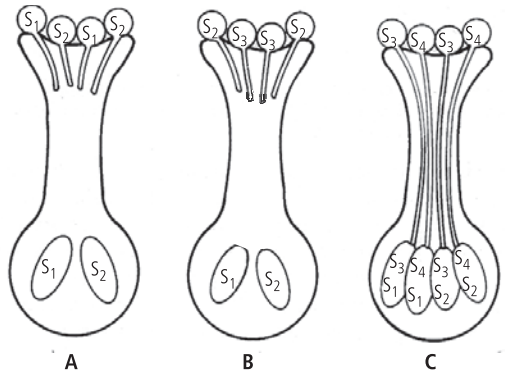


Fig.: Response of pollen on a pistil of S_1S_2 plant, showing sporophytic self-incompatibility. A. None of the pollen from a S_1S_2 plant is able to affect fertilisation. B. None of the pollen from S_2S_3 plant succeed in fertilising the ovules. C. All the pollen from S_3S_4 plants bring about fertilisation.

Fertilisation

The fertilisation involving formation of pollen tube is called **siphonogamy**. Normally, pollen grains are **monosiphonous** *i.e*, each pollen grain produces only a single pollen tube.

However, they may also be **polysiphonous** *i.e.*, more than one tube emerge from a single pollen grain *e.g.*, as many as 10 pollen tubes from a single pollen grain have been observed in *Althaea rosea*.

Pollen tube is generally unbranched but branched ones are common in some members of Amentiferae. The pollen tube enters the ovule in either of three ways:

- The process of entry of pollen tube through micropyle is called **porogamy**, *e.g.*, lily. It is the most common method.
- The process of entry of pollen tube into the ovule through chalaza is called **chalazogamy**, *e.g.*, *Betula*, *Casuarina*, etc.
- The process of entry of pollen tube through integuments is called **mesogamy**, *e.g.*, *Cucurbita*, *Populus*, *Alchimella*, etc.

Irrespective of the place of entry into the ovule, the pollen tube always enters the embryo sac through the micropylar region.

Inside the embryo sac, one male gamete fuses with the egg to form the zygote (2n), the process is known as **syngamy** or **generative fertilisation.**

The second male gamete fuses with 2 polar nuclei or secondary nucleus to form triploid primary endosperm nucleus, the process is known as **triple fusion** or **vegetative fertilisation**.

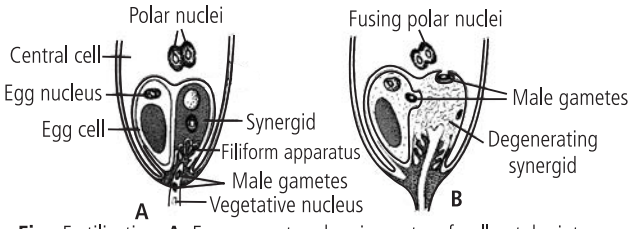


Fig.: Fertilisation. **A.** Egg apparatus showing entry of pollen tube into synergids **B.** Discharge of male gametes and their movements.

Table : Post-fertilisation transformation of floral parts

	Before fertilisation	After fertilisation
1.	Calyx, Corolla,Androecium, Style, Stigma	Wither away
2.	Ovary	Fruit
3.	Ovary wall	Pericarp
4.	Ovule	Seed
5.	Integuments (i) Outer integument (ii) Inner integument	Seed coats Testa Tegmen
6.	Micropyle	Micropyle
7.	Funicle	Stalk of seed
8.	Nucellus (persistent)	Perisperm
9.	Egg cell	Zygote (oospore)
10.	Synergids	Disintegrate and disappear

The zygote develops into **embryo** and primary endosperm nucleus develops into **endosperm**. The occurrence of syngamy and triple fusion simultaneously in angiosperms is called **double fertilisation**. Double fertilisation was first reported by **S.G. Nawaschin (1898)** in *Fritillaria* and *Lilium*.

Post-fertilisation: Structures and Events

Endosperm

Primary endosperm nucleus (PEN) divides by mitotic divisions and forms a mass of nutritive cells called endosperm. Endosperm is characteristic of all angiosperms with the exception of Families Orchidaceae, Podostemonaceae and Trapaceae.Endosperm development precedes embryo development. Endosperm accumulates food reserves and functions as the nutritive tissue for the developing embryo. It develops haustorial structures which penetrate into various ovular tissues, absorb nutrients from there and transfer them to the embryo.

Types of endosperm

Nuclear endosperm

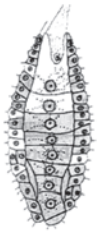
It is the most common type of endosperm found in many families of angiosperms.

The primary endosperm nucleus divides repeatedly without wall formation to produce a large number of free nuclei.

A central vacuole appears and pushes the cytoplasm containing the nuclei to the periphery. The cytoplasm thickens so that the vacuole decreases in size and ultimately disappears with the exception of few cases, *e.g.*, maize, sunflower, etc.

Cellular endosperm

Every division of the primary endosperm nucleus is followed by cytokinesis. Therefore, endosperm becomes cellular from the very beginning, *e.g.*, *Balsam, Datura, Petunia.*



Helobial endosperm

This type of endosperm is restricted largely to the monocotyledons, *e.g.*, in Order Helobiales of monocots. The endosperm is of **intermediate type** between cellular and nuclear endosperms.

The first division of primary endosperm nucleus is followed by transverse cytokinesis to form two unequal cells, larger micropylar and smaller chalazal.

Micropylar cell grows faster than the chalazal one. Further development in both the cells occurs like that of nuclear endosperm, *i.e.*, multinucleate stage followed by wall formation, *e.g.*, *Asphodelus*.

Embryo

After fertilisation, the fertilised egg is called **zygote** or **oospore** which develops into an **embryo**. This process of development of embryo is called **embryogenesis**.

Embryogeny in dicots

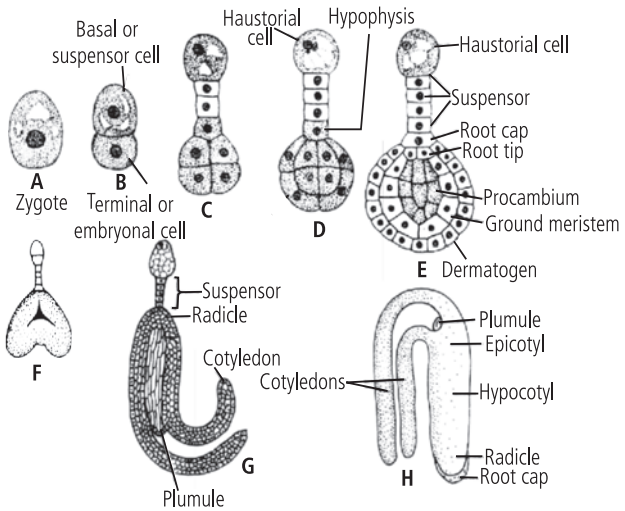


Fig.: Stages in the development of a dicot embryo

Embryogeny in monocots

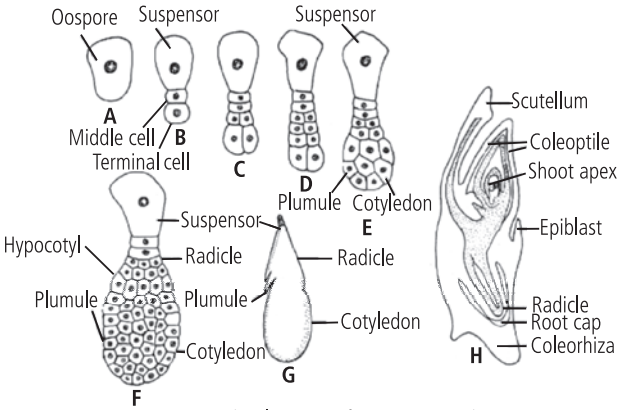


Fig.: Stages in development of a monocot embryo

Seeds

Ripened ovules are known as seeds. A true seed is defined as a fertilised mature ovule that possesses an embryonic plant, stored food (sometimes absent) and a protective coat or coats.

Seeds

Exalbuminous or non-endospermic seeds

In many seeds during embryo development, the food stored in the endosperm is continuously drawn up by the developing embryo and thus completely exhausted. Such seeds are known as **exalbuminous** or **non-endospermic seeds,** *e.g.*, gram, pea, tamarind, etc.

Albuminous or endospermic seeds

In some seeds, endosperm grows vigorously and is not completely exhausted by the developing embryo. Such seeds are known as **albuminous** or **endospermic seeds**, *e.g.*, castor, rice, wheat, barley, coconut, etc.

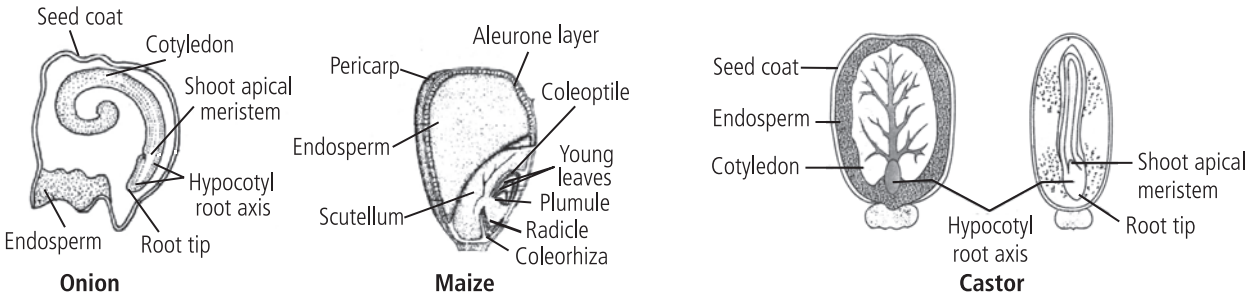


Fig.: Structures of some seeds

Methods of seed dispersal

Zoochory

Dispersal by animals including human beings.

Forced Zoochory

Seeds have spines, hooks etc., which cling to animal bodies and are carried to distance places, *e.g., Xanthium, Tribulus* etc.

Compensated Zoochory

Fruits and edible pulp. Seeds if big are thrown away, *e.g.*, mango and if small, are eaten along with fruits and passed out undigested in faeces, *e.g.*, mulberry, guava. In this way get, dispersed to distant places.

Autochory

Disperal by explosive mechanism. Fruits burst due to compression or release of pressure to throw or scatter the seeds to a distance away from the mother plant, *e.g.*, *Impatiens, Bauhinia* etc.

Hydrochory

Dispersal by the agency of water. Seeds and fruits develop floating devices like spongy or fibrous coats and are water proof, *e.g.*, coconut, lotus etc.

Anemochory

Dispersed by the agency of wind. Wind dispersed seeds have modifications like wings, hair, light weight body etc., *e.g., Moringa, Acer* etc.

Importance of seeds

Dependable method of reproduction

Unlike bryophytes and pteridophytes, pollination and fertilisation of seed plants are independent of water. Seed formation is, therefore, more dependable.

Dispersal

Seeds have adaptive strategies to get dispersed to new habitats and colonise the same.

Variations

As seeds are formed after sexual reproduction, the embryo contained in them carries a number of variations. Variations are essential for adaptability to diverse environmental conditions.

Perennation

Seed is dry (water content 10-15%) with dormant embryo and thick protective seed coat. It is most suitable for perennation through unfavourable periods.

Reserve food

Seeds have reserve food for nourishing the young seedlings till they become nutritionally independent.

Storage

Seeds can be stored for later use. This is helpful for supply of food throughout the year and to overcome drought and famine conditions.

Fruits

A fruit is a seed containing part of a plant that develops from a **fertilised ovary** and often from other tissues that surround it.

A **pseudocarpic** or **accessory** fruit or **false** fruit is a fruit whose flesh is derived not only from the ovary, but some other part like thalamus also contribute to fruit formation, *e.g.*, apple, strawberries.

A **eucarpic** or **true** fruit is a fruit which is developed only from the ovary after fertilisation, *e.g.*, mango.

The wall covering the fruit is called **pericarp**. It consists of three parts :

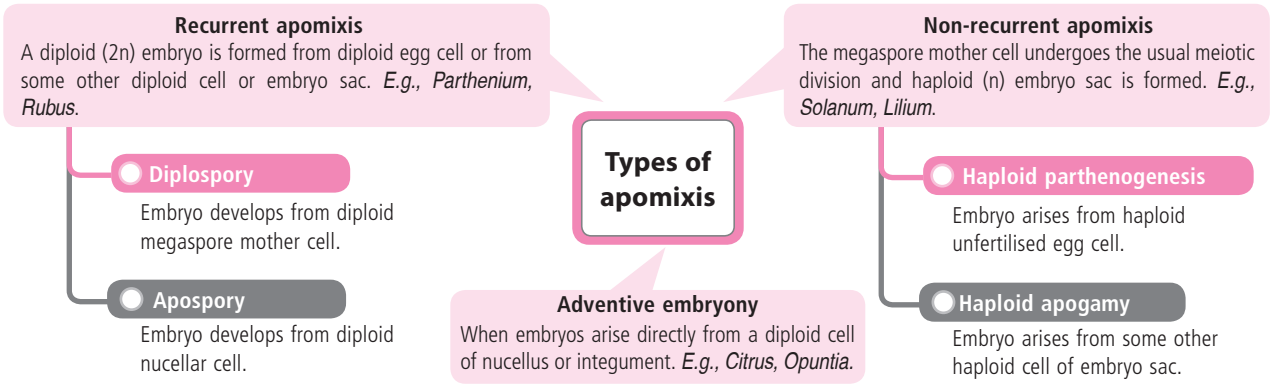
- **Epicarp**, called the skin of fruits.
- **Mesocarp**, middle fleshy and pulpy part.
- **Endocarp**, innermost portion that surrounds the seeds.

Fruits can be classified into three main groups : **simple** fruits, **aggregate** fruits and **composite (multiple)** fruits.

A **simple fruit** develops from monocarpellary ovary or multicarpellary syncarpous ovary and **aggregate fruit** develops from multicarpellary apocarpous (free) ovary while a **composite fruit** develops from a complete inflorescence.

APOMIXIS

Apomixis may be defined as, "abnormal kind of sexual reproduction which does not involve meiosis and syngamy and egg or other cells associated with egg (synergids, antipodals etc.) develop into embryo. The term apomixis was given by **Winkler** (1908).



Flow chart : Types of apomixis

PARTHENOCARPY

Parthenocarpy is the formation of fruit without fertilisation. The fruit produced due to parthenocarpy may or may not be seedless depending upon the occurrence of apomixis and subsequent development of embryo. When seeds are formed, they are abortive.

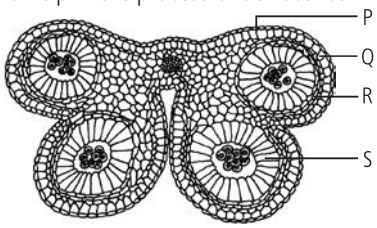
Parthenocarpy is of three types: **genetic, environmental** and **chemically induced**.

POWER EXERCISE

New MCQs

1. In flowering plants, a mature male gametophyte is derived from a pollen mother cell by
   (a) two mitotic divisions
   (b) one meiotic and two mitotic divisions
   (c) three mitotic divisions
   (d) a single meiotic division.
2. A plant has 24 chromosomes in "microspore mother cell". The number of chromosomes in its endosperm will be
   (a) 36 (b) 24 (c) 12 (d) 48.
3. Which of the following statements about sporopollenin is false ?
   (a) Exine is made up of sporopollenin.
   (b) Sporopollenin is one of the most resistant organic materials.
   (c) Exine has apertures called germ pores where sporopollenin is present.
   (d) Sporopollenin can withstand high temperatures and strong acids.

4. Given figure represents the four wall layers (P, Q, R and S) of an anther. Cells of which of the following layers develop fibrous thickenings of α-cellulose on the inner and radial walls, and help in the process of dehiscence?



(a) P (b) Q (c) R (d) S

5. In which one pair both the plants can be vegetatively propagated by leaf species?
(a) *Agave* and *Kalanchoe*
(b) *Bryophyllum* and *Kalanchoe*
(c) *Asparagus* and *Bryophyllum*
(d) *Chrysanthemum* and *Agave*

6. Potatoes are cultivated by
(a) seeds (b) cutting of roots
(c) foliar buds (d) buds on tubers.

7. In a fertilised ovule of angiosperms, n, 2n and 3n conditions occur respectively in
(a) antipodals, egg and endosperm
(b) egg, nucellus and endosperm
(c) endosperm, nucellus and egg
(d) antipodals, synergids and integuments.

8. The portion of embryonal axis between plumule (future shoot) and cotyledonary node is called
(a) hypocotyl (b) epicotyl
(c) coleorhiza (d) coleoptile.

9. This is an example of a very old viable seed excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy. It is
(a) Victoria (b) *Lupinus arcticus*
(c) *Phoenix dactylifera* (d) *Strobilanthus kunthiana*.

10. Wind pollinated flowers are
(a) small, brightly coloured, producing few pollen grains
(b) small, producing large number of dry pollen grains
(c) large, producing abundant nectar and pollen grains
(d) small, producing nectar and dry pollen grains.

Exam Section

1. Filiform apparatus is characteristic feature of
(a) aleurone cell (b) synergids
(c) generative cell (d) nucellar embryo.
(AIPMT 2015)

2. Coconut water from a tender coconut is
(a) innermost layers of the seed coat
(b) degenerated nucellus
(c) immature embryo
(d) free nuclear endosperm. *(AIPMT 2015)*

3. Apomixis is
(a) formation of seeds by fusion of gametes
(b) formation of seeds without syngamy and meiosis
(c) formation of seeds with syngamy but no meiosis
(d) none of the above. *(AIIMS 2015)*

4. The residual persistent nucellus in the seed of black pepper and beet is called
(a) perisperm (b) endosperm
(c) pericarp (d) scutellum
(e) apomixis. *(Kerala PMT 2015)*

5. Which of the following organisms breeds only once in lifetime?
(a) Bamboo (b) Oysters
(c) Pelagic fishes (d) Birds
(e) Mammals *(Kerala PMT 2015)*

6. Pollen tablets are available in the market for
(a) *in vitro* fertilization (b) breeding programmes
(c) supplementing food (d) *ex situ* conservation.
(AIPMT 2014)

7. Entomophilous flowers are
(a) brightly coloured and produce nectar
(b) colourless
(c) inconspicuous
(d) odourless. *(AMU 2014)*

8. Emasculation ensures cross-pollination in
(a) staminate flower (b) bisexual flower
(c) neuter flower (d) pistillate flower.
(WB JEE 2014)

9. The embryo sac of an angiosperm is made up of
(a) 8 cells (b) 7 cells and 8 nuclei
(c) 8 nuclei (d) 8 cells and 7 nuclei.
(K - CET 2013)

10. Vegetative propagation in water hyacinth takes place by
(a) rhizome (b) bulbil
(c) leaf bud (d) offset.
(AMU 2013)

Assertion & Reason

The following questions consist of two statements each : assertion (A) and reason (R). To answer these questions, mark the correct alternative as directed below :

(a) If both A and R are true and R is the correct explanation of A.
(b) If both A and R are true but R is not the correct explanation of A.
(c) If A is true but R is false.
(d) If both A and R are false.

1. **Assertion (A) :** Sexual reproduction or apomixis is the production of new individual through formation and fusion of male and female gametes.

Reason (R) : Offspring produced through sexual reproduction are exact copies of their parents hence called clones.

2. **Assertion (A) :** Ginger and turmeric propagate vegetatively with the help of rhizome.
   Reason (R) : Rhizomes are thick underground stems which store food for perennation under unfavourable conditions.
3. **Assertion (A) :** Tapetum is the innermost parietal layer with cells having dense cytoplasm and large nuclei.
   Reason (R) : Tapetum helps in the dehisence of anther due to the presence of fibrous band thickenings in it.
4. **Assertion (A) :** Pollens of some plant species are preserved in fossil deposits from a very long time.
   Reason (R) : Outer wall of pollen is made up of sporopollenin which is tough and resistant to chemical and biological decomposition.
5. **Assertion (A) :** The filiform apparatus of synergids is useful to the absorption and transportation of materials from nucellus to embryo sac.
   Reason (R) : Hook like structures of filiform apparatus help in easy penetration of pollen tube in embryo sac.

Short Answer Type Questions

1. Fill in the blanks:
   (a) Each ovule is attached to the placenta by a small stalk called _____.
   (b) _____ ovules are commonly found in *Santalum album*.
   (c) Curvature is observed both in the body of ovule and embryo sac in case of _____ ovule.
   (d) Pollination of flowers by means of ants is known as _____.
2. Enumerate various adaptations of wind pollinated and insect pollinated flowers.
3. How is gametophytic self incompatibility different from sporophytic self incompatibility.
4. Enlist various methods of seed dispersal in plants.
5. Write short note on parthenocarpy.

ANSWER KEY

New MCQs

1.	(b)	**2.**	(a)	**3.**	(c)	**4.**	(b)	**5.**	(b)
6.	(d)	**7.**	(a)	**8.**	(b)	**9.**	(b)	**10.**	(b)

Exam Section

1.	(b)	**2.**	(d)	**3.**	(b)	**4.**	(a)	**5.**	(a)
6.	(c)	**7.**	(a)	**8.**	(b)	**9.**	(b)	**10.**	(d)

Assertion & Reason

1.	(d)	**2.**	(b)	**3.**	(c)	**4.**	(a)	**5.**	(b)

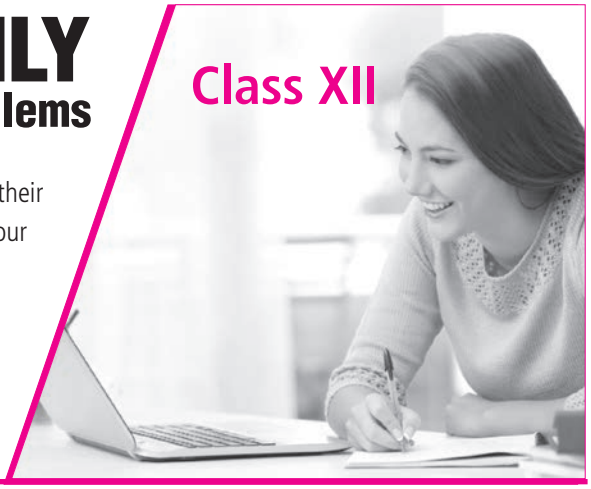
Short Answer Type Questions

1. (a) funiculus (b) Ategmic
   (c) amphitropous (d) myrmecophily
2. Adaptations of wind pollinated flowers are as follows:
   - Both the stigmas and anthers are exserted.
   - Pollen grains are dry, very small sized, non-sticky and unwettable, so that they can be carried by wind to long distances.
   - Stigma is hairy, feathery (grasses) or branched to catch the wind borne pollens.

   Pollination by insects is called entomophily, adaptations for insect pollinated flowers are as follows:
   - Insect-pollinated flowers produce nectar, which attracts the pollinators for feeding.
   - Some flowers produce edible pollen grains.
   - Flowers are fragrant and emit scent and odour.
   - Flowers are bright coloured.
3. In gametophytic self-incompatibility (GSI), the incompatibility process is determined by the genotype of male gametophyte (pollen) itself, *e.g.*, Liliaceae, Poaceae, Solanaceae, etc. whereas in sporophytic self-incompatibility (SSI), the incompatibility process is controlled by the genotype of the sporophytic tissue of the plant from which the pollen is derived, *e.g.*, Asteraceae, Brassicaceae.
4. Methods of seed dispersal in plants are as follows:
   (i) Anemochory : Dispersal by the agency of wind. Wind dispersed seeds have modifications like wings, hair, light weight body etc. *e.g., Moringa, Acer* etc.
   (ii) Hydrochory : Dispersal by the agency water. Seeds and fruits develop floating devices like spongy or fibrous coats and are water proof *e.g.*, coconut, lotus etc.
   (iii) Zoochory : Dispersal by animals including human beings.
   (a) Forced Zoochory – Seeds have spines, hooks etc., which cling to animal bodies and are carried to distant places, *e.g., Xanthium, Tribulus* etc.
   (b) Compensated Zoochory – Fruits have edible pulp. Seeds if big are thrown away, *e.g.*, mango and if small, are eaten along with fruits and passed out undigested in faeces,. *e.g.*, mulberry, guava. In this way, get dispersed to distant places.
   (iv) Autochory : Autochory Dispersal by explosive mechanism. Fruits burst due to compression or release of pressure to throw or scatter the seeds to a distance away from the mother plant, *e.g., Impatiens, Bauhinia* etc.
5. Parthenocarpy is the development of a fruit without the formation of seeds as a result of lack of pollination, or lack of fertilisation or lack of embryo development . Parthenocarpy is of three types: genetic, environmental and chemically induced.

MPP-1 MONTHLY Practice Problems

Class XII



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer.

Self check table given at the end will help you to check your readiness.

- **Reproduction in Organisms**
- **Sexual Reproduction in Flowering Plants**

Total Marks : 160 **Time Taken : 40 Min.**

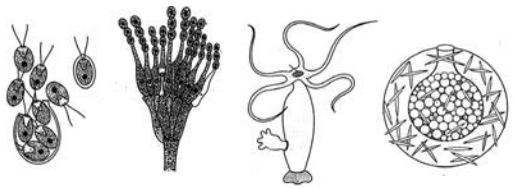
1. Organism dividing by transverse binary fission is
(a) *Euglena* (b) *Amoeba*
(c) *Hydra* (d) *Paramecium.*

2. Select the correct option regarding the ploidy level of different structures of an angiospermic ovule.

	Synergid	Nucellus	Antipodal	Egg
(a)	n	n	2n	2n
(b)	n	2n	n	n
(c)	n	2n	n	2n
(d)	n	n	n	2n

3. Which of the following is not propagated by roots?
(a) *Albizia* (b) *Aspidium*
(c) *Dalbergia* (d) *Murraya*

4. Refer to the given figures.



A B C D

All of these are
(a) bodies involved in sexual reproduction
(b) bodies involved in asexual reproduction
(c) perennating structures
(d) both (b) and (c).

5. Refer to the given statements.
(i) The pollen grains of *Parthenium* cause pollen allergy.
(ii) Pollen grains are well preserved as fossils because of the presence of pectin and cellulose.
(iii) Generative cell is mostly spindle shaped with dense cytoplasm and a nucleus.
(iv) The vegetative cell divides mitotically to give rise to the two male gametes.
(v) Mostly pollen grains are shed at 2-celled stage.

Which of the above statements are correct ?
(a) (i), (ii) and (iv) (b) (i), (iii) and (v)
(c) (i), (ii) (iii) and (v) (d) (ii), (iii) and (iv)

6. Match column I with column II and select the correct option from the codes given below.

	Column I		Column II
A.	Ruminate endosperm	(i)	*Primula*
B.	Aril	(ii)	*Lythrum*
C.	Ategmic	(iii)	*Santalum*
D.	Distyly	(iv)	*Annona squamosa*
E.	Tristyly	(v)	*Asphodelus*

(a) A-(iii), B-(v), C-(iv), D-(i), E-(ii)
(b) A-(ii), B-(v), C-(iv), D-(iii), E-(i)
(c) A-(iv), B-(i), C-(iii), D-(v), E-(ii)
(d) A-(iv), B-(v), C-(iii), D-(i), E-(ii)

7. Which characteristic distinguishes living organism unexceptionally from the non-living?
(a) Metabolism (b) Reproduction
(c) Movement
(d) Interaction with the environment

8. Essential and most critical event in sexual reproduction is
(a) formation of haploid cells by meiosis
(b) fusion of male and female gametes
(c) meiotic divisions in zygote to form embryo
(d) both (a) and (b).

9. A flower of tomato plant following the process of sexual reproduction produces 120 viable seeds. How many microspore mother cells must have undergone reduction division prior to dehiscence of anther in the above case?
(a) 30 (b) 120 (c) 90 (d) 60

10. A monocotyledonous plant bears flower but never produces fruits and seeds. The most probable cause for the above situation is
(a) plant is dioecious and bears both pistillate and staminate flowers
(b) plant is monoecious
(c) plant is dioecious and bears only staminate flowers
(d) plant is dioecious and bears only pistillate flowers.

11. Diploid zygote is universal in
(a) all sexually reproducing organisms
(b) all asexually reproducing organisms
(c) all sexually and asexually reproducing organisms
(d) none of these.

12. Match the following columns.

	Column I		Column II
A.	Arrhenotoky	(i)	Walnut
B.	Trench layering	(ii)	Rubber Plant
C.	Grafting	(iii)	Callus
D.	Tissue culture	(iv)	*Lacerta*
E.	Thelytoky	(v)	Rotifers

(a) A-(v), B-(i), C-(ii), D-(iii), E-(iv)
(b) A-(iv), B-(i), C-(iii), D-(ii), E-(v)
(c) A-(iv), B-(ii), C-(iii), D-(i), E-(v)
(d) A-(v), B-(ii), C-(iii), D-(iv), E-(i)

13. Select the mismatched pair.
(a) Wind - *Cannabis* - Entomophily
(b) Water - *Zostera* - Hydrophily
(c) Bird - *Bignonia* - Ornithophily
(d) Snail - *Arisaema* - Malacophily

14. Which of the following is endospermic or albuminous seed?
(a) Pea (b) Gram
(c) Bean (d) Wheat

15. Development of embryo in oviparous individuals occurs
(a) outside the female body
(b) inside the female body
(c) inside the freshwater
(d) inside the marine water.

16. Match column I with column II and select the correct option from the codes given below.

	Column I		Column II
A.	Sporangiospore	(i)	*Ulothrix*
B.	Zoospore	(ii)	*Rhizopus*
C.	Conidium	(iii)	*Planaria*
D.	Multiple fission	(iv)	*Penicillium*
E.	Regeneration	(v)	*Plasmodium*

(a) A-(i), B-(iv), C-(v), D-(iii), E-(ii)
(b) A-(ii), B-(i), C-(iv), D-(v), E-(iii)
(c) A-(i), B-(ii), C-(iii), D-(iv), E-(v)
(d) A-(i), B-(iv), C-(iii), D-(ii), E-(v)

17. After penetrating stigmatic and stylar tissue, the pollen tube usually grows towards egg because
(a) there is no other path to follow
(b) it grows under the control of egg nucleus
(c) it is attracted by antipodals
(d) the filiform apparatus of synergids is believed to attract the pollen tube.

18. Which of the following plants is pollinated by birds?
(a) *Salvia* (b) *Bauhinia*
(c) *Callistemon* (d) *Mimosa*

19. Parthenogenesis is induced artificially in
(a) rotifers and lizards (b) bees and wasps
(c) frogs and star fish (d) both (a) and (c).

20. Corm and rhizome are used as a means of vegetative propagation respectively in
(a) ginger and onion
(b) *Colocasia* and mints
(c) *Crocus* and *Agave*
(d) *Fressia* and *Adiantum*

21. Porogamy is commonly found in
(a) lily (b) *Casuarina*
(c) *Cucurbita* (d) *Juglans*

22. Which of the following groups of plants possess cellular endosperm?
(a) Balsam, *Datura, Petunia*
(b) *Asphodelus, Datura, Petunia*
(c) *Triticum, Datura, Capsella*
(d) *Triticum, Petunia, Phoenix*

23. Clone is
(a) descendants of a single parent
(b) fusion product of two parents
(c) formed by parthenogenesis
(d) none of these.

24. The polyestrous mammal is
(a) man (b) mouse
(c) dog (d) monkey.

25. The maturation of stamens and pistils at different times in the bisexual flower is called
(a) dicliny (b) dichogamy
(c) herkogamy (d) heterostyly.

26. Read the given statements.
Statement 1 : Angiospermic endosperm is a triploid structure.
Statement 2 : Angiospermic endosperm is formed after the fusion of diploid secondary nucleus with a haploid male gamete.
(a) Both statements 1 and 2 are true and statement 2 is the correct explanation of statement 1.
(b) Both statements 1 and 2 are true but statement 2 is not the correct explanation of statement 1.
(c) Statement 1 is true but statement 2 is false.
(d) Both statements 1 and 2 are false.

27. Which one of the following is not concerned with sexual reproduction?
(a) Zygote (b) Spores
(c) Germ cells (d) Gonads

28. Which of the following is a monoecious animal?
(a) Lizard (b) Frog
(c) Cockroach (d) Tapeworm

29. Which of the following prevents inbreeding and promotes out breeding?
(a) Monoecious condition
(b) Self incompatibility
(c) Cleistogamous condition
(d) Homogamy

30. Which of the following statements is correct?
(a) The progeny of hybrid plants maintains hybrid characters.
(b) Apomixis is genetically controlled.
(c) Occurrence of more than one embryo in a seed is referred to as parthenogenesis.
(d) Embryos formed through apomixis are mostly diseased.

31. Which of the following is correct about tissue culture ?
(a) Growth of specific plant structures on nutrient medium
(b) Growth and multiplication of cells on nutrient medium
(c) Maintenance, growth and differentiation of cells tissues and organs on nutrient medium
(d) All of these

32. A V-shaped notch in the stock is made during
(a) crown grafting (b) wedge grafting
(c) whip grafting (d) tongue grafting.

33. Select the incorrect match from the following.

	Ovule	Example
(a)	Campylotropous	*Pisum sativum*
(b)	Anatropous	*Helianthus*
(c)	Hemianatropous	*Ranunculus*
(d)	Orthotropous	*Polygonum*

34. The portion of embryonal axis above the level of cotyledons is called
(a) hypocotyl (b) epicotyl
(c) suspensor (d) haustorium.

35. Hologamy occurs in
(a) *Volvox* (b) *Spirogyra*
(c) Yeast (d) *Paramecium.*

36. Which of the following is correct about zygotic meiosis?
(a) It occurs in zygote producing diploid organism.
(b) It occurs in the zygote producing haploid organisms.
(c) It occurs in *Chlamydomonas* and *Ulothrix.*
(d) Both (b) and (c)

37. In tetrasporic embryo sac four
(a) microspores form the embryo sac
(b) megaspore mother cells form embryo sac
(c) megaspores form the embryo sac
(d) microspore mother cells form the embryo sac.

38. Filiform apparatus is formed by
(a) synergid (b) antipodal
(c) egg cell (d) polar nuclei.

39. Asexual mode of reproduction in Protozoans is
(a) strobilation (b) binary fission
(c) plasmotomy (d) schizogony.

40. Transmitting tissue is found in
(a) solid style (b) hollow style
(c) stigma (d) both (a) and (b).

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Practice paper for phase II

1. Colchicine is a cell poison which arrests cell division at _____ and can induce _____.
(a) metaphase, parthenocarpy
(b) anaphase, parthenocarpy
(c) metaphase, polyploidy
(d) anaphase, polyploidy

2. Bohr's effect is related with
(a) reduced carbon level in lymph
(b) increased carbon dioxide level in blood
(c) oxidised phosphorus level in blood
(d) reduced carbon dioxide level in blood.

3. Hisardale is a new breed of sheep developed in Punjab by crossing
(a) Merino ram and Bikaneri ewe
(b) Aseel ram and White leg horn ewe
(c) Rhode Island ram and White leg horn ewe
(d) Cochin ram and Ghagus ewe.

4. Which of the following would be least true of a regulator?
(a) It may have a larger geographic range than a conformer.
(b) It can increase its tolerance limits through acclimatisation.
(c) Much of its energy budget can be allocated to reproduction.
(d) It possesses a constant internal environment.

5. Photosynthetic roots occur in
(a) *Tinospora* (b) *Cuscuta*
(c) *Pandanus* (d) maize.

6. The following cell organelle takes part in disappearance of larval organs in frogs during metamorphosis.
(a) Vacuoles (b) Lysosomes
(c) Ribosomes (d) Microfilament

7. Read the given statements and select the correct option.
Statement 1 : GMO tomato 'Flavr Savr' has increased shelf life and better nutrient quality.
Statement 2 : This is achieved by reducing the amount of cell wall degrading enzyme 'polygalacturonase' responsible for fruit softening.
(a) Both statements 1 and 2 are correct and statement 2 is the correct explanation of statement 1.
(b) Both statements 1 and 2 are correct but statement 2 is not the correct explanation of statement 1.
(c) Statement 1 is correct but statement 2 is incorrect.
(d) Both statements 1 and 2 are incorrect.

8. Which of the following is an example of artificial passive immunity?
(a) A person, recovered from an attack of small pox
(b) Administration of Salk vaccine for poliomyelitis in newborns
(c) Administration of anti-tetanus serum in injured person
(d) Resistance transferred to the infant through mother's milk

9. Which of the following holds true for SA node?
(a) It is called pacesetter.
(b) It is regulated by the cardiac centres present in medulla oblongata of brain.
(c) It has very low rhythmicity.
(d) It is present in the left atrium near the opening of superior vena cava.

10. Given below are the differences between wind pollinated and insect pollinated flowers.

	Wind pollinated	Insect pollinated
(i)	Flowers are small and inconspicuous.	Flowers are showy and brightly coloured.
(ii)	Flowers are devoid of nectar and edible pollen.	Flowers possess nectar and edible pollen.
(iii)	Pollen grains are heavier and sticky.	Pollen grains are light and unwettable.
(iv)	Anthers and stigmas are inserted.	Anthers and stigmas are usually exserted.

Select the incorrect differences.
(a) (i) and (ii) only (b) (i) and (iv) only
(c) (iii) and (iv) only (d) (ii) and (iii) only

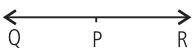
11. The mortality rate of organisms following a type III survivorship curve is
(a) fairly constant throughout life
(b) higher in post reproductive years
(c) lower after the organisms grow into reproductive individuals and become established
(d) unrelated to age.

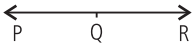
12. In *Artabotrys* _____ are modified into stiff curved hooks for climbing.
(a) pedicels (b) petioles
(c) leaf tips (d) stem buds

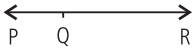
13. Which of the following is incorrect for biosynthetic phase of photosynthesis?
(a) It occurs in matrix of chloroplast.
(b) It does not require light.
(c) It produces NADPH and ATP.
(d) It is influenced by temperature.

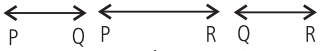
14. Which of the following statements about enzymes are correct?
(i) Enzymes do not alter the overall change in free energy for a reaction.
(ii) Enzymes are proteins whose three dimensional shape is key to their functions.
(iii) Enzymes speed up reactions by lowering activation energy.
(iv) Enzymes are highly specific for reactions.
(v) The energy input needed to start a chemical reaction is called activation energy.
(a) (i) and (v) (b) (ii) and (iv)
(c) (i), (ii) and (iv) (d) All of these

15. Which of the following is a connecting link between Phylum Annelida and Mollusca?
(a) *Peripatus* (b) *Proterospongia*
(c) *Balanoglossus* (d) *Neopilina*

16. If map distance between genes P and Q is 3 units, between P and R is 9 units, and between Q and R is 6 units, the order of genes on the linkage map can be traced as follows.
(a) 

(b) 

(c) 

(d) 

17. Mesogamy commonly occurs in
(a) *Cucurbita* (b) Lily
(c) *Juglans* (d) *Casuarina*.

18. Which of the following is an example of isometric contraction?
(a) Bending of arms (b) Stair climbing
(c) Pushing against a stationary wall
(d) Lifting a heavy weight

19. Which of the following method involves transformation of host cell by inducing pores in plasma membrane through electrical impulse using $CaCl_2$?
(a) Microinjection (b) Biolistic method
(c) Electroporation (d) Direct DNA injection

20. Acoustic zoning is a control measure for
(a) air pollution (b) noise pollution
(c) water pollution (d) radiation pollution.

21. Select the correct statement from the following.
(a) Classical taxonomy has a biosystematic concept whereas modern taxonomy has typological concept.
(b) Classical taxonomy considers species to be dynamic whereas modern taxonomy considers species to be static.
(c) Classical taxonomy studies evolution and interrelationships of species.
(d) Modern taxonomy studies primitiveness, advancement and interrelationships of species.

22. Read the given statements.
(i) Coelenterates show polymorphism.
(ii) In *Pleurobrachia* locomotion takes place by comb plates.
(iii) In roundworm true coelom is present.
(iv) Parapodia are respiratory organs found in arthropodans.
Of the above statements
(a) only (i) and (iv) are correct
(b) only (i) and (ii) are correct
(c) only (iii) and (iv) are correct
(d) only (ii) and (iii) are correct.

23. Match column I with column II and select the correct option from the given codes.

	Column I		**Column II**
A.	*Holoptelea*	(i)	Cremocarp
B.	*Capsella*	(ii)	Carcerulus
C.	Coriander	(iii)	Hesperidium
D.	*Abutilon*	(iv)	Silicula
E.	Orange	(v)	Simple samara

(a) A - (ii), B - (iii), C - (i) D - (iv), E - (v)
(b) A - (v), B - (iv), C - (i), D - (ii), E - (iii)
(c) A - (i), B - (ii), C - (iv), D - (v), E - (iii)
(d) A - (iii), B - (i), C - (ii), D - (v), E - (iv)

24. Two adjacent cells A and B are studied. Cell A has $\psi_w = -10$ atm whereas cell B has $\psi_w = -5$ atm. Movement of water will occur from
(a) A to B (b) B to A
(c) no movement of water (d) cannot be determined.

MPP-1 CLASS XII ANSWER KEY

1.	(d)	**2.**	(b)	**3.**	(b)	**4.**	(d)	**5.**	(b)	**6.**	(d)	**7.**	(b)	**8.**	(d)	**9.**	(a)	**10.**	(c)
11.	(a)	**12.**	(a)	**13.**	(a)	**14.**	(d)	**15.**	(a)	**16.**	(b)	**17.**	(d)	**18.**	(c)	**19.**	(c)	**20.**	(d)
21.	(a)	**22.**	(a)	**23.**	(a)	**24.**	(b)	**25.**	(b)	**26.**	(a)	**27.**	(b)	**28.**	(d)	**29.**	(b)	**30.**	(b)
31.	(d)	**32.**	(b)	**33.**	(a)	**34.**	(b)	**35.**	(c)	**36.**	(d)	**37.**	(c)	**38.**	(a)	**39.**	(c)	**40.**	(a)

25. Select the correct match.
(a) Hexoses - Xylose, Fructose, Erythrose
(b) Steroids - Corticosterone, Digitoxin, Strophanthin
(c) Acidic amino acids - Glutamine, Lysine, Glycine
(d) Chromoproteins - Ribonucleoproteins, Haemocyanin, Rhodopsin

26. On exposure to a chemical mutagen, adenine is replaced by thymine, in a DNA segment. It is the case of
(a) inversion (b) transition
(c) transversion (d) insertion.

27. Emasculation is not required in case of _____ flowers for performing artificial hybridisation.
(a) pea (b) papaya (c) mustard (d) rice

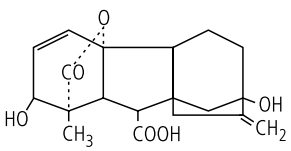
28. Oxyhaemoglobin dissociation curve shifts to right when
(a) temperature is low
(b) concentration of CO_2 increases in plasma
(c) temperature is high
(d) both (b) and (c).

29. Cyclosporin A prevents rejection of transplanted organs by
(a) destroying T-cell mediated immune responses while sparing humoral antibody responses
(b) destroying humoral antibody responses while sparing T - cell mediated immune responses
(c) destroying both T-cell mediated and humoral antibody responses
(d) none of these.

30. Which of the following holds true for monerans?
(a) An organised nucleus is present sometimes.
(b) Cell wall contains sporopollenin.
(c) Sexual reproduction does not involve fusion of gametes.
(d) Ribosomes are 80S in nature.

31. The function of intracellular membrane is not to
(a) establish a number of compartments within the cell
(b) provide for the neat spatial organisation of enzymes and pigments
(c) keep the cell rigidity so that it does not collapse
(d) provide a system of channel for the distribution of nutrients within the cell.

32. Given below is the chemical structure of a plant hormone. Select the incorrect statement regarding it.

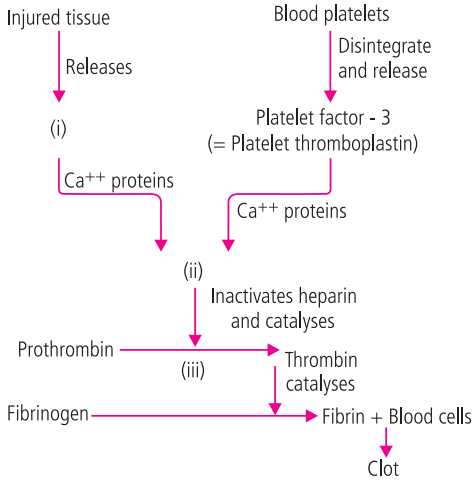


(a) Reducing sugar content of barley endosperm serves as its bioassay.
(b) It causes bolting in case of rosette plants.
(c) It overcomes natural dormancy of buds, tubers, seeds etc.
(d) It promotes formation of female flowers on genetically male plants of *Cannabis*.

33. Which of the following organisms reproduces asexually by fragmentation method?
(a) *Rhizopus* (b) *Riccia*
(c) Sea anemone (d) All of these

34. Dikaryon stage during sexual reproduction occurs in
(a) Mycoplasma (b) *Puccinia*
(c) *Marchantia* (d) *Pseudomonas.*

35. Refer to the given flow chart showing the blood clotting mechanism and identify (i), (ii) and (iii).



(a) (i) Prothrombinase, (ii) Thromboplastin, (iii) Mg^{2+}
(b) (i) Thromboplastin, (ii) Prothrombinase, (iii) Zn^{2+}
(c) (i) Thromboplastin, (ii) Prothrombinase, (iii) Ca^{2+}
(d) (i) Prothrombinase, (ii) Thromboplastin, (iii) Fe^{2+}

36. Match column I with column II and select the correct option from the given codes.

	Column I	**Column II**
A.	Potassium	(i) Organisation of mitotic spindle
B.	Calcium	(ii) Formation of chlorophyll
C.	Magnesium	(iii) Nitrogen metabolism
D.	Molybdenum	(iv) Opening and closing of stomata

(a) A - (i), B - (iv), C - (iii) D - (ii)
(b) A - (iv), B - (i), C - (ii), D - (iii)
(c) A - (iii), B - (ii), C - (iv), D - (i)
(d) A - (ii), B - (iii), C - (i), D - (iv)

37. Which of the following is correct regarding follicular phase of menstrual cycle in human female?
(a) Empty Graafian follicle changes into corpus luteum.
(b) Large amount of progesterone is secreted.
(c) It extends from 6^{th} to 13^{th} day in a 28 day cycle.
(d) The uterine glands secrete watery secretions.

38. If the sequence of coding strand in a transcription unit is : 5' - ATGCATGC-3' then the sequence of *m*RNA will be
(a) TACGTACG (b) AUGCAUGC
(c) ATGCATGC (d) UACGUACG.

39. Match column I with column II and select the correct option from the given codes.

	Column I	**Column II**
A.	Pap test	(i) Syphilis
B.	VDRL test	(ii) Typhoid
C.	Widal test	(iii) Bubonic plague
D.	Wayson stain test	(iv) Tuberculosis
E.	Mantoux test	(v) Cervical cancer

(a) A - (i), B - (ii), C - (iii) D - (iv) E- (v)
(b) A - (v), B - (i), C - (ii), D - (iii) E- (iv)
(c) A - (v), B - (iv), C - (iii), D - (ii) E- (i)
(d) A - (ii), B - (iv), C - (iii), D - (i), E- (v)

40. Read the following statements and select the incorrect one.
(a) Little decomposition occurs during the formation of primary sludge.
(b) Formation of primary sludge requires ample aeration.
(c) Activated sludge possess flocs of decomposer microbes.
(d) Formation of activated sludge requires aeration.

41. Select the correct match.
(a) Cauliflower mosaic virus - ssRNA
(b) T_4 bacteriophage - dsDNA
(c) Reovirus - ssRNA (d) Retrovirus - dsRNA

42. Which of the following is correct for a sanctuary?
(a) It is meant for protection of both flora and fauna.
(b) Private ownership is permitted.
(c) Grazing is not allowed.
(d) Boundary is well demarcated.

43. Siphonogamy is found in
(a) gymnosperms (b) angiosperms
(c) pteridophytes (d) both (a) and (b).

44. Which of the following groups include only *ex - situ* methods of biodiversity conservation?
(a) Sacred plants, home gardens, hotspots
(b) Seed banks, cryopreservation, Biosphere reserves
(c) Botanical gardens, National parks, Wildlife sanctuaries
(d) Zoological parks, cyropreservation, botanical gardens

45. Select the incorrect difference between gymnosperms and angiosperms.

	Gymnosperms	Angiosperms
(i)	Sporophylls are aggregated to form cones.	Sporophylls are aggregated to form flowers.
(ii)	Ovules occur covered inside the ovary.	Ovules lie exposed on megasporophyll.
(iii)	Endosperm is triploid and is a post fertilisation structure.	Endosperm is haploid and is a pre-fertilised structure.
(iv)	Ovules are sessile.	Ovules are generally borne on a stalk or funiculus.

(a) (i) and (ii) (b) (ii) and (iii)
(c) (iii) and (iv) (d) (i) and (iv)

46. Which of the following plants produce orthodox seeds?
(a) Cocoa (b) Legumes
(c) Jack fruit (d) Tea

47. Read the given statements.
Statement I: Microtubules cause microcirculation by directing vesicles to particular direction.
Statement II: Microtubules are believed to cause cytoplasmic streaming.
(a) Both statements I and II are true and statement II is the correct explanation of statement I.
(b) Both statements I and II are true but statement II is not the correct explanation of statement I.
(c) Statement I is true but statement II is false.
(d) Both statements I and II are false.

48. _____ is located in nonappressed part of grana thylakoids whereas _____ is present in the appressed part of grana thylakoids. _____ phosphorylation is performed in collaboration of both of them.
(a) PS I, PS II, Non-cyclic (b) PS II, PS I, Cyclic
(c) PS II, PS I, Non-cyclic (d) PS I, PS II, Cyclic

49. Human skin colour is controlled by
(a) 2 pairs of polygenes (b) 3 pairs of polygenes
(c) 4 pairs of polygenes (d) 5 pairs of polygenes.

50. Which of the following is an example of conditioned reflex?
(a) Breast feeding in new born babies
(b) Blinking of eyes (c) Riding a bicycle
(d) Both (b) and (c)

51. The biggest difference between the flow of energy and the flow of chemical nutrients in an ecosystem is
(a) the amount of energy is much greater than the amount of nutrients
(b) nutrients are recycled but energy is not
(c) organisms always need nutrients but they don't always need energy
(d) energy is recycled but nutrients are not.

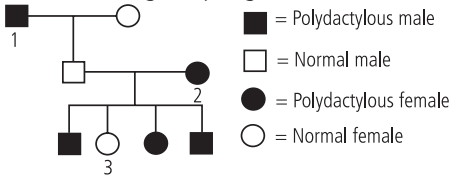
52. Reptiles got independent of water for survival and became true land animals because
(a) they possess internal fertilisation
(b) they possess shelled eggs
(c) they possess horny epidermal scales
(d) all of these.

53. Which of the following holds true for Whittaker's five kingdom classification?
(a) Cell structure is more complex in Kingdom Monera as compared to Kingdom Protista.
(b) Body organisation of protistans is more complicated as compared to fungi.
(c) Members of Plantae, Animalia and Fungi have different ecological roles due to difference in their modes of nutrition.
(d) Both (a) and (b)

54. Select the incorrect statement.
(a) White fibrous tissue occurs in pubic symphysis where it takes part in parturition.
(b) Mucoid tissue is present in umbilical cord and vitreous humour of eye.
(c) Multipolar neurons have several axons and one dendrite and are found in grey matter of brain.
(d) Osteocytes give off protoplasmic processes whereas chondroblasts do not have protoplasmic processes.

55. In case of gametophytic self incompatibility, pollen with S_1 allele (parent genotype S_1S_2) fails to germinate on stigma with genotype
(a) S_2S_3 (b) S_1S_2
(c) S_3S_4 (d) all of these.

56. In humans, polydactyly (*i.e*, presence of extra fingers and toes) is determined by a dominant autosomal allele (P) and the normal condition is determined by a recessive allele (p). Find out the possible genotypes of family members 1, 2 and 3 in the given pedigree.



	1	2	3
(a)	PP	Pp	pp
(b)	PP	PP	pp
(c)	Pp	PP	Pp
(d)	Pp	Pp	pp

57. A double stranded DNA has 30% cytosine. What is the percentage of adenine in it?
(a) 60% (b) 30% (c) 20% (d) 10%

58. Which of the following is incorrect regarding anaphase stage of cell division?
(a) It could be a stage of both mitotic and meiotic cell divisions.
(b) In meiotic cell division dissimilar chromosomes move towards opposite poles at this stage whereas in mitotic cell division similar chromosomes move towards the opposite poles at this stage.
(c) Chromosomes are single stranded at this stage irrespective of the cell division type.
(d) None of these

59. In the process of animal evolution, the transformation of habitat from water to land was assisted by the
(a) development of shelled eggs
(b) development of horny scales on skin
(c) development of ctenidial respiration
(d) both (a) and (b).

60. Which of the following holds true for pachytene stage of meiotic cell division?
(a) This stage leads to genetic recombination, hence, variations in sexually reproducing organisms.
(b) In this stage, the process of exchange of genetic material between sister chromatids of non-homologous chromosomes takes place.
(c) This stage takes place only in haploid cells of body *e.g.*, gametes.
(d) All of these

61. Cadmium pollution causes
(a) itai - itai disease (b) minamata disease
(c) fluorosis (d) blue baby syndrome.

62. Which of the following holds true for gel electrophoresis?
(a) It separates DNA fragments on the basis of their charge.
(b) Smaller DNA fragments move slower than larger DNA fragments.
(c) The separated DNA fragments can be seen by staining them with ethidium bromide.
(d) DNA being positively charged moves towards cathode.

63. Effective filtration pressure in glomerulus is caused due to
(a) powerful pumping action of the heart
(b) secretion of adrenaline
(c) afferent arteriole is slightly larger than efferent arteriole
(d) vacuum develops in proximal convoluted tubule and sucks the blood.

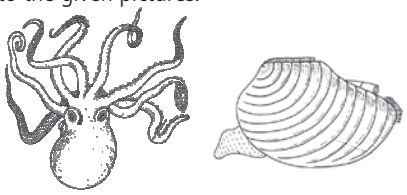
64. Bicarpellary, syncarpous, superior ovary with swollen placentae and obliquely placed carpels are found in
(a) *Solanum* (b) *Crotolaria*
(c) *Dalbergia* (d) *Lathyrus.*

65. Delta cells of islet of Langerhans secrete
(a) glucagon (b) insulin
(c) somatostatin (d) angiotensinogen.

66. Implantation of blastocyst at an abnormal site in the uterus is prevented by
(a) zona pellucida (b) corona radiata
(c) trophoblast (d) none of these.

67. The females are heterogametic in
(a) humans (b) birds
(c) *Drosophila* (d) grasshoppers.

68. Refer to the given pictures.


Organism A Organism B

Which of the following holds true for organisms A and B ?
(a) Organism A is cuttle fish whereas organism B is devil fish.
(b) Organism A is freshwater species whereas organism B is a marine species.
(c) Both organisms A and B belong to Phylum Mollusca.
(d) Organism A respires through gills whereas organism B respires through spiracles.

69. Which of the following is responsible for higher proton concentration in thylakoid lumen?
(a) Thylakoid lumen becomes enriched with H^+ due to photolytic splitting of water.
(b) NADP reductase situated on the outerside of thylakoid membrane obtains electrons from PSI and H^+ from matrix to reduce $NADP^+$ to NADP + H^+ state.
(c) Primary acceptor of electron, located on outer side of thylakoid membrane transfers electrons to an H carrier which removes a proton from matrix thereby releasing it into the lumen.
(d) All of these

70. Which of the following is an example of sex monosomy in humans?
(a) Down's syndrome (b) Patau's syndrome
(c) Turner's syndrome (d) Klinefelter's syndrome

71. Identify the recognition sequence and site of cleavage for restriction enzyme *Sal I.*

(a) 5′– A – G ↓ C–T – 3′
3′– T – C – G – A – 5′
↑

(b) 5′ – G ↓ G – A – T – C – C – 3′
3′– C – C – T – A – G – G – 5′
↑

(c) 5′– G – G ↓ C – C – 3′
3′– C – C – G – G – 5′
↑

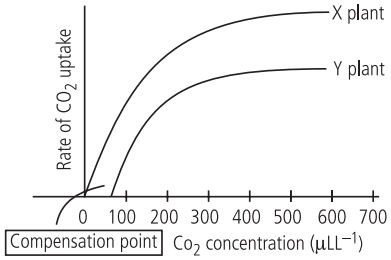
(d) 5′– G ↓ T – C – G – A – C – 3′
3′– C – A – G – C – T – G – 5′
↑

72. Which of the following holds true for the type of inflorescence shown in the picture?

(a) It is the modification of raceme.
(b) Peduncle is reduced and flattened to form receptacle.
(c) Flowers are pedicellate.
(d) Flowers are always of one type.

73. Select the hormone which is secreted by duodenum and inhibits gastric secretion and motility.
(a) Enterogastrone (b) Gastrin
(c) Duocrinin (d) Villikinin

74. Refer to the given graph and answer the question that follows.



Which of the following holds true for X and Y plants?
(a) Plant X shows high tolerance to temperature, salinity and aridity and shows high productivity as compared to plant Y.
(b) The leaves of plant Y have Kranz anatomy.
(c) Plant X shows high rate of photorespiration whereas plant Y shows negligible photorespiration.
(d) Plant X usually performs photosynthesis when stomata are open whereas plant Y performs photosynthesis even when stomata are closed.

75. Match column I with column II and select the correct option from the codes given below.

	Column I	**Column II**
A.	*Trypanosoma*	(i) Mixotrophic nutrition
B.	*Euglena*	(ii) Symbiont in intestine of termites
C.	*Trichonympha*	(iii) Photosynthetic protozoans
D.	Dinoflagellates	(iv) Parasitic protozoan

(a) A - (iv), B - (i), C - (ii) D - (iii)
(b) A - (i), B - (iii), C - (iv), D - (ii)
(c) A - (i), B - (ii), C - (iii), D - (iv)
(d) A - (iv), B - (iii), C - (ii), D - (i)

76. It is a large elongated sac like structure present beneath utricular gland and ejaculatory duct in cockroach. The secretion of this gland forms the outermost layer of the spermatophore. It is
(a) stink gland (b) phallic gland
(c) uricose gland (d) colleterial gland.

77. Which one of the following hormones never reaches to cytoplasm?
(a) Estrogen (b) FSH
(c) Progesterone (d) Testosterone

78. The syncytiotrophoblast cells of blastocyst secrete
(a) follicle stimulating hormone
(b) human chorionic gonadotropin
(c) growth hormone (d) prolactin.

79. Which of the following holds true for a dicot stem?
(a) Casparian strips are present on radial and tangential walls of endodermal cells.
(b) Vascular bundles are conjoint, collateral and open.
(c) Stem hairs are unicellular and always unbranched.
(d) Pith is absent.

80. Inflation or abnormal distension of bronchioles or alveolar sacs is known as
(a) asphyxia (b) emphysema
(c) pleurisy (d) pertussis.

81. During second and third trimester of pregnancy, the major source of estrogen and progesterone is
(a) corpus luteum (b) placenta
(c) embryoblast (d) ovary.

82. Which of the following is not present in Phylum Porifera?
(a) Canal system (b) Choanocytes
(c) Flame cells (d) Gemmules

83. r - strategists tend to
(a) have large number of offspring
(b) be relatively small organisms
(c) have short life spans
(d) all of these.

84. Periodic abstinence or rhythm method of birth control is based on which of the following facts?
(a) Ovulation occurs on 14^{th} day of menstrual cycle.
(b) Ovulation does not occur in lactating mothers.
(c) Sperms survive in uterus only for 1-2 hrs after coitus.
(d) None of these.

85. A haemophiliac man is married to a normal woman. What could be assumed about their progenies?
(a) All normal male progenies and all carrier female progenies.
(b) 50% haemophiliac male progenies and all normal female progenies.

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(c) All normal male progenies and 50% haemophiliac female progenies.
(d) All progenies normal.

86. Which of the following is the main cause of allopatric speciation?
(a) Geographical isolation (b) Reproductive isolation
(c) Allochronism (d) None of these

87. Polymerase Chain Reaction (PCR) can be used in case of
(a) gene therapy (b) prenatal diagnosis
(c) DNA fingerprinting (d) all of these.

88. Which of the following is an example of anthropogenic biome?
(a) Freshwater (b) Rainforests
(c) Grasslands (d) Croplands

89. Select the incorrect match from the following.
(a) Transgenic sheep - contains human gene for blood clotting factor IX
(b) Rosie - contains human gene for α_1 - antitrypsin
(c) Transgenic chicken - contains non-virulent genome of Avian leukosis virus
(d) Transgenic pig - contains gene expressing human growth hormone

90. The open ocean and tropical rainforest are two largest contributors to net primary productivity because
(a) both have high rates of net primary productivity
(b) both cover large surface areas on earth
(c) nutrients cycle fastest in these two ecosystems
(d) the ocean covers a large surface area and the tropical rainforest has a high rate of productivity.

ANSWER KEY

1.	(c)	**2.**	(b)	**3.**	(a)	**4.**	(c)	**5.**	(a)
6.	(b)	**7.**	(a)	**8.**	(c)	**9.**	(b)	**10.**	(c)
11.	(c)	**12.**	(a)	**13.**	(c)	**14.**	(d)	**15.**	(d)
16.	(c)	**17.**	(a)	**18.**	(c)	**19.**	(c)	**20.**	(b)
21.	(d)	**22.**	(b)	**23.**	(b)	**24.**	(b)	**25.**	(b)
26.	(c)	**27.**	(b)	**28.**	(d)	**29.**	(a)	**30.**	(c)
31.	(c)	**32.**	(d)	**33.**	(d)	**34.**	(b)	**35.**	(c)
36.	(b)	**37.**	(c)	**38.**	(b)	**39.**	(b)	**40.**	(b)
41.	(b)	**42.**	(b)	**43.**	(d)	**44.**	(d)	**45.**	(b)
46.	(b)	**47.**	(c)	**48.**	(a)	**49.**	(b)	**50.**	(c)
51.	(b)	**52.**	(d)	**53.**	(c)	**54.**	(c)	**55.**	(b)
56.	(d)	**57.**	(c)	**58.**	(c)	**59.**	(d)	**60.**	(a)
61.	(a)	**62.**	(c)	**63.**	(c)	**64.**	(a)	**65.**	(c)
66.	(a)	**67.**	(b)	**68.**	(c)	**69.**	(d)	**70.**	(c)
71.	(d)	**72.**	(b)	**73.**	(a)	**74.**	(a)	**75.**	(a)
76.	(b)	**77.**	(b)	**78.**	(b)	**79.**	(b)	**80.**	(b)
81.	(b)	**82.**	(c)	**83.**	(d)	**84.**	(a)	**85.**	(a)
86.	(a)	**87.**	(d)	**88.**	(d)	**89.**	(b)	**90.**	(d)

☺☺

UNSCRAMBLE ME

Unscramble the letters using the given clues.

	Scrambled letters	Clues	Words
1.	AHIZOOLCER	A sheath in which radicle and root cap are enclosed.	.....
2.	ETFYOOCSP	A technique used for direct visualisation of a foetus by passing a special endoscope through the abdomen into the amniotic fluid.	.....
3.	COLOEEHN	The most recent epoch of Quaternary (Neogene) period of geological time scale.	.....
4.	NIIOATGAREV	The occurrence of differently coloured patches, spots or streaks, leaves and petals of plants.	.....
5.	SEMAPRAI	Total absence of sperms from semen.	.....
6.	EOLETCRAB	A reduced leaf that arises from the stalk of an individual flower.	.....
7.	YISHCTOAEGHT	A primitive fossil amphibian which is a missing link between fishes and amphibians.	.....
8.	NEOTEORNS	Insecticide which is obtained from roots of *Derris elliptica* and is harmless to warm blooded animals.	.....
9.	IOBREPCIT	Nondigestible food product that stimulates the growth of beneficial bacteria in the digestive tract.	.....
10.	AUQRNANETI	A condition in which a person, animal or plant, suspected of carrying infectious agent is kept in isolation to prevent the spread of disease.	.....

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YOU ASK WE ANSWER

Do you have a question that you just can't get answered? Use the vast expertise of our MTG team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough. Few questions and their solutions are printed in this column. For more queries and their answers, please visit www.mtg.in

Readers can send their queries at editor@mtg.in or post to us.

Q.1. During anaerobic digestion of organic waste cellulose, hemicellulose and lipids are degraded but lignin is left undegraded. Why?

– Nitesh Sahoo, Odisha

Ans. Anaerobic digestion refers to the process of bacterial breakdown of organic matter in oxygen-free environment. The degradative microbes in anaerobic digestion system have the ability to produce the enzymes necessary for the break down of cellulose, hemicellulose, lipids etc. During anaerobic digestion of organic waste, cellulose, hemicellulose and lipids are degraded due to presence of cellulolytic microbes and acidogenic microbes. These microbes produce enzymes that depolymerise cellulose, hemicellulose and lipids. Lignin is a complex polymer of phenylpropane units, which are cross-linked to each other with a variety of chemical bonds. This structural complexity makes it difficult to be degraded. Lignin decomposition requires xylophalgeous anaerobes (lignin consumers) or high temperature pretreatment such as pyrolysis. Due to absence of these anaerobes and pyrolysis lignin is left undegraded. If we use these anaerobes during anaerobic digestion lignin is can be degraded. Conditions which favour the growth of white rot fungi including adequate nitrogen, moisture and temperature appear to be important in carrying out lignin decomposition.

Q.2. Is there any technique for controlling birth of Siamese twins?

– Biraja Prasad Dalai, Odisha

Ans. Siamese twins or conjoined twins are a type of monozygotic twins whose bodies are joined. They may share skin and tissue, or may even develop with shared organs and limbs. They are very rare occurring in only 1 out of 200,000 live births. There are no clearly identified reasons to explain why some fertilised eggs split developing into two individuals.

Since, it is not known what causes the situation that produces Siamese twins, there is also no known way to control it from happening.

Q.3. Cattle have enzyme cellulase which hydrolyses cellulose into glucose but cattle cannot digest their own stomach. Why is this so?

– Nitesh Sahoo, Odisha

Ans. Cellulose is a polysaccharide composed of glucose monomers and is the main constituent of the cell wall of plants. Cellulose is not present in animal cells. Cattle depend on plants and their products for food. They have to break down cellulose in order to release the cell content required for the nutrition of these animals.

The enzyme required to digest cellulose is called cellulase and it is not produced by these cattle. Cattle have some microorganisms (*e.g.,* bacteria) present in the rumen of their gut which secrete the enzyme cellulase.

As the digestive process works many of the bacteria are swept from the rumen into rest of the digestive system. To maintain their population in the rumen, they reproduce and multiply rapidly.

The stomach of ruminants is not made up of cellulose. Their stomach consists of mucus (protects surface), acids and certain digestive enzymes. The stomach wall of the ruminants is protected by epithelium which provides a barrier between enzymes and the stomach. Hence, cattle cannot digest their own stomach.

Q.4. What are the lines on the palms of our hands? How are they formed?

– PSSL Jayanthi, Andhra Pradesh

Ans. A hand is prehensile multifingered organ located at the end of the forearm. The glabrous skin on the front of the hand *i.e.*, palm, has lines known as palmar flexion creases which help the hand's skin to stretch and squeeze. Different palm lines are actually creases on the palms.

These lines or creases develop in the 12^{th} week of the gestation in womb. As the baby stays in a folded position and skin is very tender at that stage, wrinkles appear on the palms which later becomes palm lines. Palm lines provide an avenue for the hand's skin to fold without bunching up and making it difficult to grab onto items.

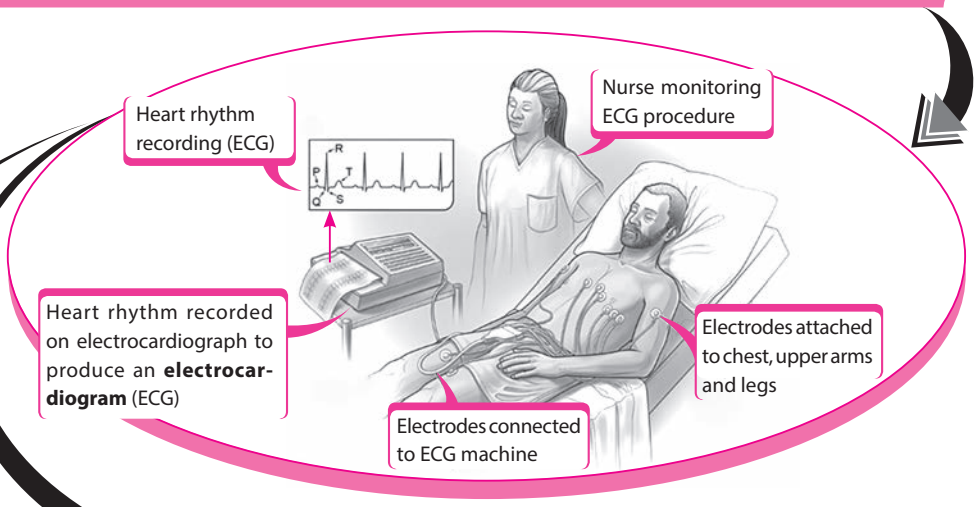
People usually have three transverse creases in their palm but one out of thirty people may have single palmar creases. Having a single palmar crease is often normal but it may also be associated with problems during development and certain disorders such as down syndrome, Aarskog syndrome, cohen syndrome, etc.

☺☺

BIO-GRAM

The Electrocardiogram (ECG)

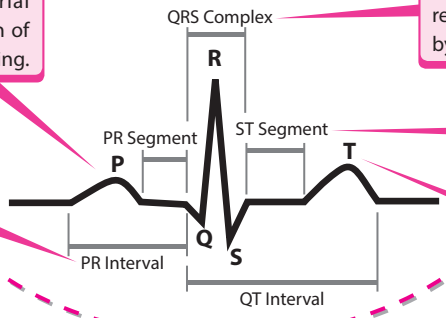
ECG is the record of electrical changes generated with each heart beat. The waves associated with electrical activity of heart during each cardiac cycle are represented by letters P, Q, R, S and T. The instrument used to record the changes is called an **electrocardiograph**.



NORMAL ECG

P Wave
It is a small upward wave due to atrial depolarisation, which causes contraction of both atria in response to SA node triggering.

PR Interval
It represents atrial depolarisation and conduction time through AV node. It is measured from beginning of the P wave to the beginning of the QRS complex..



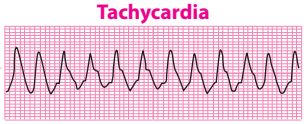
QRS Complex
It begins as a small downward deflection (Q) and continues as large upright triangular wave (R) ending as downward wave (S) at its base. It represents ventricular depolarisation. It is caused by impulse of contraction from AV node.

ST Segment
It measures time from end of ventricular depolarisation to the start of ventricular repolarisation.

T-Wave
Dome shaped wave which represents ventricular repolarisation.

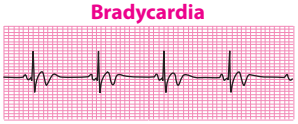
ABNORMAL ECG

Tachycardia



Tachycardia refers to heart beat faster than normal rate. It occurs when an abnormality in the heart produces rapid electrical impulses that control heart's pumping action. Various causes include damage to heart tissue, congenital heart abnormality, anaemia, hyperthyroidism, fever etc.

Bradycardia

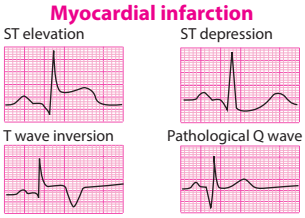


Bradycardia refers to slower heart beat than normal heart rate. It may be due to various reasons *viz.* heart tissue damage, congenital heart defect, myocarditis, etc.

Irregular heart beat

Atrial fibrillation is an irregular heart rate that can increase the risk of stroke or heart failure. Here, the upper chambers of heart (atria) beat chaotically out of coordination with lower chambers (ventricles).

Myocardial infarction



Myocardial infarction (MI) is the medical term for heart attack. It occurs when the flow of blood to the heart gets blocked. It can cause tissue damage and can be life threatening. ECG diagnosis of MI patient shows ST wave elevation or depression, T-wave inversion or pathological Q wave.

CROSS WORD

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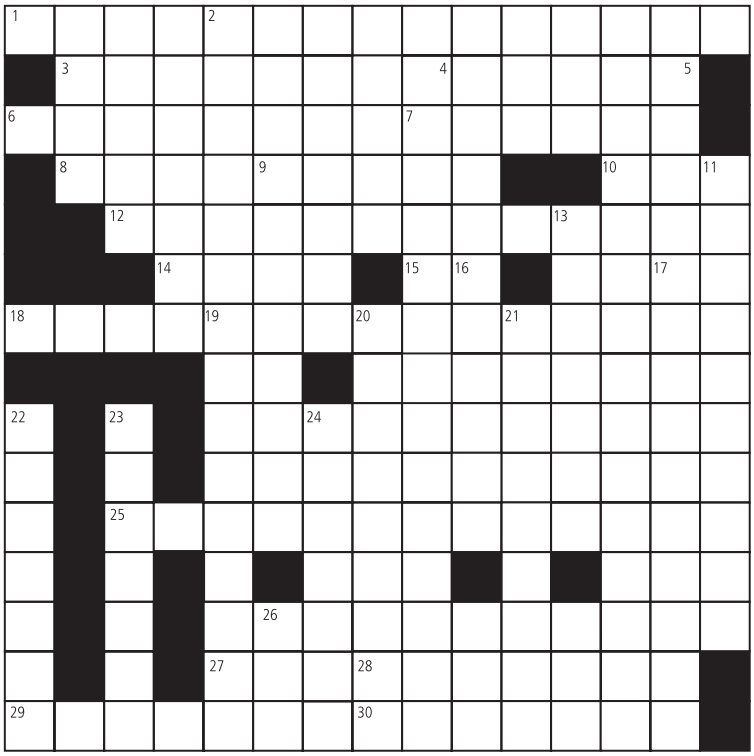

ACROSS

1. The ecological component of habitat delimited by functioning of an organism. (5)

2. A hormone secreted by medulla of the adrenal gland which prepare the body for 'flight or fight' and has widespread effects on circulation, the muscles and tissue metabolism. (11)

3. The pair of centrioles which lies in a common specialised part of cytoplasm called kinoplasm. (9)

4. The umbrella shaped and free swimming basic body forms of colonial cnidarian. (6)

6. The life cycle pattern of all seed-bearing plants such as gymnosperms and angiosperms. (9)

7. The swollen, usually unbranched, underground stems having circular nodes with buds for growth of daughter plants. (5)

8. The pain in a circumscribed area innervated by a sensory nerve of the peripheral neural system. (9)

12. A technique for introducing genetic material into living cells, especially plant cells, in which DNA-coated microscopic particles are fired into the cell using a special gun. (10)

14. The scientist who discovered evolution of oxygen occur in light reaction. (4)

18. The flower which can be divided into two similar halves only in one particular vertical plane. (11)

25. The region of chromatin in a typical nucleus which are loosely packed and stains light. (11)

26. The most recent geological period of Mesozoic era. (10)

27. The lignified outermost covering of a seed coat that develops from the integuments of the ovule after fertilisation. (5)

28. The innermost wall layer of microsporangium which nourishes the developing pollen grains. (7)

29. The phenomenon of masking or suppressing the expression of a gene by another non-allelic gene. (9)

30. The superficial outgrowth of the lichen which is primarily meant for increasing surface area and photosynthetic activity. (7)

DOWN

5. The second cervical vertebra which has a peg-like process called the odontoid process. (4)

9. The compound which destroys the beta cells of the islets of Langerhans. (7)

10. A fine powder of recycled modified plastic which is mixed with the bitumen to lay roads. (9)

11. The treatise which have all information about a particular taxon like family or genus. (9)

13. An enzyme extracted from the stomach of calf used for curdling milk for cheese. (6)

15. The points at which paired homologous chromosomes remain in contact as they begin to separate during the first prophase of meiosis forming a cross shape. (9)

16. Cancer of adipose tissue. (6)

17. The yellowish fluid that contains antibodies that provide passive immunity to the new born infant. (9)

19. The plant which generally have parallel leaf veins, scattered vascular bundles within the stems and flower parts in three or multiples of three. (7)

20. The stalk that attaches a leaf blade to the stems. (7)

21. A sensory patch of cells of semicircular ducts of internal ear which are concerned with balance of the body. (6)

22. A stimulant which is obtained from leaves of *Erythroxylum* species. (7)

23. A fluid-filled cavity that forms the main body cavity of vertebrate and most invertebrate animals. (6)

24. Any of the spore-producing structure on the undersurface of a fern frond, visible as rows of small brown dots. (4)

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