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We are happy to inform our readers that out of the 90 questions asked in NEET 2020, more than 85% questions were either exactly same or of similar type from the MTG Books.

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Here, the references of few same/similar questions are given :

Q. No.	MTG Books	Q. No. of Books	P. No.	38	NCERT Fingertips	123/XII	154
4	NCERT Fingertips	19/XII	501	39	NCERT Fingertips	82/XI	69
6	NEET Guide	18/XII	186	43	NCERT Fingertips	74,79/XI	297
32 Years		104/XII	108	44	NCERT Fingertips	35,36/XI	442
8	NCERT Fingertips	71/XII	296	49	NCERT Fingertips	11/XII	480
10	NCERT Fingertips	34/XII	351	50	NCERT Fingertips	28/XII	291
11	NCERT Fingertips	99/XII	119	53	NCERT Fingertips	47,48/XII	383
12	NCERT Fingertips	76/XI	118	55	NCERT Fingertips	25/XI	65
13	NEET Guide	71/XI	368	56	NCERT Fingertips	58/XII	79
14	NCERT Fingertips	85,86/XI	170	59	NCERT Fingertips	20/XII	381
15	32 Years	44/XII	411	60	NCERT Fingertips	85/XI	355
19	NCERT Fingertips	77/XII	191	62	NCERT Fingertips	39/XI	268
21	NCERT Fingertips	54/XI	414	66	NCERT Fingertips	29/XII	41
23	NCERT Fingertips	27/XII	260	67	NCERT Fingertips	23/XII	350
24	NCERT Fingertips	89/XII	520	68	NCERT Fingertips	25/XI	46
25	NCERT Fingertips	79/XI	536	70	NCERT Fingertips	59/XI	168
26	NCERT Fingertips	64/XI	444	74	NCERT Fingertips	11/XI	530, 531
28	NCERT Fingertips	8/XI	98	76	NCERT Fingertips	15/XII	194
30	NCERT Fingertips	63/XI	236	77	NCERT Fingertips	36/XII	222
32	NCERT Fingertips	7/XI	357	78	NCERT Fingertips	68/XII	81
33	NCERT Fingertips	1/XI	139	81	NCERT Fingertips	15/XII	319
34	NCERT Fingertips	9/XII	221	83	NCERT Fingertips	50/XII	147
35	NCERT Fingertips	7/XI	265	84	NCERT Fingertips	72/XI	327
36	NCERT Fingertips	15/XI	441	90	NCERT Fingertips	47/XII	322

and more such questions

- Which of the following refer to correct example(s) of organisms which have evolved due to changes in environment brought about by anthropogenic action?
 - Darwin's Finches of Galapagos islands.
 - Herbicide resistant weeds.
 - Drug resistant eukaryotes.
 - Man-created breeds of domesticated animals like dogs.
- Match the following columns and select the correct option.

Column-I	Column-II
(A) Organ of Corti	(i) Connects middle ear and pharynx
(B) Cochlea	(ii) Coiled part of the labyrinth

- Eustachian tube (iii) Attached to the oval window
 (D) Stapes (iv) Located on the basilar membrane
 (A) (ii) (iii) (i) (iv)
 (b) (iii) (i) (iv) (ii)
 (c) (iv) (ii) (i) (iii)
 (d) (i) (ii) (iv) (iii)
- Identify the wrong statement with reference to immunity.
 (a) When exposed to antigen (living or dead) antibodies are produced in the host's body. It is called "Active immunity".
 (b) When ready-made antibodies are directly given, it is called "Passive immunity".
 (c) Active immunity is quick and gives full response.
 (d) Fetus receives some antibodies from mother, it is an example for passive immunity.

22. Match the following columns and select the correct option.

Column-I

- | | |
|--------------------|---|
| (A) Floating ribs | (i) Located between second and seventh ribs |
| (B) Acromion | (ii) Head of the humerus |
| (C) Scapula | (iii) Clavicle |
| (D) Glenoid cavity | (iv) Do not connect with the sternum |
- | | | | |
|-----------|-------|------|-------|
| (A) | (B) | (C) | (D) |
| (a) (ii) | (iv) | (i) | (iii) |
| (b) (i) | (iii) | (ii) | (iv) |
| (c) (iii) | (ii) | (iv) | (i) |
| (d) (iv) | (iii) | (i) | (ii) |

Column-II

- | | |
|-------------------|---------------------|
| (a) ctenophora | (b) platyhelminthes |
| (c) aschelminthes | (d) annelida. |

29. Cuboidal epithelium with brush border of microvilli is found in

- | |
|---|
| (a) lining of intestine |
| (b) ducts of salivary glands |
| (c) proximal convoluted tubule of nephron |
| (d) Eustachian tube. |

30. Which is the important site of formation of glycoproteins and glycolipids in eukaryotic cells?

- | | |
|---------------------------|-----------------|
| (a) Endoplasmic reticulum | (b) Peroxisomes |
| (c) Golgi bodies | (d) Polysomes |

31. In light reaction, plastoquinone facilitates the transfer of electrons from

- | | |
|----------------------------------|---------------------------------|
| (a) PS-II to Cyt $b_6 f$ complex | (b) Cyt $b_6 f$ complex to PS-I |
| (c) PS-I to NADP ⁺ | (d) PS-I to ATP synthase. |

32. Match the following concerning essential elements and their functions in plants.

Column-I

- | | |
|-----------------|-------------------------|
| (A) Typhoid | (i) <i>Wuchereria</i> |
| (B) Pneumonia | (ii) <i>Plasmodium</i> |
| (C) Filarisasis | (iii) <i>Salmonella</i> |
| (D) Malaria | (iv) <i>Haemophilus</i> |
- | | | | |
|-----------|-------|-------|-------|
| (A) | (B) | (C) | (D) |
| (a) (i) | (iii) | (ii) | (iv) |
| (b) (iii) | (iv) | (i) | (ii) |
| (c) (ii) | (i) | (iii) | (iv) |
| (d) (iv) | (i) | (ii) | (iii) |

Column-II

- | | |
|----------|-------------------------|
| (A) Iron | (i) Photolysis of water |
|----------|-------------------------|

- | | |
|----------|-------------------------|
| (B) Zinc | (ii) Pollen germination |
|----------|-------------------------|

- | | |
|-----------|---|
| (C) Boron | (iii) Required for chlorophyll biosynthesis |
|-----------|---|

- | | |
|---------------|-----------------------|
| (D) Manganese | (iv) IAA biosynthesis |
|---------------|-----------------------|
- Select the correct option.

(A) (B) (C) (D)

- | | | | |
|----------|-----|------|-------|
| (a) (ii) | (i) | (iv) | (iii) |
|----------|-----|------|-------|

- | | | | |
|----------|-------|------|-----|
| (b) (iv) | (iii) | (ii) | (i) |
|----------|-------|------|-----|

- | | | | |
|-----------|------|------|-----|
| (c) (iii) | (iv) | (ii) | (i) |
|-----------|------|------|-----|

- | | | | |
|----------|-----|------|-------|
| (d) (iv) | (i) | (ii) | (iii) |
|----------|-----|------|-------|

24. Montreal Protocol was signed in 1987 for control of

- | |
|---|
| (a) transport of genetically modified organisms from one country to another |
| (b) emission of ozone depleting substances |
| (c) release of greenhouse gases |
| (d) disposal of e-wastes. |

25. The QRS complex in a standard ECG represents

- | |
|-----------------------------------|
| (a) repolarisation of auricles |
| (b) depolarisation of auricles |
| (c) depolarisation of ventricles |
| (d) repolarisation of ventricles. |

26. Name the plant growth regulator which upon spraying on sugarcane crop, increases the length of stem, thus increasing the yield of sugarcane crop.

- | | |
|----------------|-------------------|
| (a) Cytokinins | (b) Gibberellin |
| (c) Ethylene | (d) Abscisic acid |

27. How many true breeding pea plant varieties did Mendel select as pairs, which were similar except in one character with contrasting traits?

- | | | | |
|-------|-------|--------|-------|
| (a) 4 | (b) 2 | (c) 14 | (d) 8 |
|-------|-------|--------|-------|

28. Bilaterally symmetrical and acelomate animals are exemplified by

33. The roots that originate from the base of the stem are

- | | |
|-------------------|--------------------|
| (a) fibrous roots | (b) primary roots |
| (c) prop roots | (d) lateral roots. |

34. From his experiments, S.L. Miller produced amino acids by mixing the following in a closed flask.

- | |
|---|
| (a) CH ₄ , H ₂ , NH ₃ and water vapor at 800°C |
| (b) CH ₃ , H ₂ , NH ₄ and water vapor at 800°C |
| (c) CH ₄ , H ₂ , NH ₃ and water vapor at 600°C |
| (d) CH ₃ , H ₂ , NH ₃ and water vapor at 600°C |

35. Identify the basic amino acid from the following.

- | | |
|--------------|-------------------|
| (a) Tyrosine | (b) Glutamic Acid |
| (c) Lysine | (d) Valine |

36. The process of growth is maximum during

- | | |
|----------------|---------------|
| (a) log phase | (b) lag phase |
| (c) senescence | (d) dormancy. |

37. Presence of which of the following conditions in urine are indicative of diabetes mellitus?

- | | |
|--------------------------------------|------------------------------|
| (a) Uremia and Ketonuria | (b) Uremia and Renal calculi |
| (c) Ketonuria and Glycosuria | |
| (d) Renal calculi and Hyperglycaemia | |

38. Select the correct match.

- (a) Haemophilia – Y linked
- (b) Phenylketonuria – Autosomal dominant trait
- (c) Sickle cell anaemia – Autosomal recessive trait, chromosome -11
- (d) Thalassemia – X linked

39. Strobili cones are found in

- (a) *Salvinia* (b) *Pteris*
- (c) *Marchantia* (d) *Equisetum*.

40. Identify the wrong statement with reference to the gene 'I' that controls ABO blood groups.

- (a) The gene (I) has three alleles.
- (b) A person will have only two of the three alleles.
- (c) When I^A and I^B are present together, they express same type of sugar.
- (d) Allele 'i' does not produce any sugar.

41. Identify the correct statement with reference to human digestive system.

- (a) Ileum opens into small intestine.
- (b) Serosa is the innermost layer of the alimentary canal.
- (c) Ileum is a highly coiled part.
- (d) Vermiform appendix arises from duodenum.

42. Which of the following would help in prevention of diuresis?

- (a) More water reabsorption due to under-secretion of ADH.
- (b) Reabsorption of Na^+ and water from renal tubules due to aldosterone.
- (c) Atrial natriuretic factor causes vasoconstriction.
- (d) Decrease in secretion of renin by JG cells.

43. Match the following with respect to meiosis.

- | | |
|----------------|---------------------|
| (A) Zygote | (i) Terminalization |
| (B) Pachytene | (ii) Chiasmata |
| (C) Diplotene | (iii) Crossing over |
| (D) Diakinesis | (iv) Synapsis |

Select the correct option from the following

- | | | | |
|-----------|-----------|-----------|-----------|
| (A) (iii) | (B) (iv) | (C) (i) | (D) (ii) |
| (a) (iv) | (b) (iii) | (c) (ii) | (d) (i) |
| (c) (i) | (d) (ii) | (e) (iv) | (f) (iii) |
| (d) (ii) | (e) (iv) | (f) (iii) | (g) (i) |

44. Which of the following is not an inhibitory substance governing seed dormancy?

- (a) Gibberellin acid (b) Abscisic acid
- (c) Phenolic acid (d) Para-ascorbic acid

45. Match the following columns and select the correct option.

- | Column-I | Column-II |
|------------------------------------|-----------------------|
| (A) Bt cotton | (i) Gene therapy |
| (B) Adenosine deaminase deficiency | (ii) Cellular defence |

- (C) RNAi (iii) Detection of HIV infection
- (D) PCR (iv) *Bacillus thuringiensis*

(A) (B) (C) (D)

- (a) (iv) (i) (ii) (iii)
- (b) (iii) (ii) (i) (iv)
- (c) (ii) (iii) (iv) (i)
- (d) (i) (ii) (iii) (iv)

46. Match the following.

- (A) Inhibitor of catalytic activity (i) Ricin
- (B) Possess peptide bonds (ii) Malonate
- (C) Cell wall material in fungi (iii) Chitin
- (D) Secondary metabolite (iv) Collagen

Choose the correct option from the following:

(A) (B) (C) (D)

- (a) (ii) (iv) (iii) (i)
- (b) (iii) (i) (iv) (ii)
- (c) (iii) (iv) (i) (ii)
- (d) (ii) (iii) (i) (iv)

47. The sequence that controls the copy number of the linked DNA in the vector, is termed

- (a) selectable marker (b) Ori site
- (c) palindromic sequence (d) recognition site.

48. Snow-blindness in Antarctic region is due to

- (a) freezing of fluids in the eye by low temperature
- (b) inflammation of cornea due to high dose of UV-B radiation
- (c) high reflection of light from snow
- (d) damage to retina caused by infra-red rays.

49. According to Robert May, the global species diversity is about

- (a) 1.5 million (b) 20 million
- (c) 50 million (d) 7 million.

50. By which method was a new breed 'Hisardale' of sheep formed by using Bikaneri ewes and Marino rams?

- (a) Out crossing (b) Mutational breeding
- (c) Cross breeding (d) Inbreeding

51. Which of the following regions of the globe exhibits highest species diversity?

- (a) Western Ghats of India
- (b) Madagascar (c) Himalayas
- (d) Amazon forests

52. Match the following columns and select the correct option.

Column-I **Column-II**

- | | |
|------------------------------|-----------------------------|
| (A) 6-15 pairs of gill slits | (i) <i>Trygon</i> |
| (B) Heterocercal caudal fin | (ii) <i>Cyclostomes</i> |
| (C) Air bladder | (iii) <i>Chondrichthyes</i> |
| (D) Poison sting | (iv) <i>Osteichthyes</i> |

- | | | | |
|------------|------------|------------|------------|
| (A) | (B) | (C) | (D) |
| (a) (ii) | (iii) | (iv) | (i) |
| (b) (iii) | (iv) | (i) | (ii) |
| (c) (iv) | (ii) | (iii) | (i) |
| (d) (i) | (iv) | (iii) | (ii) |
- 53.** Which of the following statements is not correct?
- In man insulin is synthesised as a proinsulin.
 - The proinsulin has an extra peptide called C-peptide.
 - The functional insulin has A and B chains linked together by hydrogen bonds.
 - Genetically engineered insulin is produced in *E.coli*.
- 54.** Match the organism with its use in biotechnology.
- | | |
|---|---|
| (A) <i>Bacillus thuringiensis</i> | (i) Cloning vector |
| (B) <i>Thermus aquaticus</i> | (ii) Construction of first rDNA molecule |
| (C) <i>Agrobacterium tumefaciens</i> | (iii) DNA polymerase |
| (D) <i>Salmonella typhimurium</i> | (iv) Cry proteins |
- Select the correct option from the following:
- | | | | |
|------------|------------|------------|------------|
| (A) | (B) | (C) | (D) |
| (a) (ii) | (iv) | (iii) | (i) |
| (b) (iv) | (iii) | (i) | (ii) |
| (c) (iii) | (ii) | (iv) | (i) |
| (d) (iii) | (iv) | (i) | (ii) |
- 55.** Which of the following pairs is of unicellular algae?
- Laminaria* and *Sargassum*
 - Gelidium* and *Gracilaria*
 - Anabaena* and *Volvox*
 - Chlorella* and *Spirulina*
- 56.** Meiotic division of the secondary oocyte is completed
- prior to ovulation
 - at the time of copulation
 - after zygote formation
 - at the time of fusion of a sperm with an ovum.
- 57.** Secondary metabolites such as nicotine, strychnine and caffeine are produced by plants for their
- nutritive value
 - growth response
 - defence action
 - effect on reproduction.
- 58.** Which of the following statements are true for the Phylum Chordata?
- In Urochordata, notochord extends from head to tail and it is present throughout their life.
 - In Vertebrates, notochord is present during the embryonic period only.
- | | |
|---|-----------------|
| (C) | (D) |
| Central nervous system is dorsal and hollow. | |
| Chordata is divided into 3 subphyla : Hemichordata, Tunicata and Cephalochordata. | |
| (a) (D) and (C) | (b) (C) and (A) |
| (c) (A) and (B) | (d) (B) and (C) |
- 59.** Bt cotton variety that was developed by the introduction of toxin gene of *Bacillus thuringiensis* (Bt) is resistant to
- insect pests
 - fungal diseases
 - plant nematodes
 - insect predators.
- 60.** The product(s) of reaction catalysed by nitrogenase in root nodules of leguminous plants is/are
- ammonia alone
 - nitrate alone
 - ammonia and oxygen
 - ammonia and hydrogen.
- 61.** Match the following columns and select the correct option.
- | Column-I | Column-II |
|----------------------------|---------------------------------|
| (A) Pituitary gland | (i) Grave's disease |
| (B) Thyroid gland | (ii) Diabetes mellitus |
| (C) Adrenal gland | (iii) Diabetes insipidus |
| (D) Pancreas | (iv) Addison's disease |
| (A) (B) (C) (D) | |
| (a) (iv) (iii) (i) (ii) | |
| (b) (iii) (ii) (i) (iv) | |
| (c) (ii) (i) (iv) (ii) | |
| (d) (ii) (i) (iv) (iii) | |
- 62.** Which one of the following is the most abundant protein in the animals?
- Haemoglobin
 - Collagen
 - Lectin
 - Insulin
- 63.** Identify the correct statement with regard to G₁ phase (Gap 1) of interphase.
- DNA synthesis or replication takes place.
 - Reorganisation of all cell components takes place.
 - Cell is metabolically active, grows but does not replicate its DNA.
 - Nuclear division takes place.
- 64.** Match the trophic levels with their correct species examples in grassland ecosystem.
- | | |
|---------------------------------|---------------------|
| (A) Fourth trophic level | (i) Crow |
| (B) Second trophic level | (ii) Vulture |
| (C) First trophic level | (iii) Rabbit |
| (D) Third trophic level | (iv) Grass |
- Select the correct option.
- | | | | |
|------------|------------|------------|------------|
| (A) | (B) | (C) | (D) |
| (a) (ii) | (iii) | (iv) | (i) |
| (b) (iii) | (ii) | (i) | (iv) |
| (c) (iv) | (iii) | (ii) | (i) |
| (d) (i) | (ii) | (iii) | (iv) |

- 65.** The ovary is half inferior in
 (a) brinjal (b) mustard
 (c) sunflower (d) plum.

66. The body of the ovule is fused within the funicle at
 (a) hilum (b) micropyle
 (c) nucellus (d) chalaza.

67. The specific palindromic sequence which is recognised by EcoRI is
 (a) 5' - GAATT - 3'
 3' - CTTAAG - 5'
 (b) 5' - GGAACC - 3'
 3' - CCTTGG - 5'
 (c) 5' - CTAAAG - 3'
 3' - GAATT - 5'
 (d) 5' - GGATCC - 3'
 3' - CCTTGG - 5'.

68. Which of the following is correct about viroids?
 (a) They have RNA with protein coat.
 (b) They have free RNA without protein coat.
 (c) They have DNA with protein coat.
 (d) They have free DNA without protein coat.

69. In water hyacinth and water lily, pollination takes place by
 (a) insects or wind (b) water currents only
 (c) wind and water (d) insects and water.

70. The transverse section of a plant shows following anatomical features :
 (i) Large number of scattered vascular bundles surrounded by bundle sheath
 (ii) Large conspicuous parenchymatous ground tissue
 (iii) Vascular bundles conjoint and closed
 (iv) Phloem parenchyma absent
 Identify the category of plant and its part.
 (a) Monocotyledonous stem
 (b) Monocotyledonous root
 (c) Dicotyledonous stem
 (d) Dicotyledonous root

71. Which of the following statements is correct?
 (a) Adenine pairs with thymine through two H-bonds.
 (b) Adenine pairs with thymine through one H-bond.
 (c) Adenine pairs with thymine through three H-bonds.
 (d) Adenine does not pair with thymine.

72. Select the correct statement.
 (a) Glucocorticoids stimulate gluconeogenesis.
 (b) Glucagon is associated with hypoglycemia.
 (c) Insulin acts on pancreatic cells and adipocytes.
 (d) Insulin is associated with hyperglycemia.

73. Match the following columns and select the correct option.

Column-I	Column-II		
(A) Gregarious, polyphagous pest	(i) <i>Asterias</i>		
(B) Adult with radial symmetry and larva with bilateral symmetry	(ii) Scorpion		
(C) Book lungs	(iii) <i>Ctenopiana</i>		
(D) Bioluminescence	(iv) <i>Locusta</i>		
(A)	(B)	(C)	(D)
(a) (i) (iii) (ii) (iv)	(b) (iv) (i) (ii) (iii)	(c) (iii) (ii) (i) (iv)	(d) (ii) (i) (iii) (iv)

74. Match the following columns and select the correct option.

Column-I	Column - II		
(A) Eosinophils	(i) Immune response		
(B) Basophils	(ii) Phagocytosis		
(C) Neutrophils	(iii) Release histaminase, destructive enzymes		
(D) Lymphocytes	(iv) Release granules containing histamine		
(A)	(B)	(C)	(D)
(a) (iii) (iv) (ii) (i)	(b) (iv) (i) (ii) (iii)	(c) (i) (ii) (iv) (iii)	(d) (ii) (i) (iii) (iv)

75. If the head of cockroach is removed, it may live for few days because
 (a) the supra-oesophageal ganglia of the cockroach are situated in ventral part of abdomen
 (b) the cockroach does not have nervous system
 (c) the head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body
 (d) the head holds a 1/3rd of a nervous system while the rest is situated along the dorsal part of its body.

76. Name the enzyme that facilitates opening of DNA helix during transcription.
 (a) DNA ligase (b) DNA helicase
 (c) DNA polymerase (d) RNA polymerase

77. Flippers of penguins and Dolphins are examples of
 (a) adaptive radiation (b) convergent evolution
 (c) industrial melanism (d) natural selection.

78. Which of the following hormone level's will cause release of ovum (ovulation) from the Graffian follicle?
 (a) High concentration of estrogen
 (b) High concentration of progesterone
 (c) Low concentration of LH
 (d) Low concentration of FSH

79. If the distance between two consecutive base pairs is 0.34 nm and the total number of base pairs of a DNA double helix in a typical mammalian cell is 6.6×10^9 bp, then the length of the DNA is approximately

(a) 2.0 meters (b) 2.5 meters
(c) 2.2 meters (d) 2.7 meters.

80. Match the following columns and select the correct option.

Column-I

- (A) Placenta (i) Androgens
(B) Zona pellucida (ii) Human Chorionic Gonadotropin (hCG)
(C) Bulbo-urethral glands (iii) Layer of the ovum
(D) Leydig cells (iv) Lubrication of the penis
- | (A) | (B) | (C) | (D) |
|-----|-------|-------|------|
| (a) | (iv) | (ii) | (ii) |
| (b) | (i) | (iv) | (ii) |
| (c) | (iii) | (ii) | (iv) |
| (d) | (ii) | (iii) | (iv) |

Column-II

81. Match the following columns and select the correct option.

Column-I

- (A) *Clostridium butylicum* (i) Cyclosporin-A
(B) *Trichoderma polysporum* (ii) Butyric acid
(C) *Monascus purpureus* (iii) Citric acid
(D) *Aspergillus niger* (iv) Blood cholesterol lowering agent

Column-II

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

82. Goblet cells of alimentary canal are modified from

(a) squamous epithelial cells
(b) columnar epithelial cells
(c) chondrocytes
(d) compound epithelial cells.

83. Experimental verification of the chromosomal theory of inheritance was done by

(a) Mendel (b) Sutton (c) Boveri (d) Morgan.

84. The process responsible for facilitating loss of water in liquid form from the tip of grass blades at night and in early morning is

(a) transpiration (b) root pressure
(c) imbibition (d) plasmolysis.

85. Identify the substances having glycosidic bond and peptide bond, respectively in their structure.

(a) Chitin, cholesterol (b) Glycerol, trypsin
(c) Cellulose, lecithin (d) Inulin, insulin

86. Which of the following is not an attribute of a population?

(a) Sex ratio (b) Natality
(c) Mortality
(d) Species interaction

87. The enzyme enterokinase helps in conversion of

(a) protein into polypeptides
(b) trypsinogen into trypsin
(c) caseinogen into casein
(d) pepsinogen into pepsin.

88. Some dividing cells exit the cell cycle and enter vegetative inactive stage. This is called quiescent stage (G_0). This process occurs at the end of

(a) M phase (b) G_1 phase
(c) S phase (d) G_2 phase.

89. In relation to Gross primary productivity and Net primary productivity of an ecosystem, which one of the following statements is correct?

(a) Gross primary productivity is always less than Net primary productivity.
(b) Gross primary productivity is always more than Net primary productivity.
(c) Gross primary productivity and Net primary productivity are one and same.
(d) There is no relationship between Gross primary productivity and Net primary productivity.

90. Which of the following is put into anaerobic sludge digester for further sewage treatment?

(a) Primary sludge
(b) Floating debris
(c) Effluents of primary treatment
(d) Activated sludge

SOLUTIONS

1. (c) : Herbicide resistant weeds, drug resistant eukaryotes and man-created breeds of domesticated animals like dogs are examples of evolution by anthropogenic action. Darwin's Finches of Galapagos islands are example of natural selection, adaptive radiation and Founder's effect.

Monthly Test Drive CLASS XII

ANSWER

KEY

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

2. (c)
3. (c) : Active immunity is slow and takes time to give its full effective response.
4. (a) : Inspiration is initiated by the contraction of diaphragm that increases the volume of thoracic chamber in the antero-posterior axis. The contraction of external intercostal muscles lifts up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis. The overall increase in the thoracic volume causes a similar increase in pulmonary volume. An increase in pulmonary volume decreases the intrapulmonary pressure to less than the atmospheric pressure which forces the air from outside to move into the lungs.
5. (b) : During photorespiration in C₃ plants, some O₂ does bind to RuBisCO and RuBP instead of being converted to 2 molecules of PGA binds with O₂ to form one molecule of phosphoglycerate (3 Carbon) and phosphoglycolate (2 Carbon).
6. (b) : *Plasmodium* enters the human body as sporozoites (infectious form) through the bite of an infected female *Anopheles* mosquito.
7. (b) : Reserve material in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies. These are not bound by any membrane system and lie free in the cytoplasm, e.g., phosphate granules, cyanophycean granules and glycogen granules.
8. (c) : During diploneme in prophase I of meiosis I dissolution of the nucleoprotein synaptonemal complex occurs.
9. (a) : The ovary is inferior in ray florets of sunflower. It possess epigynous flower i.e., the margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arise above the ovary.
10. (b) : In gel electrophoresis , separated DNA fragments can be visualised only after staining the DNA with a compound i.e., ethidium bromide and followed by exposure to UV radiation as bright orange coloured bands.
11. (a) : *In vitro* fertilisation i.e., fertilisation outside the body in almost similar conditions as that in the body, followed by embryo transfer (ET) method. In this method, ova from the wife or donor (female) and sperms from husband or donor (male) are collected and are induced to form zygote under simulated conditions in the laboratory. The zygote or early embryos (with upto 8 blastomeres) could then be transferred into the fallopian tube (ZIFT-Zygote Intra Fallopian Transfer) and embryos with more than 8 blastomeres, into the uterus (IUT – Intra Uterine Transfer), to complete its further development.
12. (a) : Malaria, filaria and cancer are not sexually transmitted diseases (STDs).
13. (c) : Binding of oxygen with haemoglobin is related to partial pressure of O₂,partial pressure of CO₂, hydrogen ion concentration and temperature .In the alveoli, high pO₂, low pCO₂, lesser H⁺ concentration and lower temperature are factors favourable for the formation of oxyhaemoglobin, whereas in the tissues , low pO₂, high pCO₂, high H⁺ concentration and high temperature are favourable for dissociation of oxygen from the oxyhaemoglobin.
14. (c) : Sapwood is the peripheral or outermost region of the secondary xylem and lighter in colour.
15. (d)
16. (b) : In Rhodophyceae, food is stored as floridean starch which is very similar to amylopectin and glycogen in structure.
17. (a)
18. (a) : Embryological support for evolution was disapproved by Karl Ernst von Baer. He noted that embryos never pass through the adult stages of other animals.
19. (c) : Translation is the process of polymerisation of amino acids to form a polypeptide. The order and sequence of amino acids are defined by the sequence of bases in the mRNA. The amino acids are joined by a bond that is known as a peptide bond. Formation of a peptide bond requires energy. So, in the first phase itself amino acids are activated in the presence of ATP and linked to their cognate RNA-a process commonly called as charging of tRNA or aminoacylation of tRNA.
20. (d)
21. (b) : In citric acid cycle, during the conversion of succinyl-CoA to succinic acid a molecule of GTP is synthesized which is called substrate level phosphorylation.
22. (d) 23. (b)
24. (b) : Recognising the deleterious affects of ozone depletion, an international treaty, known as the Montreal Protocol was signed at Montreal (Canada)in 1987 (effective in 1989) to control the emission of ozone depleting substances.
25. (c) : The QRS complex represents the depolarisation of the ventricles, that initiates the ventricular contraction.
26. (b) : Spraying sugarcane crop with gibberellins increases the length of the stem and thus increasing the yield by as much as 20 tonnes per acre.
27. (c) : Mendel conducted artificial pollination or cross pollination experiments using several true-breeding pea lines. He selected 14 true-breeding pea plant varieties, as pairs which were similar except for one character with contrasting traits. Some of the contrasting traits selected were smooth or wrinkled seeds, yellow or green seeds, inflated (full) or constricted green or yellow pods and tall or dwarf plants.

- 28. (b)**: Platyhelminthes are bilaterally symmetrical, triploblastic and acelomate animals with organ level of organisation.
- 29. (c)**: The cuboidal epithelium is composed of a single layer of cube-like cells which is commonly found in ducts of glands and tubular parts of nephrons in kidneys and its main functions are secretion and absorption. The epithelium of proximal convoluted tubule (PCT) of nephron in the kidney has microvilli.
- 30. (c)**: Golgi apparatus is the important site of formation of glycoproteins and glycolipids. Protein synthesised by the rough endoplasmic reticulum and lipids synthesised by smooth endoplasmic reticulum reach the cisternae of the Golgi apparatus. Here, they combine with carbohydrates to form glycoproteins and glycolipids.
- 31. (a)**: After excitement, e^- is passed from PS-II(P_{680}) to primary electron acceptor (Pheophytin). From primary e^- acceptor, e^- is passed to plastoquinone. Plastoquinone (PQ) in turn transfer its e^- to Cyt $b_6 f$ complex. Therefore plastoquinone facilitates the transfer of electrons from PS-II to Cyt $b_6 f$ complex.
- 32. (c)**
- 33. (a)**: In monocotyledonous plants, the primary root is short lived and is replaced by a large number of roots. These roots originate from the base of the stem and constitute the fibrous root system e.g., wheat plant.
- 34. (a)**: In 1953, S.L. Miller, an American scientist created similar conditions in a laboratory scale. He created electric discharge in a closed flask containing CH_4 , H_2 , NH_3 and water vapor at $800^\circ C$ and observed formation of amino acids.
- 35. (c)**: Glutamic acid, valine and tyrosine are acidic, neutral and aromatic amino acid respectively.
- 36. (a)**: In most systems, the initial growth is slow i.e., lag phase, and it increases rapidly thereafter – at an exponential rate i.e., log or exponential phase.
- 37. (c)**: Diabetes mellitus is associated with formation of harmful compounds known as ketone bodies i.e., ketonuria and loss of glucose through urine i.e., glycosuria .
- 38. (c)**
- 39. (d)**: The sporophytes of pteridophytes bear sporangia that are subtended by leaf-like appendages called sporophylls. In some cases sporophylls may form distinct compact structures called strobili or cones, e.g., *Selaginella*, *Equisetum*.
- 40. (c)**: ABO blood groups are controlled by the gene *I*. The gene (*I*) has three alleles I^A , I^B and *i*. The alleles I^A and I^B produce a slightly different form of the sugar while allele *i* does not produce any sugar. Because humans are diploid organisms, each person possesses any two of the three *I* gene alleles. When I^A and I^B are present together they both express their own types of sugars, because of co-dominance.
- 41. (c)**: Ileum opens into the large intestine. Serosa is the outermost layer of the alimentary canal. The vermiform appendix is a vestigial organ, arises from the caecum.
- 42. (b)**: Aldosterone acts mainly at the renal tubules and stimulates the reabsorption of Na^+ and water and excretion of K^+ and phosphate ions. Thus, aldosterone helps in prevention of diuresis.
- 43. (b)**
- 44. (a)**: Gibberellic acid is involved in growth promoting activities, such as cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation and is called plant growth promoter. It breaks seed dormancy which is antagonistic to abscisic acid.
- 45. (a)** **46. (a)**
- 47. (b)**: Ori site is a sequence from where replication starts and any piece of DNA when linked to this sequence can be made to replicate within the host cells. This sequence is also responsible for controlling the copy number of the linked DNA in the vector. So, if one wants to recover many copies of the target DNA it should be cloned in a vector whose origin support high copy number.
- 48. (b)**: In human eye, cornea absorbs UV-B radiation, and a high dose of UV-B causes inflammation of cornea. This leads to a disorder called snow-blindness cataract. It leads to diminishing of eye sight, photo burning and later permanent damage to cornea that results in actual cataract.
- 49. (d)**
- 50. (c)**: Hisardale is a new breed of sheep developed in Punjab by crossing Bikaneri ewes and Marino rams. In cross-breeding, superior males of one breed are mated with superior females of another breed.
- 51. (d)** **52. (a)**
- 53. (c)**: Insulin consists of two short polypeptide chains : chain A and chain B, that are linked together by disulphide bridges.
- 54. (b)**
- 55. (d)**: *Gelidium*, *Gracilaria*, *Laminaria* and *Sargassum* are multicellular. *Anabaena* is filamentous blue green alga. *Volvox* is colonial.
- 56. (d)**: In humans, the secondary oocyte is produced when the primary oocyte grows in size and completes its first meiotic division. The secondary oocyte will be arrested at this stage of metaphase of meiosis II until fertilisation takes place. Thus, when a sperm cell fertilises the female sex cell, the secondary oocyte rapidly completes the remaining stages of meiosis II, giving rise to ovum, with which the sperm cell unites.

- 57. (c)**: Nicotine, strychnine and caffeine are the examples of alkaloids. These are produced by plants and are used by them in their defense against herbivores and pathogens.
- 58. (d)**: In Urochordata, notochord is present only in larval tail. Phylum Chordata is divided into three subphyla : Urochordata or Tunicata, Cephalochordata and Vertebrata.
- 59. (a)**: Bt cotton is resistance to cotton bollworm infestation. The genes *cry IAc* and *cry IIAb* control cotton bollworms, thus acts as bio-pesticide.
- 60. (d)**: The enzyme nitrogenase is a Mo – Fe protein and catalyses the conversion of atmospheric nitrogen to ammonia. The reaction is as follows :

$$\text{N}_2 + 8\text{e}^- + 8\text{H}^+ + 16\text{ATP} \longrightarrow 2\text{NH}_3 + 2\text{H}^+ + 16\text{ADP} + 16\text{Pi}$$
 (Ammonia) (Hydrogen)
- 61. (c)**
- 62. (b)**: Collagen is the most abundant protein in animal world. RuBisCO is the most abundant protein in the world of the biosphere.
- 63. (c)**: S or synthesis phase marks the period during which DNA synthesis takes place. Reorganisation of all cellular components takes place in M-phase. This phase also starts with nuclear division (Karyokinesis).
- 64. (a)**
- 65. (d)**: The ovary is superior in brinjal and mustard while it is inferior in sunflower.
- 66. (a)**: The hilum is a scar on the seed coat where funicle and body of ovule is attached.
- 67. (a)**: The palindromes in DNA are base pair sequences that are same when read forward (left to right) or backward (right to left) from a central axis of symmetry.
 Thus, GAATTC is a palindromic sequence which is recognised by EcoRI.
- 68. (b)**: Viroids are free RNA particles that lack protein coat. They are infectious agents smaller than viruses.
- 69. (a)**: In many aquatic plants with emergent flowers, pollination occurs by wind or insects, e.g., lotus, water lily, water hyacinth.
- 70. (a)**
- 71. (a)**: Adenine pairs with thymine by forming two hydrogen bonds, A = T.
- 72. (a)**: Glucocorticoids stimulate gluconeogenesis, lipolysis and proteolysis; and inhibit cellular uptake and utilisation of amino acids. Insulin acts mainly on hepatocytes and adipocytes. Glucagon is associated with hyperglycemia while insulin is associated with hypoglycemia.
- 73. (b)** **74. (a)**
- 75. (c)**: The head holds a bit of a nervous system of cockroach while the rest is situated along the ventral (belly-side) part of its body. So, if the head of a cockroach is cut off, it will still live for as long as one week.
- 76. (d)**: RNA polymerase facilitates the opening of the DNA helix and continues elongation.
- 77. (b)**: Analogous structures are result of convergent evolution, i.e., different structures evolving for the same function and hence having similarity. For example, the eye of the octopus and of mammals, the flippers of penguins and dolphins.
- 78. (a)**: FSH, LH and estrogen are at peak during ovulation (release of ovum).
- 79. (c)**: If the distance between two consecutive base pairs is 0.34 nm i.e., 0.3×10^{-9} m and the total number of base pairs of a DNA double helix in a typical mammalian cell is 6.6×10^{9} bp then the length of DNA is calculated by multiplying the total number of base pair with distance between two consecutive base pair i.e., $6.6 \times 10^9 \text{ bp} \times 0.34 \text{ nm} = 2.2 \text{ m (approx.)}$
- 80. (d)** **81. (b)**
- 82. (b)**: Certain cells of columnar epithelial cells contain mucus and are called goblet cells as they look like goblets. Such cells are present in alimentary canal.
- 83. (d)**: Sutton and Boveri proposed the chromosomal theory of inheritance but its experimental verification was done by Thomas Hunt Morgan.
- 84. (b)**: Transportation of ions from the soil into the vascular tissues of the roots, increases the pressure inside the xylem, known as root pressure. Effects of root pressure is observable at night and early morning when evaporation is low and excess water collects in the form of droplets around special openings of veins near the tip of grass blades and leaves of many herbaceous parts.
- 85. (d)**: Inulin is a polymer of fructose (polysaccharide). In a polysaccharide the individual monosaccharides are linked by a glycosidic bond. While insulin is a polymer of amino acids linked by a peptide bond.
- 86. (d)**
- 87. (b)**: Trypsinogen is activated by an enzyme, enterokinase, secreted by the internal mucosa into active trypsin.
- 88. (b)**
- 89. (b)**: Gross primary productivity (GPP) is the rate of production of organic matter during photosynthesis. A considerable amount of GPP is utilised by plants in respiration. GPP minus respiration losses (R) is the net primary productivity $\text{GPP} - \text{R} = \text{NPP}$. Therefore, GPP is always more than NPP.
- 90. (d)**: The sediment in a settling tank is called activated sludge. A small part of it is pumped back into the aeration tank to serve as the inoculum. While the remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters.



ZOOM IN BIO



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

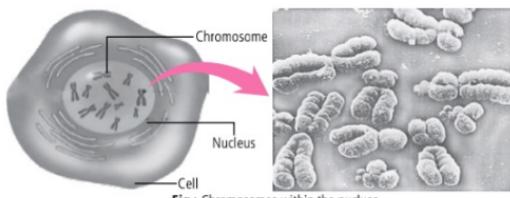
CHROMOSOMES

Nucleus is a specialised double membrane bound organelle which contains all the genetic information. It consists of five parts - nuclear envelope, nucleoplasm, nuclear matrix, chromatin and nucleolus. Chromatin is hereditary DNA-protein fibrillar complex. During prophase of nuclear division these chromatin fibres condense to form a definite number of thread-like structures called **chromosomes**. These chromosomes are composed of DNA and protein, known as hereditary vehicles as they store and transmit coded information contained in DNA in the form of linear sequences of bases (A, T, C, G).

The term chromosome comes from the Greek words for colour (chroma) and body (soma). Scientists gave this name to chromosomes because they are cell structures, or bodies, that are strongly stained by some colourful dyes used in research.

Discovery of Chromosomes

Chromosomes were observed in plant cell by Karl Wilhelm Von Nageli in 1842. German embryologist Walther Flemming in 1882, observed chromosomes in the rapidly dividing cells of salamander larvae.



How many chromosomes are there in a cell

Chromosomes have been found in the cells of all eukaryotes examined but their number vary from one species to another. The number is fixed and is same in all the individuals of a species. A few kinds of organisms, such as the Australian ant *Myrmecia*, the plant *Haplopappus gracilis*, (a relative of the sunflower that grows in an North American deserts) have only 1 pair of chromosomes, while some ferns have more than 500 pairs. Most eukaryotes have 10 to 50 chromosomes in their body cells.

The number of chromosomes in human cells is 46 with 22 autosomal pairs and 2 sex chromosomes, i.e., XX for females and XY for males. With the exception of gametes, every cell in a human body is diploid ($2n$) i.e., it contains 2 identical copies of each of the 23 chromosomes. Gametes are haploid (n) i.e., contains only single copy of each of the 23 chromosomes. The two copies of each chromosome in body cells are called homologous chromosomes.

Before cell division each homologue replicates producing two identical sister chromatids joined at the centromere or primary constriction, a condensed area found on all eukaryotic chromosomes.

STRUCTURE AND COMPOSITION OF CHROMOSOMES

Chromosomes are thread-like structures located inside the nucleus of animal and plant cells. The constricted region of linear chromosomes is known as the **centromere**. Although this constriction is called the centromere, it usually is not located exactly in the center of the chromosome and, in some cases, is located almost at the chromosome's end. The regions on either side of the centromere are referred to as the **chromosome arms**.

Centromeres help to keep chromosomes properly aligned during the complex process of cell division. As chromosomes are copied in preparation for production of a new cell, the centromere serves as an attachment site for the two halves of each replicating chromosome, known as **sister chromatids**. The short arm of the chromosome is labeled as "**p arm**." The long arm of the chromosome is labeled as "**q arm**." The location of the centromere on each chromosome gives the chromosome its characteristic shape, and can be used to help describe the location of specific genes. The terminal parts of chromosome are termed as **telomeres**. These are repetitive stretches of DNA located at the ends of linear chromosomes. They protect the ends of chromosomes in a manner similar to the way the tips of shoelaces keep them from unraveling.

Besides primary constriction a chromosome may have one or more secondary constriction near the distal part of an arm. This secondary constriction sometimes develop an outgrowth called **satellite** attached with it through chromatin thread as shown in figure. Such chromosomes bearing satellite are called **satellite (SAT) chromosomes** that serve as identifying markers and the secondary constrictions are always constant in their positions and hence can be used as markers to identify these particular chromosomes. In humans, chromosome number 13, 14, 15, 21, 22 are examples of SAT chromosomes.

Metaphase chromosome - At the time of cell division, chromatin starts condensing, and the most condensed chromatin stage is the metaphase chromosome.

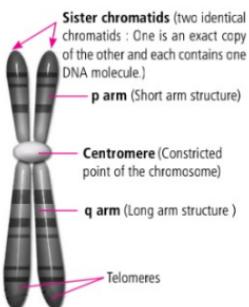


Fig.: Structure of chromosome

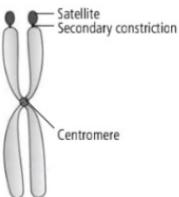


Fig.: Satellite chromosome

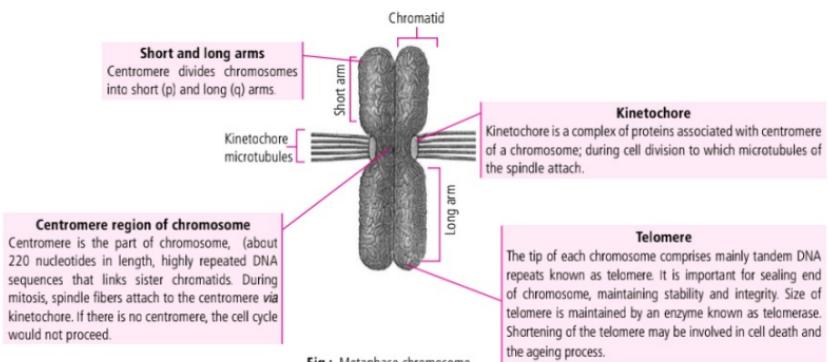


Fig.: Metaphase chromosome

The unique structure of chromosomes keeps DNA tightly wrapped around spool-like proteins, called histones. Without such packaging, DNA molecules would be too long to fit inside cells.

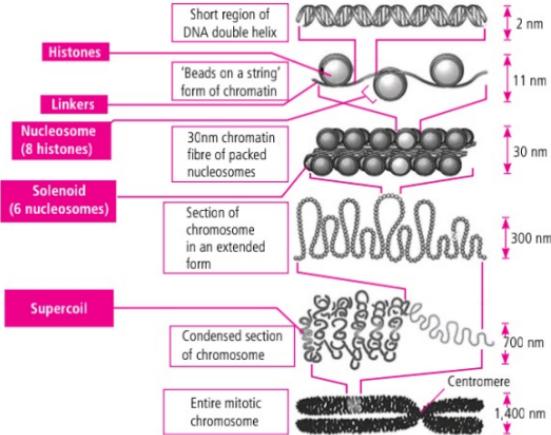


Fig.: Chromosome organisation

Chemical composition: The major chemical components of the chromosome are DNA(30-40%), RNA (0.5-10%), and proteins (50-60%; histones and nonhistone). This combination is called the chromatin. When stained, chromosomes demonstrate light and dark bands. The light bands identify **euchromatin**, which contains actively expressing genes. The dark bands are the **heterochromatin**, which is largely composed of repetitive non expressing DNA.

Snap Shots

- The 46 chromosomes found in human cells have a combined length of 200 nm ($1 \text{ nm} = 10^{-9} \text{ metre}$); if the chromosomes were to be unwound, the genetic material they contain would measure roughly 2 metres (about 6.5 feet) in length. The compactness of chromosomes plays an important role in helping to organise genetic material during cell division and enabling it to fit inside structures such as the nucleus of a cell, the average diameter of which is about 5 to 10 μm .

Types of Chromosomes on the Basis of Position of Centromere

Based on the position of centromere, chromosomes are of four types:

- Metacentric** - Centromere is present in the centre along the length of chromosomes in such a way that both the arms are of equal length.
- Sub-metacentric** - Centromere is present slightly offset from the centre of length of chromosomes.
- Acrocentric** - Centromere is present inner to the telomeric region (subterminal).
- Telocentric** - Centromere is present terminally in the area of telomere.

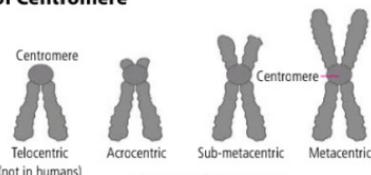


Fig.: Types of chromosomes

Special types of chromosomes

Giant chromosomes

These are of two types:

- Polytene chromosomes or salivary gland chromosomes and (ii) Lampbrush chromosomes.

Polytene chromosomes or salivary gland chromosomes: The giant chromosomes were first observed in the cells of salivary glands of dipteran insects by (*Drosophila*) by E.G. Balbiani in 1881. The name polytene was assigned to these chromosomes by Kollar (Gk. *polys* - many, *tainia* - threads).

The polytene chromosomes are much larger than the normal somatic chromosomes. These chromosomes can reach a length of 2000 μm as compared to somatic chromosomes. These chromosomes are multistranded, formed by somatic pairing between homologous chromosomes and repeated replication of their chromonemata (which causes increase in the DNA content about 1,000 times in *Drosophila*) the DNA content of somatic chromosomes. They remain attached to one other by common point called as **chromocentre**. Because of the multi-stranded condition, these chromosomes are called polytene chromosomes. These chromosomes are thought to be in permanent prophase stage.

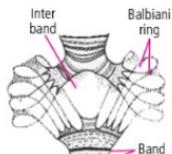
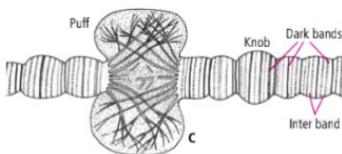
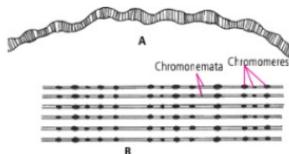


Fig.: Polytene chromosome. A. Typical polytene chromosome, B. Schematic representation of formation of a polytene chromosome and its dark bands by coming together of a number of chromonemata and their chromomeres. C. An enlarged portion of polytene chromosome showing a puff.

Fig.: Balbiani ring of a polytene chromosome

Polytene chromosomes bear alternate light and dark bands depending upon their reaction to basic dyes. At some places these chromosomes bear **puffs** or **Balbiani rings**. At the point of formation of Balbiani rings, DNA strands uncoil, become active and produce number of copies of mRNA. These puffs are temporary. At different developmental or physiological stages, different bands uncoil to produce puffs. Correlating puffs with different physiological or developmental processes, gene locations are identified on polytene chromosomes and chromosome maps are being prepared.

Lampbrush chromosomes: Lampbrush chromosomes are special type of giant chromosomes found in the nuclei of oocytes of many vertebrates, such as fishes, amphibians, reptiles and birds during the prolonged diplotene stage of first meiosis. Lampbrush chromosomes were first observed in salamander egg cells by Flemming in 1882 and given the name by Ruckert in 1892.

They are also found in the nucleus of *Drosophila* spermatocyte. These chromosomes are even larger than polytene chromosomes (their total length in a urodele oocyte may be upto 5900 μm or three times the aggregate length of total polytene chromosomes). These chromosomes consist of main axis and many fine lateral projections or loops which give them the appearance of a test tube brush or lampbrush, so called as lampbrush chromosomes.

In the early prophase, a lampbrush chromosome consists of two homologous chromosomes which are paired and each chromatid undergoes duplication to produce two chromatids. Hence they occur in bivalent stage. Each homologous chromosome is in contact with each other through a common point called **chiassata**. Each lampbrush chromosome has highly condensed two chromatids with double main axis. Along the length of chromatids there are several chromonema adjacent to each other, separated from each other by interchromomeric stretches. These chromonemas bear lateral projections called **loops**. Length of a loop vary from 5-100 μm . These loops are transcriptionally active and are involved in the transcription of mRNA, some of them are stored as informosomes (mRNA + protein) for producing biochemicals during early development stages of embryo.

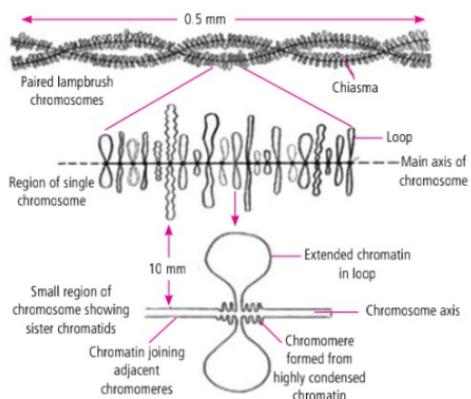
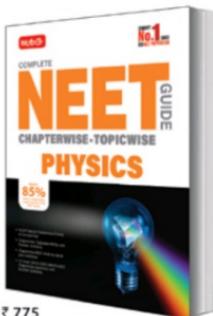


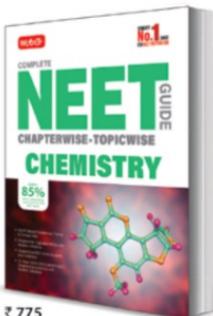
Fig.: Lampbrush chromosomes

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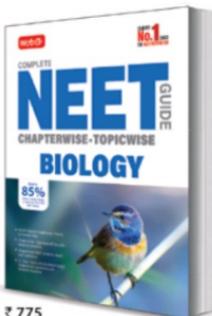
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AUTOSOMES AND SEX CHROMOSOMES

Chromosomes are broadly categorised into autosomes and sex chromosomes. Human beings have 22 pairs of autosomes and one pair of sex chromosomes. Human females are homogametic (22 + XX) and human males are heterogametic (22 + XY).

Y Chromosome

The Y Chromosome is present in males who have one X chromosome and one Y chromosome. Because only males have Y chromosome, the genes on this chromosome tend to be involved in male sex determination. Sex is determined by SRY gene. Many genes are unique to the Y chromosome but genes in areas known as pseudoautosomal regions (**PAR 1** and **PAR 2**) are present on both sex chromosomes.

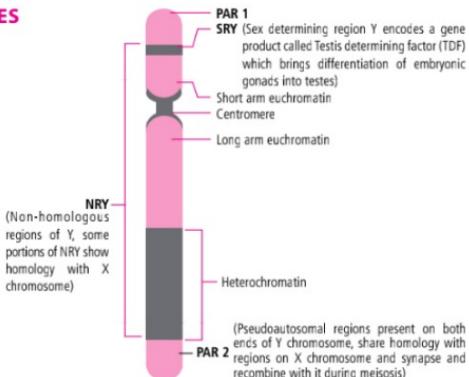


Fig.: The various regions of the human Y chromosome

Snap Shots

- In the absence of TDF, gonads differentiate into ovaries after sixth week of embryonic development, followed by development of female reproductive tract. Female sex is therefore called default sex.

X Chromosome and Barr Bodies

The X chromosome is significantly longer than Y chromosome and contains hundreds more genes. Because the additional genes in X chromosome have no counter part in the Y chromosome, the X genes are dominant.

Sex chromatin body or barr body is inactivated X chromosome found in female cells derived from buccal mucosa or in fibroblasts but not in similar male cells. Out of two X chromosomes one of the X chromosomes in females is inactivated early in embryonic development, shortly after the embryo formation sex is determined. Number of Barr bodies is one less than the number of X chromosomes present in an individual, e.g., 1 for normal XX, 2 for XXX.

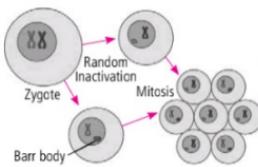


Fig.: Summary of the process of X-inactivation

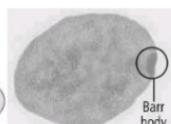


Fig.: Barr body in human nucleus

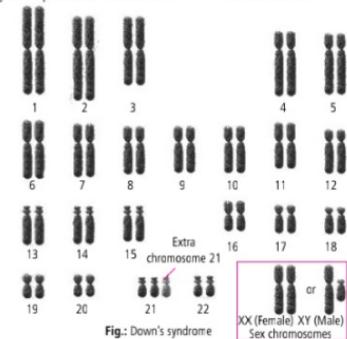


Fig.: Down's syndrome

CHROMOSOMAL ABNORMALITIES

These abnormalities may be due to absence or excess or abnormal arrangement of one or more chromosomes.

These are of 2 types :

- Abnormalities due to aneuploidy
- Aberrations either in autosomes or in sex chromosomes.

Autosomal Abnormalities (Non-disjunction involving autosomes)

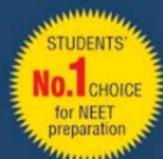
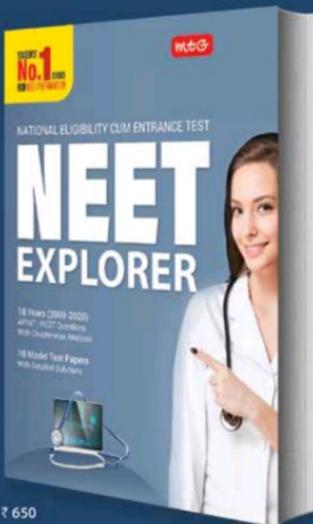
Down's syndrome

In humans, the defect is associated with chromosome 21, in which the chromosomal segment is present in three copies instead of two.

Both the chromosomes of the pair 21 pass into single egg due to non-disjunction during oogenesis.

It is characterised by palmar crease, round face, permanently open mouth, broad flat face, congenital heart disease.

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Snap Shots

- Down's syndrome is more common in females. In mothers, 30-35 years old, the risk to give birth to a child with Down syndrome is 1 in 750 and by age 45, the risk is as high as 1 in 16.

Sex Chromosomal Abnormalities

These are due to sex chromosomal aneuploidy.

Turner's syndrome

Turner's syndrome is due to monosomy ($2n - 1$). It is formed by the union of an allosome free egg ($22 + 0$) and a normal X sperm or a normal egg and an allosome free sperm ($22 + 0$). The individual has $2n = 45$ chromosomes ($44 + X0$) instead of 46.

Such persons are sterile females who have rudimentary ovaries, undeveloped breasts, webbed neck, short stature, abnormal intelligence. They may not menstruate or ovulate.

Klinefelter's syndrome

This syndrome arises due to trisomy of X chromosome. It is formed by union of an abnormal XX egg and normal Y sperm or normal X egg and abnormal XY sperm. The individual has 47 chromosomes ($44 + XXY$). Such persons are sterile males characterised by undeveloped testes, long limbs, knock knees, mental retardation, enlarged breast.

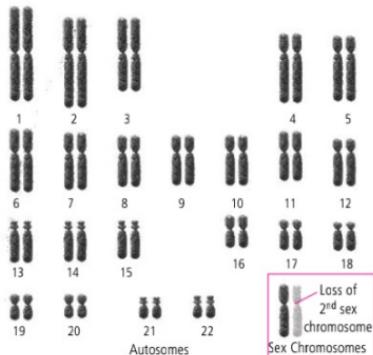


Fig.: Turner's syndrome

CYTogenetic Applications

Karyotyping (A cytogenetic technique): Karyotyping is the process of pairing and ordering all the chromosomes of an organism, thus providing a genome wide snapshot of an individual's chromosomes (karyogram/ idiogram).

It can be used for many purposes; such as to study chromosomal aberrations, cellular function, taxonomic relationships, and to gather information about past evolutionary events.

The study of karyotypes is made possible by staining. Usually, a suitable dye, such as Giemsa, is applied after cells have been arrested during cell division by a solution of colchicine usually in metaphase or prometaphase when chromosomes are in most condensed form. For humans, white blood cells are used most frequently because they are easily induced to divide and grow in tissue culture.

Six different characteristics of karyotypes are usually observed and compared:

- Differences in absolute sizes of chromosomes
- Differences in the position of centromeres
- Differences in relative size of chromosomes
- Differences in basic number of chromosomes
- Differences in number and position of satellites
- Differences in degree and distribution of heterochromatic regions

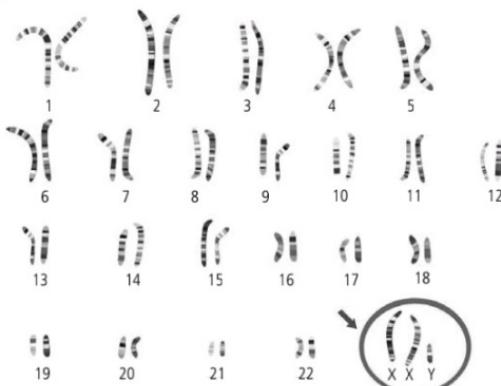


Fig.: Klinefelter's syndrome karyotype

Snap Shots

- Heterochromatin stains darker than euchromatin. Heterochromatin is packed tighter. It consists mainly of genetically inactive and repetitive DNA sequences as well as containing a larger amount of Adenine-Thymine pairs. Euchromatin is usually under active transcription and stains much lighter as it has less affinity for the Giemsa stain. Euchromatin regions contain larger amounts of Guanine-Cytosine pairs. The staining technique using Giemsa staining is called G banding and therefore produces the typical "G-Bands".

Chromosome Banding Techniques

Banding Patterns

Chromosomes in metaphase can be identified using certain staining techniques, so called banding. The band width and the order of bands is characteristic of a particular chromosome - a trained cytogeneticist can identify each chromosome (1,2,3...22, X and Y) by observing its banding pattern under the microscope.

The banding techniques fall into two principal groups: 1) those resulting in bands distributed along the length of the whole chromosome, such as G-, Q- and R-bands and 2) those that stain a restricted number of specific bands or structures. These latter include methods which reveal centromeric bands, C-bands, and nucleolar organiser regions, NOR's (at terminal regions of acrocentric chromosomes). C-banding methods do not permit identification of every chromosome in the somatic cell complement, but can be used to identify specific chromosomes.

A range of different chromosome banding patterns are: G-bands, R-bands, C-bands, Q-bands, and NOR-bands.

- G-Banding:** Chromosomes incubated in saline solution are stained with Giemsa following digestion with trypsin. It brings out sulphur rich protein parts. G-banding is absent in plant chromosomes.
- R-Banding:** Chromosomes incubated in buffer solution at high temperature are treated with Giemsa stain to produce bands in sulphur deficient parts. It is reverse of G-banding.
- C-Banding:** Each chromosome possesses a different degree of constitutive heterochromatin which enables the identification of individual chromosomes. Constitutive heterochromatin is located near the centromere, at telomeres and in the nucleolar organizer regions; it is composed of highly repetitive DNA. The banding method is a complex technique as it involves treatment of chromosomes with strong alkali, and then denaturation of DNA by high temperature with acid or alkali treatment followed by DNA renaturation that occurs in treatments with sodium-citrate at 60°C and then staining with Giemsa stain. By these treatments, the repetitive DNA (heterochromatin) re-natures but low repetitive and unique DNAs do not re-nature. This results in differential staining of the specific chromosome regions. It has been used to identify chromosomes of various plant and animal species including human.
- N-banding:** Briefly, air-dried chromosomes slides are stained for 90 minutes with Giemsa. The N-bands are generally located at the secondary constriction, satellites, centromeres, telomeres and heterochromatic segments. N-bands represent certain structural non-histone proteins specifically linked to the nucleolar organizer region of the eukaryotic chromosomes.

The N-banding patterns have been used for the location of nucleolar regions in the different organisms, such as, mammals, birds, amphibians, fishes, insects and plants. N-banding patterns differ in the chromosomes of different species.

In plants C and N banding techniques are commonly used.

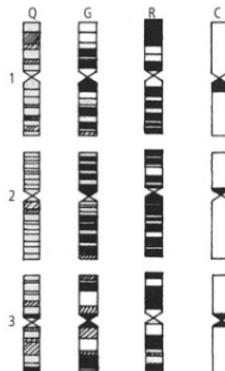


Fig.: Banding patterns of first three (largest) human chromosomes in response to various staining techniques :
Q-Quinacrine, G-Giemsa, R-Reverse Giemsa,
C-Constitutive heterochromatin

- Q-banding:** The chromosomes stained with Quinacrine mustard show bright and dark zones under UV light. This technique is used to identify Y chromatin in human males. It brings out AT rich regions.

Snap Shots

- A modified Giemsa-N-banding technique was developed by Singh and Tsuchiya in 1982 for the identification of barley chromosomes. This method is a combination of acetocarmine staining and Giemsa-N-banding. After processing according to this method, the centromeric region looks like a "diamond-shaped" structure; this is not seen in other techniques.

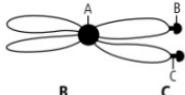
Chromosome Mapping

The diagrammatic representation of the relative distance between the linked genes of a chromosome is called linkage or genetic map. The method of constructing genetic maps of different chromosomes is called genetic mapping or chromosome mapping. Chromosome maps were first prepared in *Drosophila* by Sturtevant. It is useful in knowing the relative distance, location, order or sequence, chances of recombination, strength of linkage of genes on chromosomes.

Chromosome Functions

- Chromosomes contain genes. All the hereditary information is located in the genes.
- Chromosomes control the synthesis of structural proteins and thus help in cell division and cell growth.
- They control cellular differentiation.
- By directing the synthesis of particular enzymes, chromosomes control cell metabolism.
- Chromosomes can replicate themselves or produce their carbon copies for passing to daughter cells and next generation.
- Sat chromosomes produce nucleoli for synthesis of ribosomes.
- Their haploid or diploid number respectively bring about gametophytic and sporophytic characteristics to the individual.
- Chromosomes form a link between the offspring and the parents.
- Some chromosomes called sex chromosomes (e.g., X and Y or X and O) determine the sex of the individual.
- Through the process of crossing over, chromosomes introduce variations.
- Mutations are produced due to change in gene chemistry.

POWER EXERCISE

- Chromosome carrying centromere at one end is called
 - metacentric
 - submetacentric
 - acrocentric
 - telocentric.
 - Banding technique which is reverse to G - banding and produce bands in sulphur deficient regions is _____.
 - R - banding
 - C - banding
 - Q - banding
 - N - banding
 - The highly elongated diploid eukaryotic chromosomes with lateral loops and double main axis is
 - polytene chromosome
 - lampbrush chromosome
 - autosome
 - sex chromosome.
 - Palm crease, broad flat face, permanently open mouth with genetic make up of (45 + XX or 45 + XY) are characters of which of the following syndrome?
- | | |
|---|---|
| <ol style="list-style-type: none"> Turner's syndrome Down's syndrome None of these | <ol style="list-style-type: none"> Klinefelter's syndrome None of these |
|---|---|
- What does A, B and C represent in the given figure of a chromosome?
 

A	B	C
---	---	---

(a) Centriole	Telomere	Primary constriction
(b) Centriole	Satellite	Secondary constriction
(c) Centromere	Satellite	Secondary constriction
(d) Centromere	Telomere	Primary constriction
 - Number of Barr bodies in 44 + XXX condition would be
 - 3
 - 2
 - 1
 - 0.

7. Which of the following occurs due to non-disjunction of sex chromosomes?
 (a) Turner's syndrome (b) Down's syndrome
 (c) Edward's syndrome (d) Cri du chat syndrome
8. _____ is the primary constriction in a chromosome.
 (a) Telomere (b) Sarcomere
 (c) Centromere (d) Chromomere
9. Match the columns and select the correct option
- | Column I | Column II | | |
|-----------------|------------------------------|----------|----------|
| A. Karyotyping | (i) Spindle fibres | | |
| B. C-banding | (ii) Idiogram | | |
| C. Barr body | (iii) Secondary constriction | | |
| D. Centriole | (iv) Pericentromeric regions | | |
| | (v) Inactivated X chromosome | | |
| A | B | C | D |
| (a) (ii) | (iii) | (i) | (iv) |
| (b) (v) | (i) | (iii) | (iv) |
| (c) (iii) | (ii) | (v) | (i) |
| (d) (ii) | (iv) | (v) | (i) |
10. When the chromosome has a centromere nearer to one end of the chromosome resulting into one shorter and one longer arm, the chromosome is termed as
 (a) metacentric (b) sub-metacentric
 (c) acrocentric (d) telocentric. (*AMU 2012*)
11. Find the incorrect sentence.
 (a) Balbiani rings are the sites of RNA transcription.
 (b) The two chromatids of a homologous chromosome are attached to each other by secondary constriction.
 (c) Chromatin fibres condense to form chromosomes.
 (d) Polytene chromosomes occur in the salivary glands of insects such as *Drosophila*.
12. **Statement 1 :** Sat chromosomes are called marker chromosomes.
- Statement 2 :** Secondary constriction function as markers because they occupy constant position.
- (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 and statement 2 is false.
 (d) Both statements 1 and 2 are false.
13. The chromosomal condition in Turner's syndrome is
 (a) 21 trisomy with XY (b) 44 autosomes + XXY
 (c) 44 autosomes + YY (d) 44 autosomes + XO
 (e) 18 trisomy with XY. (*Kerala PMT 2011*)
14. Somatic cells of a human have _____ chromosomes and are called _____.
 (a) 46, haploid (b) 46, diploid
 (c) 44, diploid (d) 23, haploid
15. A man with enlarged breasts, sparse body hair and XYY genotype is suffering from
- (a) Down's syndrome (b) Turner's syndrome
 (c) Klinefelter's syndrome (d) super male. (*BHU 2010*)
16. Giant chromosomes are formed by
 (a) somatic pairing between non homologous chromosomes and endomitosis
 (b) crossing over between non-sister chromatids
 (c) somatic pairing between homologous chromosomes and endomitosis
 (d) crossing over of homologous chromosomes.
17. In plant karyotyping, which of the following banding technique/techniques is/are commonly used?
 (a) C – banding
 (b) G – banding
 (c) N – banding
 (d) Both (a) and (c)
18. Which of the following statement is correct regarding chromosomes functions?
 (a) Sat chromosomes do not produce nucleoli for synthesis of ribosomes.
 (b) Kinetochore is dense mass of protein attached to microtubules.
 (c) Chromosome do not control the synthesis of structural proteins.
 (d) Autosomes determine the sex of the individual.
19. Due to non-disjunction of chromosomes during spermatogenesis, 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 (*Karnataka CET 2010*)
20. Lightly stained, diffused fibrous part of chromatin that takes part in transcription is _____.
 (a) chromomere (b) euchromatin
 (c) heterochromatin (d) both (b) and (c)

ANSWER KEY

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



WHO AM I ...

- | | |
|-----------------------|--------|
| 1. Supplementary gene | Pg. 70 |
| 2. Turner's syndrome | Pg. 76 |

BIO Digest

This article covers high yield facts of the given topic.



Respiration in Plants

- Respiration is a vital, energy yielding, enzymatically controlled catabolic process which involves a stepwise oxidative breakdown of food substance inside living cells.
- The exchange of respiratory gases, i.e., O₂ and CO₂ between the organism and its surroundings is known as **external respiration** and the exchange of respiratory gases between tissue cells and surrounding environment is called **internal respiration**.
- The actual respiration by which chemical energy or bond energy of organic molecules is released by oxidation is called **cellular respiration**.

CELLULAR RESPIRATION

- Cellular respiration uses glucose and oxygen to produce carbon dioxide, water and energy.
- This released energy is used to synthesise energy rich molecules called **ATP**.
- The overall general reaction for cellular respiration can be represented as:



Respiratory Substrates

- The organic substances that are oxidised during respiration to liberate energy in living cells are called as respiratory substrates. The commonly used respiratory substrates are carbohydrates, proteins, fats and organic acids.
- The most common respiratory substrate is **glucose**.
- Proteins are rarely used in respiration, e.g., during germination of protein rich seeds and spores.

Respiratory Quotient

- Respiratory quotient (R.Q.) is the ratio of volume of carbon dioxide liberated in respiration to the volume of oxygen consumed in it over a specific period of time by a unit tissue, organ or organisms. The ratio is expressed as:

$$\text{R.Q.} = \frac{\text{Volume of CO}_2 \text{ liberated}}{\text{Volume of O}_2 \text{ consumed}}$$

- Respiratory quotient can be unity (carbohydrate, during aerobic respiration), more than unity (organic acids), less than unity (fats, proteins), zero and infinity (carbohydrate, during anaerobic respiration).

TYPES OF RESPIRATION

- Respiration can be studied under two major categories - aerobic and anaerobic.
- Aerobic respiration** is that type of respiration in which organic food is completely oxidised with the help of oxygen (as terminal oxidant) into carbon dioxide and water.
- It occurs by two methods : **common pathway and pentose phosphate pathway**. The common pathway of aerobic respiration takes place in three steps - **glycolysis, Krebs' cycle and terminal oxidation**.
- Anaerobic respiration** is an enzyme mediated catabolic process where oxygen is not used as an oxidant and the organic food is broken down incompletely to liberate energy. The commonly produced products of anaerobic respiration are CO_2 , ethyl alcohol and lactic acid.

GLYCOLYSIS

- It is the first stage of breakdown of glucose, common to both aerobic respiration and anaerobic respiration.
- It occurs in cytosol and involves partial oxidation of glucose into two molecules of pyruvic acid through a series of enzyme mediated reactions.
- It is also called **EMP pathway**, since it was discovered by three German scientists - Gustav Embden, Otto Meyerhof and J. Parnas in 1930.
- Glycolysis has two phases, **preparatory** and **pay off**. In the preparatory phase, glucose is broken down to glyceraldehyde 3-phosphate consuming ATP. In the pay off phase, the latter is changed into pyruvate producing NADH and ATP.

Net products of glycolysis

- In glycolysis, two molecules of ATP are consumed during double phosphorylation of glucose to form fructose-1, 6 biphosphate, while four molecules of ATP are produced by substrate level phosphorylation. Hence, there is a gain of **2 ATP molecules**.
- Two molecules of NADH are formed at the time of oxidation of glyceraldehyde 3-phosphate to 1, 3-biphosphoglycerate.
- Since each NADH is equivalent to 3ATP, 6 more ATP molecules are formed. Thus, a total of **10 ATP molecules** are produced and the net gain of ATP in glycolysis is **8 ATP molecules**.
- The net reaction of glycolysis is as follows:
 $\text{Glucose} + 2\text{NAD}^+ + 2\text{ADP} + 2\text{H}_3\text{PO}_4 \rightarrow 2 \text{ Pyruvate} + 2\text{NADH} + 2\text{H}^+ + 2\text{ATP}$

Significance

- First enzymatic breakdown of glucose and formation of two molecules of pyruvic acid.
- Intermediates of glycolysis are used for synthesis of important biochemicals. For example, phosphoenolpyruvate yields shikimic acid which is used in synthesis of amino acids, tryptophan, tyrosine and phenylalanine.
- Tryptophan is raw material for IAA synthesis. The amino acids are employed for synthesis of proteins, alkaloids, flavonoids and lignin. Similarly, pyruvic acid forms amino acid alanine.

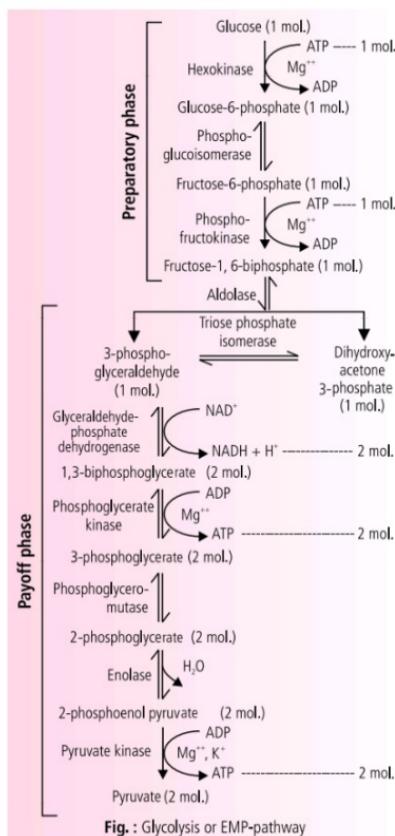
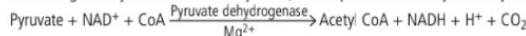


Fig. : Glycolysis or EMP-pathway

Oxidation of Pyruvate : The Link Reaction

- Pyruvate formed at the end of glycolysis does not enter the next step of citric acid cycle directly. Rather, it is transported from cytoplasm to mitochondria through a specific transport protein.
- Pyruvate undergoes oxidative decarboxylation to produce CO_2 and NADH. The resultant product combines with sulphur containing coenzyme A to form acetyl CoA, in the presence of enzyme complex pyruvate dehydrogenase.



KREBS' CYCLE

- Citric acid cycle or Krebs' cycle is the next step of glycolysis linked by pyruvate oxidation. Krebs' cycle was proposed by **Hans Adolf Krebs** in 1937. It operates in the mitochondrial matrix.
- The cycle consists of 10 enzymatic steps, four of which are dehydrogenations and two decarboxylations.
- Oxalacetate released at end picks up another molecule of activated acetate to repeat the cycle, as two molecules of acetyl-CoA are formed from one molecule of glucose. Therefore, net gain of Krebs' cycle is :
$$2 \text{ Acetyl-CoA} + 6\text{H}_2\text{O} + 6\text{NAD}^+ + 2\text{FAD} + 2\text{GDP} + 2\text{Pi} \rightarrow 4\text{CO}_2 + 2\text{H}_2\text{O} + 6\text{NADH} + 6\text{H}^+ + 2\text{FADH}_2 + 2\text{GTP} + 2\text{CoA}$$
- During the process of oxidation of 2 acetyl CoA via Krebs' cycle, 8 reducing equivalents (6 as NADH and 2 as FADH₂) are produced.
- Being catabolic, Krebs' cycle provides a number of intermediates which are used in different anabolic pathways to form important biomolecules like glutamic acid, aspartic acid, etc., **hence this cycle is amphioxin in nature**.

TERMINAL OXIDATION

- It is an oxidation that occurs towards the end of catabolic process and consists of two processes : electron transport and oxidative phosphorylation.

Electron transport chain

- The inner mitochondrial membrane has groups of several proton (H^+) and electron (e^-) acceptors. These groups are arranged in a specific series called electron transport chain (ETC) or electron transport system (ETS).

Table: Multiprotein complexes in electron transport chain

Complex name	Description
NADH – Coenzyme Q reductase (or NADH dehydrogenase complex)	This complex comprises NADH dehydrogenase , FMN and FeS centre. Two protons and two electrons from $\text{NADH} + \text{H}^+$ are transferred to FMN, which gets reduced to FMNH_2 . Electrons are then transferred from FMNH_2 to Coenzyme Q (CoQ) , also called ubiquinone (UQ) which gets reduced to CoQH_2 . During this process, 2H^+ are transferred from the matrix side of inner membrane of mitochondrion to the intermembrane space.
Succinate – Coenzyme Q reductase (or succinate dehydrogenase complex)	It includes the membrane bound enzyme of Krebs' cycle, succinate dehydrogenase , FAD and FeS centre. Two hydrogens removed from succinate reduce FAD to FADH_2 . From FADH_2 , the electrons are transferred to CoQ via FeS centre and CoQ is reduced to CoQH_2 .
Cytochrome c reductase (cytochrome bc ₁ complex)	It consists of cytochrome b , FeS complex and cytochrome c₁ . Electrons donated by CoQH_2 are transferred through cyt b, FeS centre and cyt c ₁ to cytochrome c, which gets reduced. 4H^+ are transferred from matrix to intermembrane space. Like CoQ, cytochrome c is a mobile electron carrier and is not the part of any complex mentioned here.
Cytochrome c oxidase complex	It includes cytochrome a , cytochrome a₃ and two copper centres. Electrons are received from cytochrome c (which gets oxidised). Electrons are ultimately transferred to oxygen to form water. This step is called terminal oxidation .

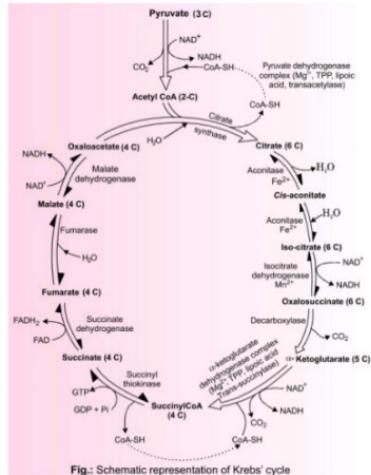


Fig.: Schematic representation of Krebs' cycle

Oxidative phosphorylation

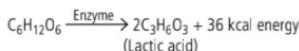
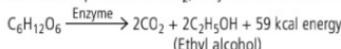
- Oxidative phosphorylation is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced coenzymes (NADH, FADH₂) produced in respiration.
- Oxidative phosphorylation requires enzyme ATP synthase. It is considered to be the fifth complex of electron transport chain. ATP synthase is located in F₁ or head piece of elementary particles (F₀ – F₁) present on mitochondrial membrane.
- The protons (H⁺) originating from electron transfer are translocated by the respiratory chain across the membrane from the M (matrix) side to the C (cytosol) side or outer side.
- Transport of the electrons from NADH over ETC helps in pushing three pairs of protons to the outer chamber while two pairs of protons are sent outwardly during electron flow from FADH₂ (as the latter donates its electrons further down to the ETC).
- According to the chemiosmotic hypothesis of Peter Mitchell, this translocation creates a pH difference and a membrane potential. Both constitute the proton-motive force that tends to move H⁺ from the C side back to the M side of the membrane.
- Since the inner mitochondrial membrane is highly impermeable to H⁺ ions, these can only reach the M side through the "proton channel" of the ATPase. When H⁺ moves from the C side to the M side, the F₁-ATPase, operating in reverse, catalyses ATP synthesis.

Balance Sheet of ATP

- The total ATP production obtained from complete oxidation of glucose molecule to CO₂ and H₂O under aerobic conditions is 36 or 38.

ANAEROBIC RESPIRATION

- Anaerobic respiration is an enzyme mediated energy liberating, catabolic process of step-wise but incomplete breakdown of organic substrate without using oxygen as an oxidant. Energy is liberated during breaking of bonds between various types of atoms. The common products of anaerobic respiration are CO₂, ethyl alcohol and lactic acid.



- In microorganisms, the term anaerobic respiration is replaced by **fermentation**. The latter is defined as anaerobic breakdown of carbohydrates and other organic compounds to form alcohol and organic acids with the help of microbes or their enzymes.

Mechanism of Anaerobic Respiration

- Glycolysis, the enzymatic breakdown of glucose into two molecules of pyruvate is common to both anaerobic and aerobic mechanism of respiration.
- Here onwards, pyruvate formed is anaerobically broken down into various products depending upon the organism and the site, i.e., type of tissue where it is occurring.
- For example, alcohol is formed in fungi (*Rhizopus*, yeast), bacteria and lactic acid is formed in lactic acid bacteria, e.g., *Lactobacillus*, some fungi and muscles of vertebrates.

Plant Growth and Development

- 'Growth' and 'development' are sometimes used interchangeably, but in botanical sense they describe separate events in the organisation of the mature plant body. Plant growth is generally indeterminate, i.e., continued throughout the life.

GROWTH

- Growth** is defined as a permanent or irreversible increase in dry weight, size, mass or volume of a cell, organ or organism. During growth, anabolic processes exceed catabolic processes. Growth is final end product of successful metabolism.

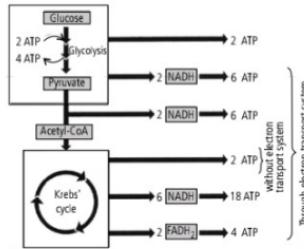


Fig.:Summary of ATP produced

- In plants growth is restricted to some specific regions (called **meristems**). The growing regions in plants are **apices of shoot** and **root** where meristems are present. Plant growth takes place in three steps or phases: **formative phase**, **enlargement phase** and **differentiation phase**.
- The increase in growth per unit time is called **growth rate**. It may result in two types of growth:
 - Arithmetic growth** – It is a type of growth in which the rate of growth is constant and increase in growth occurs in arithmetic progression, i.e., 2, 4, 6, 8, etc. Here after mitosis, one daughter cell remains meristematic while, other grows and differentiates. Here, a **linear curve** is obtained on plotting growth against time.
 - Geometric growth** – It is quite common in unicellular organisms when grown in nutrient rich medium. Here, every cell divides. The daughter cells grow and divide and the process is repeated for generation. Initial growth is slow as the number of cells initially are small. Later on, there is rapid growth at exponential rate. It is called **log** or **exponential growth**.
- If total growth is plotted against time, an S-shaped or **sigmoid curve** is obtained. It consists of four parts – **lag phase**, **log phase** (exponential phase), **phase of diminishing growth** and **stationary phase**.
- The total growth per unit time is called **absolute growth rate**. It is the actual growth curve obtained by plotting growth against time. The growth of a system over a period of time compared to its initial growth is called **relative growth rate**. Growth is measured by measuring increase in length, e.g., stem, root, pollen tube; increase in volume, e.g., fruits; increase in area, e.g., leaves increase in diameter, tree trunks and fruits increase in fresh or dry weight, etc.
- Various factors affect growth such as : intensity, quality and duration of sunlight; temperature; water; nutrients; gravity; carbon dioxide and oxygen.

DEVELOPMENT

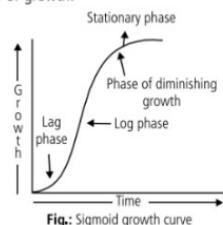
- Development** is the sequence of changes that occur in the structure and functioning of an organism, organ, tissue or cell involving its formation, growth, differentiation, maturation, reproduction, senescence and death. The ability to change under the influence of internal or external stimuli is called **plasticity**. The intrinsic plasticity is found in cotton, coriander, etc. Environmental plasticity is best seen in emergent hydrophytes like buttercup (*Ranunculus*). In both cases, plants show heterophily.
- Heterophily** is the occurrence of different types of leaves on the same plant habitually in different growth phases or under different environmental conditions.
- Differentiation** is the permanent qualitative change in structure, chemistry and physiology of cell wall and protoplasm of cells, tissues and organs.
- Dedifferentiation** is the process of despecialisation of differentiated living cells so that they regain the capacity to divide and form new cells. A dedifferentiated tissue can act as meristem, e.g., interfascicular vascular cambium, cork cambium.
- Redifferentiation** is the structural, chemical and physiological specialisation of cells derived from dedifferentiated meristematic cells. Secondary phloem, secondary xylem and cork cells are some of the tissues formed through redifferentiation.

PLANT GROWTH REGULATORS

- Plant growth regulators (PGR) are of diverse chemical compositions that function in low concentration and regulate plant growth, differentiation and development. **Plant hormones** or **phytohormones** are a type of PGR.
- Phytohormones are of two major types: **growth promoters** (e.g., auxins, gibberellins and cytokinins) and **growth inhibitors** (e.g., abscisic acid and ethylene).

Auxins

- Auxins are weakly acidic growth hormone having an unsaturated ring structure.
- They can be natural Indole 3 - acetic acid (IAA), Phenyl acetic acid (PAA), Indole 3 - acetonitrile (INA)** and synthetic (**Indole 3-butyrlic acid, NAA, 2, 4-D, 2, 4, 5-T**) compounds having similar structure and properties.
- IAA is the universal natural auxin. It is found in shoot apices, leaf primordia and developing seeds and is synthesised from amino acid tryptophan, a precursor of IAA or auxins.
- Avena curvature test** and **root growth inhibition test** are done for examining auxin effect.



Functions

- Promotes cell enlargement and division and initiates root formation on stem cuttings.
- Regulates cambial activity and xylem differentiation.
- Shows apical dominance *i.e.*, inhibits the growth of lateral buds.
- Prevents or delays abscission as well as induces synthesis of ethylene.
- Auxins **induce parthenocarpic development of fruits** and such fruits are seedless.
- Auxins **induce feminisation**, *i.e.*, on male plant, female flowers are produced.
- 2, 4-D is a famous herbicide or weedicide (especially kills broad leaved weeds). It kills weeds perhaps by over stimulated root growth.
- Auxins are responsible for phototropism and geotropism.

Gibberellin

- Gibberellin is a weakly acidic growth hormone, having gibbane ring structure.
- **Hori and Kuroswa** discovered the active substance from filtrate of fungus, *Gibberella fujikuroi* and named it gibberellin.
- **GA₃** was first gibberellin to be isolated in its pure form and remains the most extensively studied.
- The major sites of gibberellin production in plants are embryos, roots and young leaves near the shoot tip.
- **Mevalonic acid** (derived from acetyl Co-A) acts as precursor for synthesis of gibberellins.
- **Barley endosperm test** and **germination of dwarf pea** seeds are used as bioassays.

Functions

- Stimulates stem elongation and leaf expansion.
- Overcome natural dormancy of buds, tubers, seeds, etc.
- Induces elongation of reduced stem or bolting in rosette plants *e.g.*, henbane, cabbage.
- Promotes seed germination by inducing production of hydrolytic enzymes for solubilising reserve food.
- Promotes flowering in long day plants during non-inductive period.
- Controls fruit growth and development as well as induces parthenocarpy. **Gibberellic acids are more potent parthenocarpic agents than auxins.**
- Promotes formation of male flowers on female plants *e.g.*, *Cannabis*. They can also replace female flowers with male ones on monoecious plants of cucurbits.

Cytokinins

- Cytokinins are basic hormones, derivatives of either aminopurine or phenyl urea that promote cytokinesis.
- The first cytokinin was discovered from autoclaved herring sperm DNA.
- The first natural cytokinin was obtained from unripe maize grains, called zeatin (6-hydroxy 3-methyl trans 2-butanyl amino purine). It is found in coconut milk. It is mainly found in roots, however it is also synthesised in endosperm regions of seeds, growing embryos, young fruits and developing shoot buds.
- **Tobacco pith culture, retardation of leaf senescence and excised radish cotyledon expansion** are used as bioassays for cytokinins.

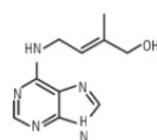


Fig.: Common cytokinin

Functions

- Promotes cell division.
- Essential for morphogenesis and differentiation of tissues and organs.
- Delays senescence by mobilisation of nutrients.
- Overcome apical dominance caused by auxins and promote lateral bud development.
- Induces accumulation of salts inside cells and helps in phloem transport.
- Promotes femaleness in flowers.

Abscisic Acid

- Abscisic acid is a mildly acidic growth hormone which acts as a general growth inhibitor.
- It is also called **stress hormone** since its production is stimulated under conditions of drought, water logging and adverse environmental conditions.
- The hormone was first isolated by Addicott *et al* (1963) from cotton bolls. It is found in many parts of the plant but is more abundant in chloroplast of green cells. It is synthesised from **mevalonic acid** or **xanthophyll**.
- **Rice seedling growth inhibition test** and **inhibition of α -amylase synthesis in barley endosperm** are used as bioassay.

Functions

- Induces dormancy of buds, seeds and underground stems, hence also called **dormin**.
- Promotes abscission of flowers and fruits.
- Induces senescence of leaves by promoting degradation of chlorophyll and proteins.
- Inhibits seed germination by inhibiting gibberellin mediated amylase formation.
- It is **antagonist**, to gibberellin and counteracts the effect of growth promoting hormones-auxins and cytokinins.
- Used as **antitranspirant**, as application of even minute quantities of ABA on leaves causes partial closure of stomata.
- Induces flowering in some short day plants, even under unfavourable photoperiods.
- External application on stem cuttings initiate rooting.

Ethylene

- Ethylene is the only **gaseous phytohormone** which stimulates transverse or isodiametric growth but retards the longitudinal one.
- It is found in almost all parts of plants in minimal amount but maximum production occurs during ripening of fruits and in tissues undergoing senescence. It is synthesised from amino acid methionine in plants.
- The '**triple response**' of etiolated pea plant and **gas chromatographic assay** are used as bioassays.

Functions

- Promotes apical dominance and prolongs dormancy of lateral buds but breaks the dormancy of buds, seeds and storage organs.
- Induces abscission and senescence of various parts i.e., leaves, flowers and fruits.
- Induces epinasty, a phenomenon which decreases the sensitivity to gravity.
- Helps in root initiation, growth of lateral roots and root hairs.
- Stimulates flowering in pineapple and other related plants and helps in synchronising fruit set.
- Induces ripening of fleshy climacteric fruits and dehiscence of dry fruits. Ethylene lamps are used for ripening of fleshy fruits e.g., banana, mango, apple, tomato.
- Ethylene is used to induce feminising effect e.g., number of female flowers and thus fruits in cucumber.

SEED GERMINATION

- Seed germination is the activation and growth (rejuvenation) of the embryo into a seedling during favourable conditions. It may be epigeal (cotyledons are pushed out of the soil) and hypogaeal (cotyledons do not come out of the soil).
- Seeds which germinate only in presence of light are called **photoblastic seeds**. The capacity of a seed to germinate and develop into a seedling is called **seed viability**.

PHOTOPERIODISM

- **Photoperiodism** is the effect of photoperiods or daily duration of light hours (and dark periods) on the growth and development of plants, especially flowering. Photoperiodism was first studied by Garner and Allard (1920) in 'Maryland mammoth' variety of tobacco.
- **Long day plants** (LDPs) flower when they receive long photoperiods or light hours which are above a critical length, e.g., henbane (*Hyoscyamus niger*), wheat, oat, sugar beet, spinach (*Spinacia oleracea*), radish, barley, larkspur, lettuce, etc.



- **Short day plants** (SDPs) flower when photoperiod is less than critical day length, e.g., *Nicotiana tabacum*, *Glycine max* (soybean), *Xanthium strumarium* (cocklebur), *Cannabis sativa*, etc.
- **Day neutral plants** (DNP) are irrespective of the day length. They flower at about the same time under all day lengths, e.g., *Cucumis sativus*, *Gossypium hirsutum*, *Pisum sativum*, etc.
- **Long short day plants** (L-SDPs) require long photoperiods for floral initiation and short photoperiods for blossoming. The plants flower between summer and autumn, e.g., *Bryophyllum*, *Cestrum*.
- **Intermediate day plants** (IDPs) flower within a definite range of light hours. Flowering does not take place above and below this range, e.g., wild kidney bean.
- **Short-long day plants** (S-LDPs) require short photoperiods for initiation of flowering and long photoperiods for blossoming, e.g., *Campanula medium* and petkus variety of rye.

VERNALISATION

- Vernalisation is the process of shortening of the juvenile or vegetative phase and hastening flowering by a previous cold treatment. In vernalisation by cold treatment, winter varieties are transferred into spring or summer varieties.
- Site of vernalisation is **apical meristem** or all the **meristematic cells**, e.g., shoot tip, embryo tips, root apex, etc. As a result of vernalisation, a flowering hormone called **vernalin** is formed (reported by Meichers), but vernalin has never been isolated. Once a plant is vernalised, it can be de-vernalised by exposing the plant to temperature of 30°C or above. For establishing vernalisation, plant should be kept at low temperature for 4-5 days depending upon the species.
- Vernalisation has advantages like crops can be grown earlier as juvenile or vegetative period is shortened and brings about early flowering. Plants can be grown in such regions where normally they do not grow. Yield of the plant is increased.

SEED DORMANCY

- In majority of plants, seeds remain in an inactive state and germinate only after a specific period of rest. Such inactive state is called **dormancy** or **quiescence**. Dormancy may be defined as, "the inactive state of the seed in which growth of the embryo is temporarily suspended for a specific length of time".



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

UNIT-III : CELL : STRUCTURE AND FUNCTIONS

CHAPTER-8 : CELL : THE UNIT OF LIFE

Multiple Choice Questions

1. The intake of solid material from outside to the inside of a cell is

- (a) pinocytosis
- (b) phagocytosis
- (c) exocytosis
- (d) autolysis.

2. Identify the cell organelle and select the correct option as per the given codes.

- (i) Suicide bag of cell
- (ii) Protein factories of cell
- (iii) Power house of cell

Ribosome Mitochondria Lysosome

- | | | | |
|-----|-------|-------|-------|
| (a) | (iii) | (ii) | (i) |
| (b) | (ii) | (iii) | (i) |
| (c) | (i) | (iii) | (ii) |
| (d) | (ii) | (i) | (iii) |

3. Select the mismatched pair.

- | | |
|---------------------------|----------------------|
| (a) Plastid | - E. Haeckel |
| (b) Ribosomes | - Robinson and Brown |
| (c) Mitochondria | - Novikoff |
| (d) Endoplasmic Reticulum | - Porter |

4. The chromosomes having a median centromere are

- (a) metacentric
- (b) acrocentric
- (c) telocentric
- (d) sub-metacentric.

5. Which among the following organelles is the site for protein synthesis?

- (a) Centrosome
- (b) Lysosome
- (c) Ribosome
- (d) Golgi complex

6. Which of the following statements is not true about nucleoplasm?

- (a) It is the site of ribosome formation.
- (b) It is a part of cell that contains genetic material for controlling cytoplasmic structure and function.
- (c) It forms the bulk of cells.
- (d) It contains a fibrous matrix.

7. The cell organelles that perform autolysis are

- (a) ribosomes
- (b) lysosomes
- (c) oesomes
- (d) chloroplasts.

8. Consider the following statements (A-C) each with one blank.

- A. (i) are colourless plastids usually occur in unexposed part of plants.
- B. (ii) are orange-red plastids that are rich in carotenoid and lipids.
- C. The inner membrane of chloroplasts gives rise to flattened sacs called (iii).

Which of the following options give the correct fill ups for respective blanks.

- (a) (i) - Leucoplasts (ii) - Cristae
- (b) (ii) - Chromoplasts (iii) - thylakoids
- (c) (i) - Chromoplasts (iii) - cristae
- (d) (ii) - Leucoplasts (iii) - thylakoids

9. A complex structure formed by infolding of plasma membrane in prokaryotes is

- (a) mesosomes
- (b) aleuroosomes
- (c) sphaerosomes
- (d) oleosomes.

- Q10.** According to the fluid mosaic model
(a) all biomembranes are either made of a unit membrane or a multiple of unit membrane
(b) if a membrane contains more than three layers, it must be multiple of unit membrane
(c) the membrane does not have a uniform disposition of lipids and proteins
(d) a biomembrane contains four molecular layers, two of phospholipids and two of proteins.

- Q11.** Fibril organisation is _____ in centriole and _____ in case of cilia and flagella
(a) $9 + 0, 9 + 2$ (b) $9 + 2, 9 + 2$
(c) $9 + 2, 9 + 0$ (d) $9 + 0, 9 + 0$

- Q12.** Read the given statements and select the correct one.
(a) Na^+/K^+ exchange pump is an energy dependent process.
(b) Active transport is a physical process.
(c) Metabolic inhibitors stop passive transport.
(d) Active transport is bidirectional.

- Q13.** Thread-like protoplasmic projections which are formed on the free surface of absorptive cells of intestine are
(a) intermediate filaments (b) microvilli
(c) microtubules (d) neurofilaments.

- Q14.** Glyoxisomes are microbodies, containing enzymes for
(a) β -oxidation of fatty acids
(b) peroxide biosynthesis
(c) polypeptide synthesis
(d) changes in the plasma membrane.

- Q15.** Refer to the given statements regarding a type of cell organelle.
(i) They are colourless
(ii) Its inner membrane is thrown up into folds called cristae
(iii) They produce carbon dioxide and water by breaking down of organic food.
The above features are attributed to
(a) chloroplasts (b) mitochondria
(c) Golgi apparatus (d) centromere.

Match The Columns

- 16.** Match Column I with Column II.

Column I	Column II
A. Chloroplasts	(i) Nuclear division
B. Nucleoplasm	(ii) Photosynthesis
C. Chromosomes	(iii) Respiration
D. Mitochondria	(iv) Ribosome formation

- 17.** Match the Column I with Column II. (There can be more than one match for items in column I.)

Column I	Column II
A. Vacuoles	(i) Packaging materials
B. Ribosomes	(ii) Protein factories
C. Lysosomes	(iii) Suicidal bag
D. Golgi bodies	(iv) Osmotic pressure
	(v) Excretion

- (vi) Secretion
(vii) Polypeptide synthesis
(viii) Disposal bags

Passage Based Questions

- 18.(A)** Complete the given passage with appropriate words or phrases.

A centriole possess a whorl of (i) peripheral fibrils. Fibrils are absent in the centre. The arrangement, is therefore, called (ii). Each fibril is made up of (iii) subfibrils. Therefore, it is called (iv) fibril. The adjacent (iv) fibrils are connected by C-A proteinaceous (v). Centrioles can be transformed into (vi) vi formed from centrioles give rise to (vii) and (viii).

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

Active transport involves an expenditure of energy by the cells. It is a physical process. It gets reduced with the increase in oxygen content of the surrounding environment. In the process, ADP is dephosphorylated to form ATP. It requires carrier molecules. $\text{K}^+ - \text{H}^+$ exchange pump operates with the help of enzyme ATPase which also functions as a carrier molecule. For every ATP molecule hydrolysed, two Na^+ ions are pumped outward and three K^+ ions are pumped inwardly. Metabolic inhibitors do not influence active transport.

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.

- 19.** **Assertion :** Endoplasmic reticulum keeps various organelles in their position.

Reason : Endoplasmic reticulum acts as a means of quick intercellular transport.

- 20.** **Assertion :** Golgi complex is called suicide bags.

Reason : Large number of digestive enzymes or acid hydrolases are present in Golgi complex.

- 21.** **Assertion :** Leucoplasts do not attract animals.

Reason : Leucoplasts are coloured plastids.

- 22.** **Assertion :** Cell is the basic unit of life.

Reason : All the activities of life are performed by cells.

- 23.** **Assertion :** Cell wall of Gram (+) ve bacteria contain teichoic acid

Reason : Gram (+)ve bacteria are resistant to antibiotics.

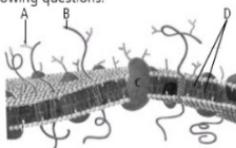
- 24.** **Assertion :** In a bacterial cell, pili takes part in adhesion.

Reason : Formation of pili in a bacterial cell is controlled by nucleoid gene.

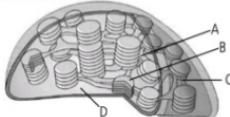
- 25.** **Assertion :** Membrane transport requires carrier proteins.
Reason : Transport across the cell membrane always occurs along the concentration gradient.
- 26.** **Assertion :** SER contains ribophorins.
Reason : Enzyme for detoxification are absent in SER.
- 27.** **Assertion :** Microfilaments are made up of actin protein.
Reason : Microfilaments take part in endocytosis.
- 28.** **Assertion :** Heterochromatin takes part in transcription.
Reason : Heterochromatin contains active genes.

Figure Based Questions

- 29.** Refer to the given figure of fluid mosaic model and answer the following questions.



- (a) Identify the parts labelled as A, B, C and D in the given figure.
(b) Briefly describe the part labelled as B.
(c) Give three evidences in support of fluid mosaic model.
- 30.** Observe the given figure of chloroplast and answer the following questions.

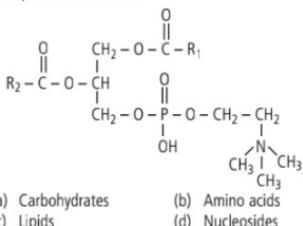


- (a) Identify A, B, C and D in the given figure.
(b) Briefly describe the part labelled as B.
(c) What are the functions of chloroplast?

CHAPTER-9 : BIOMOLECULES

Multiple Choice Questions

- 1.** Given molecular formula belongs to which of the following group of biomolecules?



- (a) Carbohydrates (b) Amino acids
(c) Lipids (d) Nucleosides

- 2.** Which of the following statements is incorrect regarding amino acids?

- (a) Physical and chemical properties of amino acids are mainly due to amino, carboxyl and R functional groups.
(b) Amino group provides an acidic property to the amino acid while carboxyl group gives it a basic reaction.
(c) Four substituent groups occupy four valency positions in an amino acids hence, they are substituted methanes.
(d) Both (b) and (c)

- 3.** Which of the following options consists of essential amino acid only?

- (a) Leucine, isoleucine, tryptophan
(b) Phenylalanine, glycine, serine
(c) Proline, glutamic acid, valine
(d) Lysine, arginine, serine

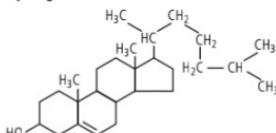
- 4.** Select the incorrect match from the following.

- | | |
|---------------------|-------------|
| (a) Polysaccharide | - Cellulose |
| (b) Oligosaccharide | - Raffinose |
| (c) Disaccharide | - Starch |
| (d) Monosaccharide | - Galactose |

- 5.** Coenzyme is non-protein organic group which

- (a) gets attached to the apoenzyme to form holoenzyme or conjugate enzyme
(b) takes part in only catalytic activity of the enzyme
(c) requires a single apoenzyme for picking up and transferring a group
(d) does not help in group transfer.

- 6.** Identify the given structural formula and select the correct option.



- (a) Terpenes (b) Cholesterol
(c) Steroids (d) Oleic acid

- 7.** Read the given statements and select the incorrect option.

- (a) In protein structure, covalent bonds are the strongest.
(b) Tertiary structure gives the protein a three dimensional conformation.
(c) The helices of protein are always left handed.
(d) Proteins are heteropolymers of amino acids.

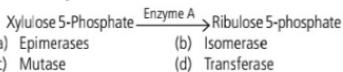
- 8.** The type of chemical linkage formed between the monosaccharide units of oligosaccharides and polysaccharides is

- (a) glycosidic bonds (b) ester bonds
(c) peptide bonds (d) hydrogen bonds.

9. (i) includes all building up reactions while (ii) constitutes breakdown reactions.

- (a) (i) - Catabolism, (ii) - anabolism
- (b) (i) - Anabolism, (ii) - catabolism
- (c) (i) - Apoenzyme, (ii) - coenzyme
- (d) (i) - Coenzyme, (ii) - apoenzyme

10. Enzyme A, used in the given reaction, belongs to which class of enzyme?



11. How many enzymes are involved in conversion of threonine to isoleucine?

- (a) Four
- (b) Two
- (c) Three
- (d) Five

12. Read the following statements and select the correct option.

- (a) Enzymes are highly specific for reactions
- (b) Change in pH do not effect enzymatic activity.
- (c) Enzyme can either start a chemical reaction or increase its rate of reaction.
- (d) Activators decrease activity of enzymes.

13. Michaelis-Menten constant (K_m) indicates

- (a) the substrate concentration at which the chemical reaction catalyse by an enzyme attains half its maximum velocity
- (b) the substrate concentration at which the chemical reaction catalyse by an enzyme double its maximum velocity
- (c) the rate of reaction
- (d) rise in velocity of a reaction for a short time followed by a sharp fall.

14. A combination of nitrogen base with pentose sugar is known as

- (a) nucleoside
- (b) nucleotide
- (c) energy carrier
- (d) ribonucleotide.

15. Consider the following differences between purine and pyrimidine and select the incorrect ones.

	Purine	Pyrimidine
(i)	Purines are larger-sized nitrogen containing biomolecules.	Pyrimidines are smaller-sized nitrogen containing biomolecules.
(ii)	A purine is 6-membered.	A pyrimidine is 9-membered.
(iii)	It is a single ring.	It is a double ring.
(iv)	A purine contains four nitrogen atoms at 1, 3, 7 and 9 positions.	A pyrimidine has nitrogen atoms at two places, 1 and 3 positions.
(v)	Purine bases are of two types: adenine (A) and guanine (G).	Pyrimidine bases are of three types: cytosine (C), thymine (T) and uracil (U).

- (a) (i) and (ii) only
- (b) (ii) and (iii) only
- (c) (i) and (iv) only
- (d) (ii) and (v) only

Match The Columns

16. Match Column I with Column II.

Column I	Column II
A. Insulin	(i) Phospholipids
B. Lecithin	(ii) Enzyme
C. Trypsin	(iii) Alkaloids
D. Morphine	(iv) Hormone

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

Column I	Column II
A. Chromoproteins	(i) Abrin
B. Drugs	(ii) Kinesin
C. Toxins	(iii) Vinblastin
D. Molecular motors	(iv) Casein
E. Storage proteins	(v) Ricin
	(vi) Dynein
	(vii) Ferritin
	(viii) Rhodopsin
	(ix) Haemoglobin
	(x) Curcumin

Passage Based Questions

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

Reduction or stoppage of enzyme activity due to presence of adverse conditions or chemicals is called enzyme inhibition. (i) inhibition is that inhibition which can be overcome by the withdrawal of inhibitor. (ii) inhibition is of permanent nature as the enzyme conformation is harmed. Denaturation of enzyme is an example of (ii) inhibition. A competitive inhibitor of succinate dehydrogenase is (iii). Non-competitive inhibitor has no structural similarity with the (iv) of the enzyme. An allosteric inhibition has (v) function Equilibrium constant for inhibitor binding is called (vi). (vii) inhibition gives evidence for lock and key hypothesis of enzyme action.

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

DNA is the smallest macromolecule with a diameter of 1 nm. DNA chain is built up of deoxyribose sugar, phosphoric acid and a nitrogen base. Nitrogen base provides acidity to the nucleic acids. Phosphate group lie at right angles to the longitudinal axis of DNA chains. The two DNA chains are held together by nitrogen bonds between their bases. The DNA strand which functions as template for RNA synthesis is known as coding strand. In RNA purine and pyrimidine bases are in equal number.

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.

19. Assertion : Catabolism is a constructive process.

Reason : Catabolism produces complex material from simpler ones.

20. Assertion : Nucleotide is acidic in nature.

Reason : Nucleotide is formed by the union of a nitrogen base with a pentose sugar.

21. Assertion : Sucrose is a non-reducing sugar.

Reason : In a sucrose molecule, aldehyde group of glucose and ketone group of fructose are lost due to formation of glycosidic bond between them in a sucrose molecule.

22. Assertion : Chitin is soft and leathery.

Reason : Monomeric residues are joined together by 1-4 β linkages in chitin.

23. Assertion : Unsaturated fats lower blood cholesterol.

Reason : Unsaturated fats have lower melting point.

24. Assertion : Fats can be converted to carbohydrates.

Reason : Fats are stored in oil seeds.

25. Assertion : An apoenzyme takes part in group transfer.

Reason : An apoenzyme is heat stable.

26. Assertion : DNA is Fuelgen positive.

Reason : DNA contains ribose sugar.

27. Assertion : Enzymes lower the activation energy.

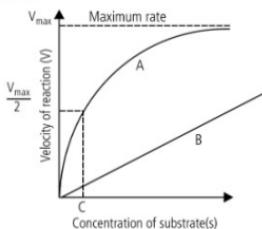
Reason : Activation energy decreases the kinetic energy of the system.

28. Assertion : Inulin is used in testing kidney function.

Reason : Inulin is not metabolised in human body.

Figure Based Questions

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

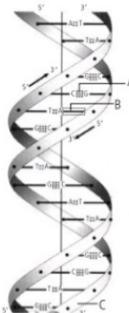


(a) What is denoted by A and B in the given graph?

(b) What does C denote?

(c) What is represented by graph?

30. Observe the given figure and answer the following questions.



(a) Identify the labelled parts A, B and C in the given figure.

(b) Briefly describe the given figure.

CHAPTER-10 : CELL CYCLE AND CELL DIVISION

Multiple Choice Questions

1. The phase between end of M-phase of previous cell cycle and initiation of DNA replication is

- (a) G₁ phase
- (b) S-phase
- (c) Interphase
- (d) G₀ phase.

2. Select the mismatch pair.

- | | |
|------------------|-------------------------------|
| (a) S-phase | - DNA synthesis |
| (b) Interphase | - Metabolically inactive cell |
| (c) Cytokinesis | - Division of cytoplasm |
| (d) Karyokinesis | - Division of nucleus |

3. During which meiotic state, bivalent chromosomes clearly appear as tetrads?

- | | |
|---------------|---------------|
| (a) Leptotene | (b) Zygotene |
| (c) Pachytene | (d) Diplotene |

4. Select the incorrect statement for meiosis.

- (a) It occurs in diploid cell.
- (b) It introduces variations.
- (c) It occurs in haploid cell.
- (d) After meiosis number of chromosome is reduced to half.

5. In which stage of meiosis, the chromosomes become gradually visible due to compaction of chromatin?

- | | |
|---------------|---------------|
| (a) Diplotene | (b) Leptotene |
| (c) Zygotene | (d) Pachytene |

- 6.** In an organism, karyokinesis was not followed by cytokinesis, and as a result, a multinucleate condition arose. What term would you use for such condition?
 (a) Syncytium (b) Synapsis
 (c) Crossing over (d) Chiasmata
- 7.** Various events of mitosis is given below. Arrange them in the correct sequence.
 (i) Condensation of chromosomal material.
 (ii) Development of nuclear envelop around the chromosomes.
 (iii) Alignment of chromosomes at the equatorial plate.
 (iv) Separation of chromatids.
 (a) (i), (ii), (iii), (iv) (b) (ii), (i), (iv), (iii)
 (c) (i), (iii), (iv), (ii) (d) (iii), (ii), (iv), (i)
- 8.** Which stage of meiosis is marked by the formation of chiasmata?
 (a) Prophase I (b) Anaphase II
 (c) Telophase I (d) Metaphase I
- 9.** Identify the meiotic stage in which the homologous chromosomes separate, while sister chromatids remain associated at their centromeres.
 (a) Metaphase II (b) Anaphase I
 (c) Anaphase II (d) Telophase I
- 10.** Haplontic life cycle of some lower plants occur due to
 (a) zygotic meiosis (b) gametic meiosis
 (c) sporic meiosis (d) none of these.
- 11.** How do colchicine affects the cell division and cell cycle?
 (a) It inhibits cytokinesis.
 (b) It induce the formation of multiple contractile rings.
 (c) It inhibits spindle formation during mitosis.
 (d) It inhibits chromosome replication.
- 12.** What happens to cells during quiescent stage (G_0) of the cell cycle?
 (a) They remain metabolically active but do not proliferate.
 (b) They terminate the cell cycle.
 (c) They enter the cell cycle.
 (d) DNA synthesis occur but cell do not divide.
- 13.** Which of the following statements is not correct regarding cell division?
 (a) Cell division is a means of sexual reproduction in lower organisms.
 (b) During cell division, there is replication of DNA.
 (c) Cell division helps in maintenance of cell size.
 (d) Cell division helps in regeneration of a part or whole of the organism.
- 14.** Enzyme that helps in the reunion of the separated segments of chromatid during re-annealing is
 (a) hexokinase (b) ligase
 (c) R-protein (d) U-protein.

- 15.** In animal cells, the peculiar arrangement of chromosomes 'bouquet stage' can be observed in _____ of meiosis I.
 (a) Pachytene (b) Leptotene
 (c) Zygotene (d) Diplotene

Match The Columns

- 16.** Match Column I with Column II.
- | Column I | Column II |
|-----------------|---|
| A. Zygotene | (i) Chromosomes align at equatorial plate |
| B. Diakinesis | (ii) Homologous chromosomes separate and sister chromatids remain associated at centromeres |
| C. Anaphase | (iii) Terminalisation of chiasmata |
| D. Metaphase-I | (iv) Pairing of homologous chromosomes |

- 17.** Match the Column I with Column II. (There can be more than one match for items in column I.)

- | Column I | Column II |
|-----------------|---|
| A. G_1 phase | (i) Cell organelles increase in number |
| B. S phase | (ii) Cell organelles do not increase in number |
| C. G_2 phase | (iii) Pre-mitotic gap phase |
| D. G_0 phase | (iv) Synthetic phase
(v) Quiescent stage
(vi) Amount of DNA per cell doubles
(vii) Phase between M-phase of cell cycle and initiation of DNA replication |

Passage Based Questions

- 18.(A)** Complete the given passage with appropriate words or phrases.
 (i) is the typically longer and complex phase of meiosis. It consists of (ii) stages. (iii) is the initial stage, during which chromosomes gradually become visible under microscope. In (iv) pairing of homologous chromosomes occur by formation of (v). Pachytene is characterised by occurrence of (vi). The X-shaped structure, called chiasmata can be observed (vii) stage. In diakinesis terminalisation of (viii) is observed.

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

Interphase is also called intramitosis. The interphase cell is metabolically inactive. It is divided into three stages G_1 , S and G_2 . The first check point lies between G_1 and G_2 phase whereas the second check point lies between G_2 and M phase. Many cells stop at this stage and enter G_1 phase and

stops the cell cycle. G₁ phase synthesises RNAs, proteins and other biochemicals for spindle formation and M phase division.

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.

- 19. Assertion :** Meiosis introduces new combination of traits in the progeny.
Reason : Meiosis involves crossing over.

- 20. Assertion :** During G₁ phase, cell organelles do not increase in number.

Reason : The cells in G₁ phase are metabolically inactive and do not grow continuously.

- 21. Assertion :** During metaphase, the chromosomes align at equatorial plate.

Reason : Total number of chromosomes can be observed during metaphase.

- 22. Assertion :** The colchicine treated meristematic cells show doubling of chromosomes.

Reason : Colchicine does not inhibit chromosome replication.

- 23. Assertion :** Chiasmata is observed in the zygote stage.
Reason : Chiasmata is a permanent structure.

- 24. Assertion :** In animal cells, the poles are formed by the asters.

Reason : They are called amphiaster, since two asters are present at the spindle of animal cells.

- 25. Assertion :** During crossing over, the R-protein causes re-annealing.

Reason : U-protein or enzyme produces a complex known as synaptonemal complex.

- 26. Assertion :** Cell division occurs only in asexually reproducing organisms.

Reason : Cell division is always equational.

- 27. Assertion :** The mitotic division is called equational division.

Reason : The second meiotic division is also homotypic or equational division.

- 28. Assertion :** During cytokinesis, in an animal cell, the central equatorial part of spindle gets change into dense fibrous and vesicular structure called midbody.

Reason : In plant cell phragmoplasts are formed during cytokinesis.

Figure Based Questions

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

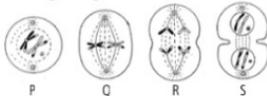
(a) Identify the given figure.

(b) What is the significance of this stage?

(c) Which enzyme helps in the re-annealing of separated chromatid segments?



- 30.** Refer to the given figure and answer the following question.



(a) What do the figures represent? Also identify the stages P, Q, R and S from the given figure.

(b) What major changes occur in the given figure S?

(c) How do this figure differ from mitosis?

SOLUTIONS

CHAPTER-8 : CELL : THE UNIT OF LIFE

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

6. (c) 7. (b) 8. (b) 9. (a) 10. (c)

11. (a) 12. (a) 13. (b) 14. (a) 15. (b)

16. A-(ii), B-(iv), C-(i), D-(iii)

17. A-(iv, v), B-(i, vii), C-(iii, viii), D-(i, vi)

- 18.(A) (i) nine (ii) 9 + 0
(iii) three (iv) triplet
(v) linkers (vi) basal bodies
(vii) cilia (viii) flagella

- (B) Active transport involves an expenditure of energy by the cells. It is a physical vital process. It gets reduced with

the increase decrease in oxygen content of the surrounding environment. In the process, ADP ATP is dephosphorylated to form ATP ADP. It requires carrier molecules. K⁺-H⁺ Na⁺ - K⁺ exchange pump operates with the help of enzyme ATPase which also functions as a carrier molecule. For every ATP molecule hydrolysed, two three Na⁺ ions are pumped outwardly and three two K⁺ ions are pumped inwardly. Metabolic inhibitors do not influence active-passive transport.

19. (b) 20. (d) 21. (c) 22. (a) 23. (c)

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

29. (a) In the given figure, A is oligosaccharide, B is peripheral protein, C is integral protein and D is phospholipid bilayer.

(b) The labelled part B represent peripheral proteins or extrinsic

proteins. They are located on the two surfaces of the membrane. The extrinsic proteins are attached covalently to phospholipid head or non-covalently to transmembrane proteins. They provide structural and functional specificity to the membranes.

(c) Three evidences in support of fluid mosaic model are:

- This model provides for the occurrence of protein particles both on the surface and interior of cell membranes. Freeze etching technique has confirmed the occurrence of particles over and inside the membrane.
- Fluid mosaic model can explain the presence of different types of permeability and retentivity of various cell membranes.
- It accounts for dynamic nature of biomembranes with their quick repair.

30. (a) In the given figure, A represents Granum, B represents Thylakoid, C represents Stroma lamella and D represents Stroma.

(b) The labelled part B represent thylakoids. They are membrane lined flattened sacs which run throughout the stroma or matrix of the chloroplast. Since, they take part in photosynthesis, they are also called photosynthetic thylakoids. Thylakoids are thus the structural elements of the chloroplast. They generally run parallel but may show interconnections. Thylakoids may also be attached to the inner membrane of chloroplast envelope. Because of the presence of grana, thylakoids are differentiated into two — granal thylakoids and stroma or intergranal thylakoids. Thylakoid membranes possess photosynthetic pigments and coupling factors.

(c) Chloroplasts are the centres of photosynthesis or formation of organic compounds from inorganic raw materials. The organic substances, thus synthesised, not only provide body building material to autotrophic plants themselves but also to all heterotrophic plants as well as animals. Chloroplasts pick up carbon dioxide and the use of same in photosynthesis. Chloroplasts liberate oxygen which is passed into the atmosphere. This keeps the balance of oxygen constant in the atmosphere. Chloroplasts store fat in the form of plastoglobuli.

CHAPTER-9 : BIOMOLECULES

- (c) 2. (b) 3. (a) 4. (c) 5. (a)
- (b) 7. (c) 8. (a) 9. (b) 10. (a)
- (d) 12. (a) 13. (a) 14. (a) 15. (b)

16. A-(iv), B-(i), C-(ii), D-(iii)

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

- | | |
|-----------------------|-------------------|
| 18.(A) (i) Reversible | (ii) Irreversible |
| (iii) Malonate | (iv) substrate |
| (v) Regulatory | (vi) K_i |
| (vii) Competitive | |

(B) DNA is the **smallest** largest macromolecule with a diameter of 1-nm – 2 nm. DNA chain is built up of deoxyribose sugar, phosphoric acid and a nitrogen base. Nitrogen-base Phosphate group provides acidity to the nucleic acids. Phosphate group Nitrogen base lie at right angles to the longitudinal axis of DNA chains. The two DNA chains are held together by **nitrogen** hydrogen bonds between their bases. The DNA strand which functions as template for RNA synthesis is known as **coding antisense strand**. In RNA DNA, purine and pyrimidine bases are in equal number.

- (d) 20. (c) 21. (a) 22. (b) 23. (b)
- (b) 25. (d) 26. (c) 27. (c) 28. (a)

29. (a) In the given graph, A denotes the effect of substrate concentration on reaction velocity with enzyme and B denotes effect of substrate concentration on reaction velocity reaction without enzyme.

(b) C is Michaelis Menten constant (K_m) lies between 10^{-1} to 10^{-6} M. A high K_m indicates low affinity while a low K_m shows strong affinity.

(c) Graph shows the effect of substrate concentration on the rate of reaction with or without enzyme. Increase in substrate concentration increases the rate of reaction. It appears as a hyperbolic curve. A stage is reached where velocity is maximum. It does not increase further by increasing the substrate concentration. At this stage the enzyme molecules become fully saturated and no active site is left free to bind additional substrate molecules. This saturation effect is shown by all enzymes.

30. (a) In the given figure of double helical structure of DNA, A-represents hydrogen bonds, B-represents glycosidic bond and C-represents sugar phosphate backbone.

(b) The given figure indicates the secondary structure of DNA. One of the secondary structures exhibited by DNA is the famous Watson-Crick model. This model says that DNA exists as a double helix. The two DNA chains are antiparallel. In one chain the direction is $5' \rightarrow 3'$ while in the opposite is it is $3' \rightarrow 5'$. The two chains are held together by hydrogen bonds between their bases. Adenine (A), a purine of one chain lies exactly opposite thymine (T), a pyrimidine of the other chain. Similarly, cytosine (C, a pyrimidine) lies opposite guanine (G, a purine). This allows a sort of lock and key arrangement between large sized purine and small sized pyrimidine. It is strengthened by the appearance of hydrogen bonds between the two. Three hydrogen bonds occur between cytosine and guanine (C = G) at positions 1 – 1', 2' – 6' and 6' – 2'. There are two such hydrogen bonds between adenine and thymine (A = T) which are formed at positions 1' – 3' and 6' – 4'. Hydrogen bonds occur between hydrogen of one base and oxygen or nitrogen of the other base.

CHAPTER - 10 : CELL CYCLE AND CELL DIVISION

1. (a) 2. (b) 3. (c) 4. (c) 5. (b)
 6. (a) 7. (c) 8. (a) 9. (b) 10. (a)
 11. (c) 12. (a) 13. (a) 14. (c) 15. (b)
16. A-(iv), B-(ii), C-(ii), D-(i)
 17. A-(ii, vii), B-(iv, vi), C-(i, iii), D-(v)
- 18.(A)** (i) Prophase I (ii) 5
 (iii) Leptotene (iv) zygotene
 (v) synaptonemal complex
 (vi) Recombination nodule
 (vii) dipotene
 (viii) chiasmata
- (B)** Interphase is also called **intermitosis** intermitosis. The interphase cell is metabolically inactive. It is divided into three stages G_1 , S and G_2 . The first check point lies between G_1 and G_2 S phase whereas the second check point lies between G_2 and M phase. Many cells stop at this stage and enter G_1 G₀ phase and stops the cell cycle. G_1 phase synthesizes RNAs, proteins and other biochemicals for spindle formation cell growth and M-phase division replication of DNA.
19. (a) 20. (c) 21. (b) 22. (a) 23. (d)
 24. (b) 25. (c) 26. (d) 27. (b) 28. (b)

- 29.** (a) The given figure shows the pachytene stage of meiosis I.
 (b) During this stage, crossing over occurs. Crossing over is the exchange of genetic material or chromatid segments between two homologous chromosomes. It introduces new combination of genes or recombinations. Recombinations result in variations.
 (c) R-protein enzyme helps in re-annealing of separated chromatid segments during pachytene stage.
- 30.** (a) The figures represent the stages of meiosis II. Here, P - Prophase II, Q - Metaphase II, R - Anaphase II S - Telophase II.
 (b) During telophase II is figure, following changes occur:
 (i) the groups of chromosomes arrange themselves into haploid nuclei
 (ii) nucleolus is formed
 (iii) nucleoplasm and nuclear envelope appears
 (iv) chromosomes elongate to form chromatic.
 (c) The given figure represents the stages of meiosis II. It differs from mitosis in following ways :
 (i) It always occurs in haploid cells.
 (ii) It is not preceded by DNA replication.
 (iii) The two chromatids of a chromosome are often dissimilar.
 (iv) The daughter cells formed after meiosis II are neither similar to each other nor similar to the parent cell.

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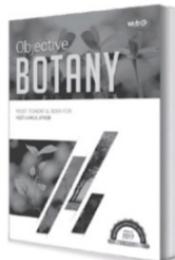
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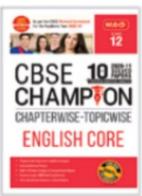
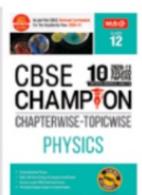
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GENERAL INSTRUCTIONS

- All questions are compulsory.
- Section A contains question numbers 1 to 5, multiple choice questions/assertion and reason of one mark each.
- Section B contains question numbers 6 to 12, short answer type questions of two marks each.
- Section C contains question numbers 13 to 21, long answer type I questions of three marks each.
- Section D contains question numbers 22 to 24, case-based type questions of three marks each.
- Section E contains question numbers 25 to 27, long answer type II questions of five marks each.
- There is no overall choice in the question paper. However, internal choices are provided in two questions of one mark, one question of two marks, two questions of three marks and all three questions of five marks.

Time Allowed : 3 hours

Maximum Marks : 70

SECTION - A

- Which of the following glands is enlarged in malaria?
 - Pancreas
 - Liver
 - Spleen
 - All of these
- Disease due to malfunctioning of organs is
 - deficiency disease
 - degenerative disease
 - allergy
 - heredity disease.

OR

- Which one of the following contains only bacterial diseases?
- Cholera, typhoid, pneumonia
 - Malaria, AIDS, cholera
 - Typhoid, tuberculosis, influenza
 - Diabetes, malaria, syphilis

Directions : In the following question, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- If both assertion and reason are true and reason is the correct explanation of assertion.

UNIT - VIII

- Human Health and Diseases
- Microbes in Human Welfare

- If both assertion and reason are true but reason is not the correct explanation of assertion.
- If assertion is true but reason is false.
- Assertion :** Lactic acid bacteria (LAB) grow in milk and convert it to curd.
Reason : LAB improves nutritional quality of curd by increasing vitamin B₁₂.
- The pesticides are considered as hazardous because
 - they persist in the environment
 - they affect the target organism only
 - they do not enter the food chain
 - they do not kill natural enemy populations.

OR

- The purpose of biological treatment of waste water is to
- reduce BOD
 - increase BOD
 - reduce sedimentation
 - increase sedimentation.

5. LSD (lysergic acid dimethylamide) causes
 (a) severe damage to CNS (b) chronic sensation
 (c) cancer (d) both (a) and (b).

SECTION - B

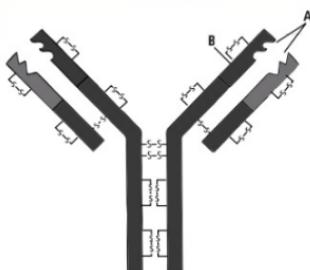
6. (a) Which microbe is used to ripen Swiss cheese?
 (b) Name the enzyme which is used as a 'clot buster' in blood vessels of the patients who have undergone myocardial infarction.
7. List the symptoms of filariasis. How does a healthy person acquire this infection?
8. Explain why a little curd is added to milk to set it into curd.
9. Why do sportspersons often fall a victim to cocaine addiction?
10. Mention any four important advantages of biogas generation.
11. (a) Name the respective forms in which the malarial parasite gains entry into (i) Human body and (ii) Body of female *Anopheles*.
 (b) Name the hosts where the sexual and the asexual reproductions of malarial parasites occur respectively.
 (c) Name the toxin responsible for the appearance of symptoms of malaria in humans. Why do these symptoms occur periodically?

OR

- (a) List any two situations when a medical doctor could recommend injection of preformed antibodies into the body of a patient. Name this kind of immunization and mention its advantages.
- (b) Name the kind of immunity attained when instead of antibodies weakened antigens are introduced into the body.
12. How has the fungus, *Trichoderma polysporum* proved to be very essential to organ-transplant patients?

SECTION - C

13.



- (a) Identify the labelled parts 'A' and 'B'.
 (b) What does the diagram illustrate?

- (c) Mention the type of immune response provided by the given structure.

14. (a) Name the two microbes used as biocontrol agents.
 (b) Name a genus of baculovirus. Why are they considered good biocontrol agents?

OR

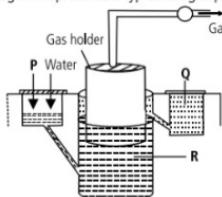
- (a) Mention important functions of activated sludge in a sewage treatment plant.
 (b) What is the role of flocs in sewage treatment?
15. (a) What is cancer? Mention one property on the basis of which cancer cells differ from normal cells.
 (b) Differentiate between benign and malignant tumour.
16. What is the mechanism by which the human immunodeficiency virus results in the loss of natural defence of the body against various infections?
17. A person injured by road accident was brought to a nursing home. The doctor immediately gave him an injection to protect him against a deadly disease.
 (a) What did the doctor inject into the patient's body?
 (b) Name the disease against which this injection was given and the kind of immunity it provides.
 (c) How do you think this injection would protect the patient against the disease?

OR

- What are the characteristics of good antibiotics? How pathogens develop resistance to antibiotics?
18. During the secondary treatment of the primary effluent how does the significant decrease in BOD occur?
19. How do B-cells of the immune system respond to antigen?
20. How is the fetus with Rh-positive blood affected if the mother is Rh-negative?
21. What is single cell protein? How is it produced? Discuss its importance to humans.

SECTION - D

22. Given diagram represents a typical biogas plant.

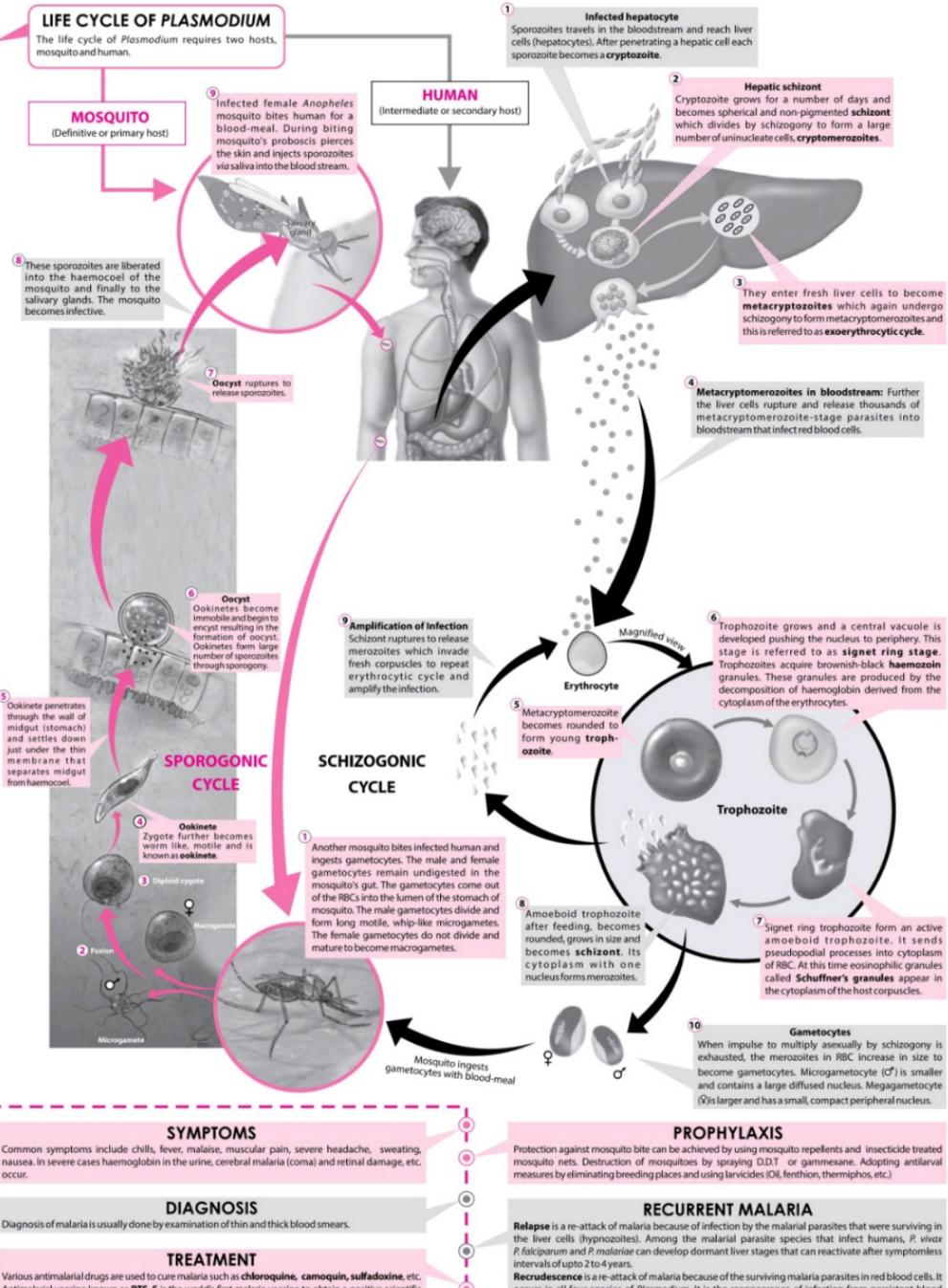


- (a) Identify P, Q, and R.
 (b) Explain the sequence of events occurring in a biogas plant.

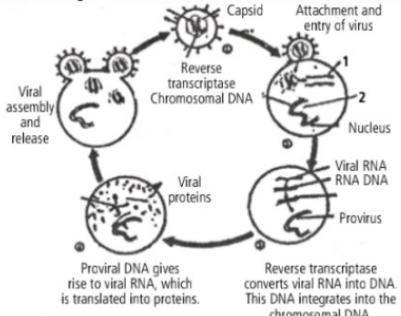
CONCEPT MAP

MALARIA : CAUSE, SYMPTOMS AND TREATMENT

Malaria is an acute febrile illness that results in intermittent fevers; and is caused by a parasite of Genus *Plasmodium* belonging to a protozoan Phylum, Apicomplexa. The parasite shows an alternation of generation accompanied by an alternation of host (**digenetic**). Asexual cycle (schizogonic cycle) occurs inside the red blood cells of the vertebrate host (human) and sexual cycle (sporogonic cycle) occurs in an invertebrate host (*Anopheles* mosquito). Malarial parasite is transmitted to human through the bite of infected female *Anopheles* mosquito during its blood-meal. Distinct species of *Plasmodium* are *Plasmodium malariae* (causes quartan malaria), *Plasmodium vivax* (causes benign tertian malaria), *Plasmodium falciparum* (causes malignant tertian malaria) and *Plasmodium ovale* (causes mild tertian malaria). **Laveran** (1880) discovered the malarial parasite, *Plasmodium*. **Sir Ronald Ross** (1897) observed that malarial parasite is transmitted by the bite of a female, *Anopheles* mosquito.

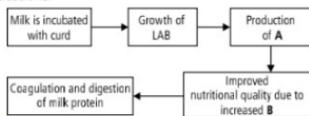


23. The diagram below illustrates the attack of a virus on a host cell.



- Name the parts numbered 1 and 2.
- Describe the functions performed by the part labelled number 1 on its entry into host cell.
- What are such viruses called?
- Name any two human diseases caused by such viruses.

24. Refer to the given flow chart and answer the following questions.



- Identify the missing parts A and B.
- What is the optimum temperature at which the above mentioned process occur and the role of bacteria in the process?

SECTION - E

25. (a) Spleen acts as a lymphoid organ. Justify the statement.
(b) Differentiate between the following :

- Innate and acquired immunity
 - B - lymphocytes and T - lymphocytes
- (c) What are antigen presenting cells? Mention its types.

OR

- To which category of cells do B-cells and T-cells belong?
How do they differ from each other with reference to their formation and response to antigens?

- How does the skin serve as the first line of defence?
- Name the plant source of ganja. How does it affect the body of the abuser?

26. (a) Name the primary and secondary hosts of *Plasmodium*.

- Give a diagrammatic representation of the part of life cycle of malarial parasite *Plasmodium vivax* passed in the insect.

OR

Write short notes on the following:

- Vaccine
- Lymphoid organs
- AIDS
- Organ transplantation

27. What is biological control? Explain with examples.

OR

How sewage water is treated before it could be discharged into natural water bodies?

SOLUTIONS

- (c)** Malaria is caused by a protozoan parasite *Plasmodium* species. In infections with *Plasmodium* species, anaemia is inevitable. In chronic cases, spleen becomes enlarged and fibrosed so much that it ruptures under the influence of trauma.
- (b)** Degenerative disease occurs due to deterioration and loss of specialised function of the cells of a tissue or organ. It may be caused by a defective blood supply, deposition of calcium salts or fibrous tissue in the affected organ or tissue.

OR

(a) Cholera is a food borne bacterial disease. It is caused by a Gram -ve, slightly curved bacterium *Vibrio cholerae* which contains a single polar flagellum. Typhoid is bacterial disease caused by *Salmonella typhi*. Pneumonia is bacterial disease caused by *Streptococcus pneumoniae* and *Haemophilus influenzae*.

3. (b)

- Pesticides include insecticides, fungicides, weedicides, rodenticides and algicides. All the pesticides are persistent and harmful. Some are fat soluble and show biomagnification (organic pesticides) and some like arsenic and sulphur are persistent. Hence, all pesticides are harmful.

OR

(a) Secondary treatment of sewage (or biological treatment) depletes 90-95% of the BOD and many pathogens are removed. Reduction of BOD by 90% is achieved through mineralisation of small fraction of organic matter and conversion of large proportion to removable solids.

- LSD is the most potent hallucinogen obtained from ergot fungus, *Claviceps purpurea*. It causes chronic sensation and severe damage to central nervous system. The hallucinogenic effect of LSD can last from two to twelve hours. During this time, judgement may be impaired, visual perception may seem distorted and hallucinations may occur (the sense of reality may become highly distorted).

- Large holed Swiss cheese is ripened with the help of CO₂ producing (causing holes) bacterium called *Propionibacterium shermanii*.

(b) Streptokinase is used as a clot buster in blood vessels of the patients who have undergone myocardial infarction.

7. Filariasis is a helminthic disease caused by *Wuchereria* (*W. bancrofti* and *W. malayi*). It causes swelling of lymphatic vessels of lower limbs resulting in swelling of feet, legs, scrotal sacs and thighs. It spreads from one human being to other through the bite of female mosquito, *Culex*.
8. For the production of curd, a small amount of curd known as starter or inoculum is added to fresh milk at suitable temperature. Curd contains millions of lactic acid bacteria (LAB). These bacteria grow in milk and convert the lactose sugar of milk into lactic acid. Lactic acid coagulates and partially digests milk protein casein. This causes curdling of milk and it changes to curd, which has improved nutritional quality due to more vitamin B₁₂ content.
9. Sportspersons often become addicted to cocaine to enhance their performance. Cocaine is a stimulant that increases heartbeat, blood pressure, body temperature and delays fatigue. Sportspersons misuse it to enhance their athletic performances.
10. The important advantages of biogas generation are given below:
- Biogas can be stored and used more efficiently and economically.
 - The energy value of biogas is lower than that of organic matter but due to more efficient handling, the net energy output is roughly equal to the output in direct burning of organic wastes.
 - The manure produced in biogas plants is used as fertiliser.
 - Biogas use does not add to pollution.
11. (a) (i) Sporozoite (ii) Gametocyte.
(b) The sexual reproduction of malarial parasite occurs in mosquito and asexual reproduction occurs in human body.
(c) The release of merozoites and toxin haemozoin from the bursting of schizont in RBCs causes chill and high fever. The released merozoites then attack fresh RBCs leading to the formation of trophozoites causing decrease in fever. The trophozoites then grow in size to become schizont that causes increase in temperature. The schizonts again develop merozoites inside themselves thus causing recurrence of fever with the release of merozoites after few days e.g., at regular intervals of 48 hours in case of *vivax* malaria.
- OR
- (a) If a person is infected with some deadly microbes to which quick immune response is required as in tetanus, we need to directly inject the preformed antibodies or antitoxin. Even in the cases of snake bites the injection which is given to the patients, contain preformed antibodies against the snake venom. This type of immunisation is called passive immunisation. It provides immediate relief but may cause some problems.
(b) In vaccination, a preparation of antigenic proteins of pathogens or inactivated weakened pathogens are introduced into the body. This produces immune response and the type of immunity is called passive immunity.
12. *Trichoderma polysporum* produces a bioactive molecule known as cyclosporin – A which has antifungal, anti-inflammatory and

immunosuppressive properties. It inhibits activation of T-cells and therefore prevents rejection reactions in organ transplantation.

13. (a) (i) 'A' – Antigen binding site
(ii) 'B' – Variable region of heavy chain
(b) This diagram illustrates the structure of an antibody molecule.
(c) Humoral immune response is an antibody mediated immune response, which is regulated by antibodies in body fluids.
14. (a) (i) *Nucleopolyhedrovirus*
(ii) *Bacillus thuringiensis*
(b) *Nucleopolyhedrovirus* a genus of baculoviruses are useful in controlling many insects and other arthropods. They are species specific narrow spectrum bioinsecticides with no side effects on plants, mammals, birds, fish and non-target insects. Therefore, they serve as an important component of integrated pest management programme in dealing with ecological sensitive areas. These properties are useful in organic farming.
- OR**
- (a) A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum. The remaining major part of the activated sludge is pumped into large tanks called anaerobic sludge digesters. The anaerobic bacteria present in this tank, digest the organic mass and aerobic bacteria and fungi in sludge and produce mixture of gases like methane, hydrogen sulphide and CO₂ which constitute biogas.
(b) Flocs are masses of aerobic bacteria held together by slime and fungal filaments to form mesh like structures. These microbes digest a lot of organic matter converting it into microbial biomass and releasing a lot of minerals to reduce the biochemical oxygen demand or BOD.
15. (a) Cancer is an abnormal and uncontrolled division of cells, known as cancer cells that invade and destroy the surrounding tissues. Contact inhibition is the property on the basis of which cancer cells differs from normal cells.
- (b)
- | | Benign tumor | Malignant tumor |
|-------|--|--|
| (i) | It remains confined to the affected organ. | It spreads to other organs of the body. |
| (ii) | Rate of growth is usually slow. | Rate of growth is usually rapid. |
| (iii) | It causes limited damage to the body. | The cancer cells migrate to other sites of the body and start a new tumor there. This property is called metastasis. |
| (iv) | It is non-cancerous. | It is cancerous. |
16. Human Immunodeficiency Virus (HIV), after getting into a person's body, enters into macrophages where RNA genome of the virus changes to form viral DNA with the help of reverse transcriptase enzyme. The viral DNA then

gets integrated into host cells DNA to direct the synthesis of virus particles. Simultaneously, HIV enters into helper T-lymphocytes where it replicates in the same way to produce more virus particles. The progeny virus particles are released by the lysis of the host cell. This process is repeated. In this way, there occurs progressive decrease in number of helper T-lymphocytes in the body of the infected person. As a result, the patient becomes so immunodeficient that he/she is unable to protect himself/herself against the infections of bacteria, viruses, fungi, etc.

17. (a) The doctor injected Antitetanus serum (ATS) into the patient's body.
(b) Injection was given against the bacterial disease tetanus. It provides passive immunity.
(c) Spores of *Clostridium tetani* are found in the soil and remain infectious for more than 40 years. A person gets tetanus infection when spores enter the body through an injury or wound. These spores release bacteria that spread in the body and make a poison called tetanus toxin. Antitetanus serum (ATS) contains readymade antibodies which are directly injected into a person to protect the body against foreign agents. ATS stops toxin production within the body and neutralises already circulating toxin if the infection occurs.

OR

Characteristics of a good antibiotic : (a) Harmless to host with no side effect. (b) Harmless to normal microflora of alimentary canal. (c) Ability to destroy pathogen with broad spectrum action. (d) Quick action.

Resistance to antibiotics in bacteria comes from (i) development of biofilm (copious mucilage), (ii) antibiotic resistant genes producing enzyme that destroy antibiotics, (iii) efflux system that prevents the drug from reaching its target, (iv) modification of target site, (v) alternative metabolic pathway that bypasses the action of drug.

18. During the secondary treatment, the primary effluent is passed into large aeration tanks where it is continuously agitated mechanically. The air is allowed to pass through agitating mixture to make it aerobic. This allows vigorous growth of useful aerobic microbes into flocs. These microbes use the major part of the organic matter in the effluent. This considerably reduces the BOD (biochemical oxygen demand) of the effluent. The sewage water is treated till the BOD is reduced.
19. When a B-cell encounters antigen, it is activated and divides to produce a clone of daughter B-cells. These cells specialise into plasma B-cells and memory B-cells. Plasma cells produce antibodies that dispose off the antigen while memory B cells live for a long time and serve to quickly dispose off the antigen in case re-infection of the same virus or bacterium occurs.
20. An Rh-ve person, if exposed to Rh+ve blood, will form specific antibodies against the Rh antigens. This is observed in case of Rh-ve blood of a pregnant mother with Rh+ve blood of

the fetus. Rh antigens of the fetus do not get exposed to the Rh-ve blood of the mother in the first pregnancy as the two bloods are well separated by the placenta. However, during the delivery of the first child, there is a possibility of exposure of the maternal blood to small amounts of the Rh+ve blood from the fetus. In such cases, the mother starts preparing antibodies against Rh antigen in her blood. In case of her subsequent pregnancies, the Rh antibodies from the mother (Rh-ve) can leak into the blood of the fetus (Rh+ve) and destroy the fetal RBCs. This could be fatal to the fetus or could cause severe anaemia and jaundice to the baby. This condition is called erythroblastosis fetalis. This can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the first child.

21. The microorganisms such as bacteria, yeasts, filamentous algae, are treated in various ways to be used as food and are called single cell protein (SCP). The term SCP does not indicate its actual meaning because the biomass is not only obtained from unicellular microorganisms but also from multicellular microorganisms.

Microbes like *Spirulina* can be grown on waste water from potato processing plants (containing starch), straw, molasses, animal manure and even sewage, to produce food rich in proteins, minerals, fats, carbohydrates and vitamins. Commercial production of SCP is mostly based on yeasts and some other fungi.

Advantages of SCP are as follows:

- It provides a protein rich supplement in human diet.
- It reduces the pressure on agricultural production systems for the supply of the required proteins.
- SCP production is based on industrial effluents so it helps to minimise environmental pollution.

22. (a) In the given figure, P is Cow dung, Q is Sludge and R is Digester.

(b) In a biogas plant, production of biogas takes place by anaerobic digestion of biomass with the help of methanogenic bacteria. Biowastes are collected in the digester. Mostly, fresh cattle dung with water is used. It is fed into the digester through the inlet and allowed to remain there. A floating gas holder present over the digester keeps on rising as the gas is produced due to anaerobic microbial decomposition (digestion). The accumulated gas is conducted through the outlet pipe and is used for domestic purposes. The digested sludge is removed and is used as fertiliser.

23. (i) 1 is viral RNA and 2 is provirus.
(ii) Viral RNA initiates the formation of viral DNA in the host.
(iii) Retroviruses.
(iv) Cancer, AIDS.

24. (a) A - Lactic acid; B - Vitamin B₁₂
(b) Indian curd is prepared by inoculating skimmed and cream milk with *Lactobacillus acidophilus* at a temperature of about 40°C or less.

25. (a) Spleen acts as a secondary lymphoid organ where mature B and T lymphocytes undergo proliferation and differentiation. In spleen, lymphocytes develop immune response and become effector cells.

(b) (i) Differences between innate and acquired immunity are as follows:

	Innate Immunity	Acquired Immunity
(i)	This includes all the defence elements with which an individual is born.	This immunity is acquired after the birth.
(ii)	It consists of various types of barriers that prevent the entry of foreign agents.	It consists of specialised cells (T-cells and B-cells) and antibodies that circulate in the body fluid.
(iii)	It remains throughout life.	It can be short lived or long - lived.

(ii) Differences between the role of B-lymphocytes (B-cells) and T-lymphocytes (T-cells) in generating immune responses are :

	B-lymphocytes (B-cells)	T-lymphocytes (T-cells)
(i)	B-cells form humoral or antibody mediated immune system (AMIS).	T-cells form cell-mediated immune system (CMIS).
(ii)	They defend against viruses and bacteria that enter the blood and lymph.	They defend against pathogens including protists and fungi that enter the cells.
(iii)	Plasma cells formed by division of B-cells produce antibodies and provide immunity against foreign substances.	T-lymphocytes produce different types of T-cells, e.g., killer T-cells react against cancer cells, suppressor cells inhibit immune system.

(c) The cells that engulf antigens and present their fragments to T-cells are called antigen presenting cells (APCs). There are three types of APCs found in the body :

- (i) Macrophages (ii) Dendritic cells
- (iii) B-cells.

OR

(a) B-cells and T-cells belong to the category of lymphocytes. B-cells and T-cells are formed in the bone marrow but they differ from each other on the basis of place of their maturity and function. B-cells are differentiated in bone marrow while T-cells are differentiated in thymus. B-cells produce antibodies to kill

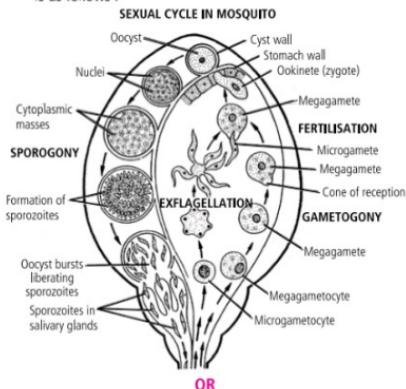
the antigens while T-cells produce killer, helper and suppressor T-cells to fight with antigens. The T-cells play two important functions — effector and regulatory. The effector function includes cytolysis (destruction of cells by immune process) of cells infected with microbes and tumour cells, and lymphokine production. The regulatory functions are either to increase or to suppress other lymphocytes and accessory cells.

(b) The skin is the physical barrier of innate immunity, as its outer tough layer stratum corneum prevents entry of microbes. The oil and sweat secreted respectively by sebaceous and sudoriferous glands of skin contain fatty acids and lactic acid, which make the skin surface acidic. These have antibacterial and antifungal activity. Lysozyme present in sweat also kills many bacteria. Thus, they provide first line of body defence.

(c) Ganja is obtained from *Cannabis sativa*. It is hallucinogenic. It alters thoughts, feelings and perceptions and causes illusions.

26. (a) Primary host of *Plasmodium* is female *Anopheles* mosquito and secondary host is human being.

(b) Diagrammatic representation of part of life cycle (sexual phase) of *Plasmodium vivax* in mosquito (female *Anopheles*) is as follows :



(a) Vaccine: It is a preparation of dead/weakened germs of a disease which on inoculation into a person provides temporary/permanent active/passive immunity by inducing antibody formation. The antibodies produced in the body against these antigens would neutralise the pathogenic agents during actual infection. The vaccines also generate memory B and T cells that recognise the pathogen quickly on subsequent exposure and attack the invaders with a large production of antibodies.

(b) Lymphoid organs: These are those organs where the maturation and proliferation of lymphocytes takes place. There are two types of lymphoid organs:

- (i) Primary lymphoid organs are those where T lymphocytes and B lymphocytes mature and acquire their antigen-specific receptors. Bone marrow and thymus are primary lymphoid organs. B-lymphocytes mature in bone marrow and T-lymphocytes mature in thymus.
- (ii) Secondary lymphoid organs are those where B lymphocytes and T lymphocytes undergo proliferation and differentiation. They acquire immune response in these organs and become effector cells. Lymph nodes and spleen are secondary lymphoid organs.
- (c) AIDS – The full form of AIDS is Acquired Immuno Deficiency Syndrome. It is caused by human immunodeficiency virus (HIV), a member of a group of viruses called retroviruses. These viruses are called retroviruses because they have RNA as their genome, enclosed within an envelope. Other than sexual contact, transmission of HIV infection in humans could also occur by :

- (i) Transfusion of contaminated blood and blood products.
- (ii) From infected mother to her child through placenta.
- (d) Organ transplantation: It is the implantation of an organ or tissue from one part of the body to another or from one person (donor) to another (recipient). Tissue matching, blood group matching are essential before undertaking any graft/transplant and even after this the patient has to take immunosuppressants all his/ her life. This is because the body is able to differentiate 'self' and 'nonself' and the cell-mediated immune response may cause graft rejection.

Organ transplantation is of four types:

- (i) Autograft,
(ii) Isograft,
(iii) Allograft and
(iv) Xenograft

27. Biological control is the use of living organisms to control pests. A natural enemy such as a parasite, predator, or disease organism is introduced into the environment of a pest. Some examples of biological control are as follows :

- (i) Bioherbicides are living organisms, which control the weeds. First bioherbicide was developed in 1961 and it was a mycoherbicide derived from a fungus *Phytophthora palmivora*, which controls the growth of milkweed vines in Citrus orchards.
- (ii) Control of overgrowth of cacti by introduction of cochineal insect (*Cactoblastis cactorum*) in India and Australia.
- (ii) The Ladybird beetle and dragonflies are useful to get rid of aphids and mosquitoes, respectively.
- (iv) The microbial biocontrol agents that can be introduced in order to control butterfly caterpillars is the bacteria

Bacillus thuringiensis (often written as Bt). The dried spores are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed.

- (v) Baculoviruses are the pathogenic viruses, which infect and kill many insect pests and other arthropod pests. Most important baculovirus involved in biological control is Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. They have been shown to have no negative impacts on plants, mammals, birds, fish, or even on non-target insects. Baculoviruses are known to control pests like potato beetles, aphids and corn borers.

OR

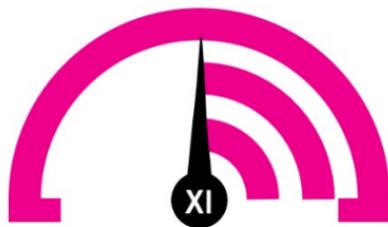
Sewage water can be purified by passing it through sewage treatment plants with the action of microorganisms. A sewage treatment plant separates solids from liquids by physical processes and purifies the liquid by biological processes. There are three stages of this treatment; primary, secondary and tertiary. **Primary treatment is physical, secondary biological and tertiary chemical.**

Primary treatment phase of sewage treatment removes floating and suspended solids from sewage through two processes of filtration and sedimentation. First floating matter is removed through sequential filtration. The filtrate is kept in large open settling tanks where grit settles down. Aluminium or iron sulphate is added in certain places to flocculation and settling down of solids. The sediment is called primary sludge while the supernatant is called effluent. The primary sludge traps a lot of microbes and debris. It is subjected to composting or land fill where anaerobic digestion removes the organic matter.

During secondary treatment, the primary effluent is taken to aeration tanks. A large number of aerobic heterotrophic microbes grow in the aeration tank. They form flocs are masses of bacteria held together by slime and fungal filaments to form mesh-like structures. The microbes digest a lot of organic matter, converting it into microbial biomass and releasing a lot of minerals. As a result the BOD of the waste matter is reduced to 10-15% of raw sewage, it is passed into settling tank. In settling tank, the bacterial flocs are allowed to undergo sedimentation. The effluent or supernatant is generally passed into natural water bodies and sediment of settling tank is called activated sludge.



MONTHLY TEST DRIVE



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.

Total Marks : 160

Morphology of Flowering Plants

Time Taken : 40 Min.

Anatomy of Flowering Plants

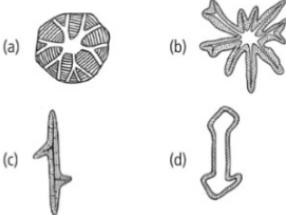
- The condition, where stamens are fused by both anthers and their filaments is known as
 (a) synantherous (b) polyadelphous
 (c) synandrous (d) diadelphous.
- Photosynthetic roots are found in
 (a) *Trapa* (b) *Tinospora*
 (c) *Taeniophyllum* (d) all of these.
- Read the following statements and choose the correct ones.
 (i) The period between the appearance of two successive leaf primordia is called phymomer.
 (ii) Histogens are tissue producing regions, that includes dermatogen, periblem and plerome.
 (iii) Cell division in quiescent centre of root is very few due to little synthesis of DNA, RNA and proteins.
 (iv) Calyptrogen differentiates in dicots only.
 (a) (i) and (ii) only (b) (ii) and (iii) only
 (c) (iii) and (iv) only (d) (i) and (iv) only
- In *Cucurbita* stem, mechanical strength, flexibility is provided by
 (a) angular collenchyma (b) lame late collenchyma
 (c) lacunate collenchyma (d) sclerenchyma.
- In this type of inflorescence, an unbranched peduncle bears pedicellate flowers in an acropetal fashion but the pedicels of lower flowers are longer so that, all the flowers lie at the same level. It is found in
 (a) corymb in *Iberis amara*
 (b) typical raceme in *Raphanus*
 (c) umbel in *Centella asiatica*
 (d) spikelet in oat.
- Identify the type of inflorescence in given plants.
 A. *Morus* B. *Colocasia*
 C. *Zinnia* D. *Coconut*

	A	B	C	D
(a)	Spadix of spadices	Catkin	Spadix	Capitulum
(b)	Catkin	Spadix	Capitulum	Spadix of spadices
(c)	Catkin	Spadix of spadices	Capitulum	Spadix
(d)	Capitulum	Catkin	Spadix of spadices	Spadix

- Study the given characters and identify the family. Taproot, erect stem, alternate leaves in vegetative region, axillary inflorescence, actinomorphic flower, calyx with valvate aestivation, gamopetalous corolla, 5 stamens, bicarpellary, syncarpous, superior ovary and fruit is many seeded berry.
 (a) Fabaceae (b) Solanaceae
 (c) Liliaceae (d) Compositeae
 - The young endodermal cells possess a band of thickening which runs along their radial and tangential wall. This band of thickening is called Caspary strip. It is made up of
 (a) suberin and cellulose (b) lignin and cellulose
 (c) cellulose only (d) suberin and lignin.
 - Family Labiatea has a special type of inflorescence having two clusters of 3 – 9 flowers that develop on a node in the axis of opposite leaves is known as
 (a) cyathium (b) verticillaster
 (c) hypanthodium (d) spike of spikes.
 - Match column I with column II and select the correct option from the codes given below.
- | Column I | Column II |
|------------------------------|-----------------------|
| A. Polycarpellary apocarpous | (i) Mustard gynoecium |
| B. Tricarpellary syncarpous | (ii) Rose gynoecium |

- C. Bicarpellary syncarpous (iii) *Asphodelus*
gynoecium
(a) A-(i), B-(ii), C-(iii) (b) A-(ii), B-(iii), C-(i)
(c) A-(iii), B-(i), C-(ii) (d) A-(i), B-(iii), C-(ii)

11. The grit of guava contains



12. These are sharp and stiff epidermal outgrowths, which do not have vascular supply and help in plant protection from excessive transpiration and grazing animals. Find the structure.
(a) Aerial hairs (b) Root hairs
(c) Stinging hairs (d) Prickles

13. Carpophore is a condition where the thalamus is prolonged into gynoecium to form a central axis. This condition can be studied in
(a) sunflower (b) marigold
(c) rose (d) coriander.

14. Read the given statements and select the correct option.
Statement A : *Juglans regia* has a husk like exocarp, a woody pericarp and a single seed having convoluted edible cotyledons.

Statement B : *Juglans regia* was previously considered to be a drupe.

- (a) Both statements A and B are correct.
- (b) Both statements A and B are incorrect.
- (c) Statement A is correct but statement B is incorrect.
- (d) Statement B is correct but statement A is incorrect.

15. Select the incorrect match.

- | | |
|---------------------------------|-------------------------------|
| (a) Phloem parenchyma | - Lateral conduction of food |
| (b) Palisade mesophyll | - Main site of photosynthesis |
| (c) Spongy mesophyll | - Compactly arranged cells |
| (d) Xylem vessels and tracheids | - Mechanical support to leaf |

16. Dendrochronology is the science of

- (a) analysis of annual growth rings in trees
- (b) study of tree physiology
- (c) study of evolutionary development of trees
- (d) analysis of flowering in tree species.

17. Identify A, B, C, and D in the given table.

	Plant species	Type of fruit	Edible part
A.	<i>Citrus reticulata</i>	Hesperidium	A
B.	<i>Artocarpus heterophyllus</i>	B	Bracts, perianth, seeds
C.	C	Drupe	Endosperm and embryo
D.	<i>Litchi chinensis</i>	D	Aril

- | A | B | C | D |
|--------------------|---------|-------------------------|-------|
| (a) Placental hair | Sorosis | <i>Cocos nucifera</i> | Nut |
| (b) Mesocarp | Sorosis | <i>Mangifera indica</i> | Berry |
| (c) Endocarp | Syconus | <i>Pyrus malus</i> | Drupe |
| (d) Endosperm | Berry | <i>Cocos nucifera</i> | Nut |

18. In monocot roots, regulation of flow of fluid inwardly as well as outwardly is done by

- (a) passage cells (b) pith
- (c) pericycle (d) epidermis.

19. A special type of false berry where exocarp does not separate from mesocarp. In this type of fruit normally endocarp, mesocarp and placentae are edible except in
(a) gourd (b) melon
(c) cucumber (d) pumpkin.

20. Select the incorrect match of vascular bundles with plant species.

Key :

- | | | | |
|-----|---------|-----|----------|
| (a) | Pumpkin | (b) | Yucca |
| (c) | Prunus | (d) | Dracaena |

21. Presence of diadelphous androecium with nectar glands on inner bases of filaments is characteristic feature of the Family
(a) Fabaceae (b) Solanaceae
(c) Liliaceae (d) Asteraceae.

22. Select the correct statement regarding the secondary growth in dicots.

- (i) Spring wood contains wider elements and lighter in colour as compared to autumn wood.
- (ii) In *Cassia fistula*, the vessels are broad in spring wood and quite narrow in autumn wood.
- (iii) In *Syzygium cumini*, large sized vessels are distributed throughout spring and autumn wood.
- (iv) Tyloses are ingrowth of adjacent parenchyma cells into the cavities of tracheids and vessels of sapwood.

- (a) Only (i) and (ii)
 (b) Only (i), (ii) and (iii)
 (c) Only (iv)
 (d) (i), (ii) (iii) and (iv).
- 23.** Identify the correct matched pairs.
- | | |
|---|-------------------------|
| (i) Stomatal crypts | - <i>Nerium</i> |
| (ii) Leaves with multilayered epidermis | - <i>Ficus</i> |
| (iii) Phloem parenchyma | - <i>Arparagus</i> stem |
| (iv) Absence of stomata on leaves | - <i>Nymphaea</i> |
- (a) (i) and (ii) only
 (b) (ii) and (iii) only
 (c) (iii) and (iv) only
 (d) (i) and (iv) only
- 24.** The plant species majorly used as green manure and in crop rotation belong to the Family
- (a) Liliaceae
 (b) Solanaceae
 (c) Fabaceae
 (d) Asteraceae.
- 25.** Identify the name and family of plant that possesses given floral diagram.
- 
- (a) *Cassia fistula*, Fabaceae
 (b) *Hibiscus rosa sinensis*, Malvaceae
 (c) *Allium cepa*, Liliaceae
 (d) *Solanum nigrum*, Solanaceae
- 26.** Which of the following is not a distinguishing feature between monocot and dicot stem?
- (a) Presence of xylem parenchyma
 (b) Types and arrangement of vascular bundles
 (c) Presence of phloem parenchyma
 (d) Hypodermal tissue
- 27.** Lacuna or protoxylem cavity is made up from (i) and (ii). It is absent in (iii).
- | | | |
|---------------------------|------------------|------------------|
| (i) | (ii) | (iii) |
| (a) protoxylem vessel | xylem parenchyma | <i>Asparagus</i> |
| (b) protoxylem vessel | xylem tracheids | cucurbita |
| (c) protoxylem parenchyma | xylem tracheids | cucurbita |
| (d) protoxylem parenchyma | xylem tracheids | <i>Asparagis</i> |
- 28.** Guar gum, extracted from *Cyamopsis tetragonoloba* of the Family Fabaceae is used in
- (a) pharmaceutical, textile, explosives, photography
 (b) pharmaceutical, canvas making, canned food
 (c) ceramics, dyes, paper, plastics
 (d) all of these.
- 29.** Select the option that correctly fill any three blanks. Medullary rays in dicot stems connect (i) with (ii) and (iii). These help in (iv) of water and transport (v) from pith to (vi) and vice versa.
- (a) (i) xylem, (iii) cortex, (iv) radial conduction
 (b) (iv) lateral conduction, (v) food, (vi) cortex
 (c) (i) pith, (ii) pericycle, (v) gases
 (d) (ii) phloem, (iv) radial conduction, (v) food
- 30.** Akash went for a school trip. He collected some leaves but he forgot to tag them. He analysed the morphology and anatomy of leaf. Leaf has stomata on upper surface only. The leaves are covered with mucilage and possess aerenchyma. He identified the plant as
- (a) *Nymphaea* (b) *Hydrilla*
 (c) *Potamogeton* (d) Cactus.
- 31.** Read the following statements regarding secondary growth and state them as true (T) or false (F).
- The primary xylem get completely destroyed as the new secondary xylem becomes functional.
 - Initially, vascular cambium derived from pericycle gives rise to only ray cells.
 - Cork protects the interior from entry of bacteria.
 - Secondary phloem is generally made up of sieve tube, companion cells and phloem parenchyma. Phloem fibres are absent.

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A	B	C	D
(a) F	T	T	T
(b) F	T	T	F
(c) T	F	F	F
(d) T	F	F	T

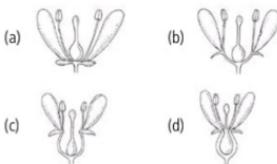
32. $\oplus \overset{P}{3+3} \text{ or } (3+3) \overset{A}{3+3} \overset{G}{(3)}$ is the floral formula of the Family

- (a) Solanaceae
- (b) Fabaceae
- (c) Liliaceae
- (d) Asteraceae.

33. Dilation is a phenomenon where

- (a) secondary xylem gradually moves outside with increase in phloem
- (b) secondary phloem gradually moves outside with increase in cortex
- (c) cambium gradually moves outside with increase in secondary xylem
- (d) secondary xylem moves outside with increase in cambium.

34. Which one of the following represents position of floral parts on thalamus of rose?



35. Select the number of characters that belongs to maize.

Casparian strips, Spikelets inflorescence, Single cotyledon, Taproot, Caryopsis fruit, Conjoint and collateral open vascular bundle, Schizolysigenous cavity.

- (a) 6
- (b) 4
- (c) 3
- (d) 5

36. In garden nasturtium, the number of vascular strands are

- (a) two in lateral roots and four in main roots
- (b) four in lateral roots and two in main roots
- (c) one in lateral roots and two in main roots
- (d) two in lateral roots and six in main roots.

37. Bark, the group of dead cells, is insect repellent, decay proof

and acts as a heat screen. It is commercially used in

- (i) medicine and as spice
- (ii) tanning and drugs
- (iii) insulator and linoleum
- (iv) bottle stopper and sound proofing agent.

- (a) (i), (ii) and (iii) only
- (b) (i), (ii), (iii) and (iv)
- (c) (i), (ii) and (iv) only
- (d) (i) and (iv) only

38. Read the given statements and select the correct option.

Statement A : Epidermal cells in cereals have a deposition of silica.

Statement B : Silica provides stiffness and protection against grazing.

- (a) Both statements A and B are true and B is the correct explanation of A.
- (b) Both statements A and B are true but B is not the correct explanation of A.
- (c) Statement A is true but statement B is false.
- (d) Both statements A and B are false.

39. Identify the correct set of statements.

- (i) The endodermis regulates the flow of fluid and function as biological checkpost.
- (ii) The protoxylem cavity of maize in schizolysigenous in origin.
- (iii) Carcerulus fruit found in *Abutilon* develops from an inferior unilocular ovary.
- (iv) Free central placentation can be seen in sunflower.
- (a) (i) and (ii)
- (b) (iii) and (iv)
- (c) (i) and (iv)
- (d) (ii) and (iii)

40. A plant with umbel inflorescence, 6 stamens in two whorls and tricarpellary, syncarpous, superior ovary and the fruit is loculicidal capsule with endospermic seed can be placed in Family

- (a) Fabaceae
- (b) Solanaceae
- (c) Liliaceae
- (d) Cruciferae.



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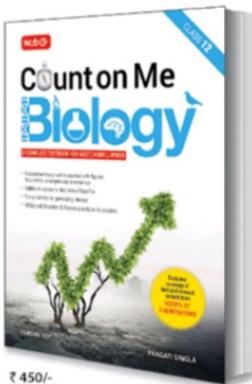
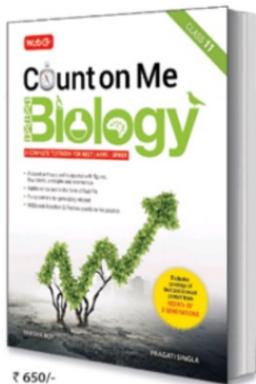
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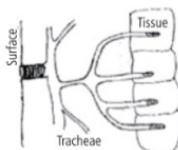


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BIOLOGY OLYMPIAD PROBLEMS

1. The following diagram shows the respiratory system of insects. In resting condition, the tracheoles are filled with fluid diffused from surrounding tissues. The amount of O_2 dissolved in the fluid is enough for normal activity. During rigorous activity, however, lactic acid starts accumulating in the tissues and there is an increased oxygen demand. How does the system meet the excess demand of O_2 ?



- (a) Exercise leads to more diffusion of fluid in tracheoles and it leads to increased gaseous exchange.
- (b) The fluid moves from tracheoles to tissues so that more oxygen comes in contact with the tissues.
- (c) During rigorous activity skin surface also helps in gaseous exchange along with the tracheolar system.
- (d) Increased activity expands the tracheoles which results in increased air contact with tissues.

(NSEB 2015-16)

2. Above 40°C most living cells synthesise heat shock proteins (HSP), the best strategy for HSPs to protect the cell would be to

- (a) envelope vital proteins to prevent their denaturation
- (b) absorb more water to achieve cooling of the cells
- (c) achieve cooling by promoting evaporation of water from the cells
- (d) lower the general metabolic rate of the cells to conserve energy.

(NSEB 2015-16)

3. Which of the following process occurring in the stomach is autocatalysis?

- (a) Low pH denaturing the proteinaceous substances in food
- (b) Low pH activating pepsinogen to pepsin
- (c) Absorption of monomeric molecules in chyme
- (d) Pepsin activating more pepsinogen molecules

(NSEB 2015-16)

4. Reproductive barriers are mechanisms which help maintain species over time. Three examples of reproductive barriers in certain species are given below.

- A. Two species of garter snakes occur in the same area but one lives in water while the other is terrestrial.

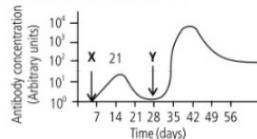
- B. Some Salamander subspecies of genus *Ensatina* live in the same region and occasionally hybridise resulting in trait individuals in the next generation.

- C. Blue-footed boobies (a type of bird) mate only after a courtship display wherein the male draws the female's attention to its bright blue feet.
Indicate whether these are examples of pre-zygotic or post-zygotic reproductive barriers.

- (a) A-Pre-zygotic, B-Pre-zygotic, C-Pre-zygotic
- (b) A-Post-zygotic, B-Post-zygotic, C-Pre-zygotic
- (c) A-Pre-zygotic, B-Pre-zygotic, C-Post-zygotic
- (d) A-Pre-zygotic, B-Post-zygotic, C-Pre-zygotic

(NSEB 2014-15)

5. An exposure to antigen A indicated at 'X' causes rise in concentration of antibodies to A as shown in the diagram. What is the event indicated at "Y"?



- (a) Exposure to a new antigen B
- (b) Repeat exposure to antigen A
- (c) Immunocompromise
- (d) Infusion of leucocytes

(NSEB 2015-16)

6. Damage to the right parietal lobe of human brain causes a condition called Contralateral Neglect Syndrome. In this syndrome the person

- (a) tends to ignore stimuli from the left side of the body
- (b) tends to ignore stimuli from the right side of the body
- (c) is not able to co-ordinate between the stimuli from the right and left sides of the body
- (d) shows more sensitivity towards the stimuli from the left side of the body.

(NSEB 2014-15)

7. Two nearby seashores A and B were compared using dominance and diversity indices. It was found that the diversity index of A was better than that of B while the dominance index of B was better than that of A. Which of the following can be true?

- (a) Eutrophication has occurred at A.
- (b) Eutrophication has occurred at B.
- (c) Habitat loss could be a problem at A.
- (d) Indicator species are present at B.

(NSEB 2014-15)

8. In an experiment, *E. coli* cells growing at 37°C were shifted to 20°C and grown for a few generations. Which of the following changes in the membrane would help the *E. coli* cells adapt to the new environment?

- Increase in the unsaturated fatty acid content
- Increase in the number of integral membrane proteins
- Increase in the phospholipid content
- Increase in the length of the hydrophobic tail

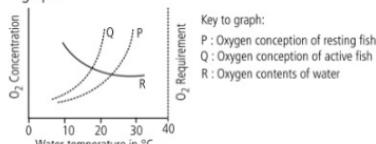
(INBO 2016)

9. Which of the following results in inclusive fitness?

- | | |
|-------------------------------|------------------------|
| (i) Altruism | (ii) Kin selection |
| (iii) Parental care | (iv) Batesian Mimicry |
| (a) (i), (ii), (iii) and (iv) | (b) (i) and (ii) only |
| (c) (i) and (iii) only | (d) (ii) and (iv) only |

(NSEB 2015-16)

10. Which of the following statements can be deduced from the graph?

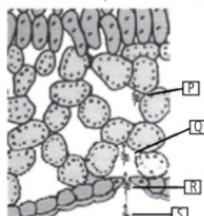


- Fish need more O₂ when water is warmer.
 - Warm water carries less O₂ than cold water.
 - An active fish uses more O₂ than an inactive fish.
 - Fish prefers cooler water for feeding.
- (a) (i), (ii) (iii) and (iv) (b) (i) and (ii) only
(c) (i), (ii) and (iii) only (d) only (i)

(NSEB 2014-15)

11. The process of photosynthesis needs carbon dioxide to diffuse from the atmosphere into the leaf and into the carboxylation site of RuBisCO. This happens through a series of steps. Each step in this diffusion pathway imposes resistance to CO₂ diffusion. This is depicted in the diagram. Various resistances are listed below.

- Boundary layer resistance
- Stomatal resistance
- Liquid phase resistance
- Intercellular air space resistance

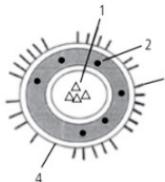


Which of the following shows the correct combination?

- P-(i); Q-(iii); R-(ii); S-(iv)
- P-(i); Q-(ii); R-(iii); S-(iv)
- P-(iii); Q-(iv); R-(ii); S-(i)
- P-(iv); Q-(iii); R-(ii); S-(i)

(INBO 2016)

12. Liposomes are vesicles used to entrap drugs for targeted delivery to specific organs. Following is schematic representation of a liposome. 1, 2, 3 and 4 would be



- 1-Water soluble drug, 2-water insoluble drug, 3-Homing peptide, 4-Polar head of lipid
- 1-Hydrophobic drug, 2- Hydrophilic drug, 3-Water soluble drug, 4-Protein coat
- 1-Homing peptide, 2-Hydrophobic drug, 3-Hydrophilic proteins, 4-Polar head groups of proteins
- 1-Hydrophobic drug, 2-Phospholipids, 3-Hydrophilic drug, 4-Hydrophilic proteins

(INBO 2015)

13. The ABC model postulates that the organ identity in each whorl of a flower is determined by the combination of the following five genes.

Apetala 1 (AP1); Apetala 2 (AP2); Apetala 3 (AP3)

Pistillata (PI); Agamous (AG)

The table below indicates the normal expression pattern of these genes in the whorls of a wild flower. As shown in the table, the expression of AP1 or AP2 in a whorl leads to the suppression of AG in that same whorl and vice versa.

AP3 or PI (B)			
AP1 or AP2 (A)		AG (C)	
Sepals	Petals	Stamens	Carpels
1 Outermost whorl	2	3	4 Innermost whorl

Which of the following patterns will develop (from outermost whorl to the innermost whorl) if only the activity of genes AP3 and PI is lost?

- Sepals, Petals, Petals, Carpels
- Sepals, Stamens, Stamens, Carpels
- Sepals, Sepals, Carpels, Carpels
- Sepals, Sepals, Petals, Carpels

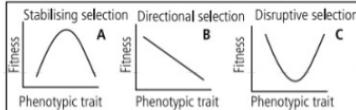
(INBO 2015)

14. Dividing chromosomes can be labelled with a thymine analogue, bromodeoxy-uridine. After differential staining, the chromosomes can be seen as darkly stained (old) strands and lightly stained (new) strands. The following chromosomes were observed and photo-graphed while studying division of human blood cells.

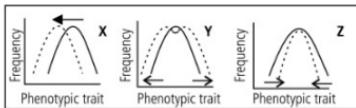


From the picture, which of the following can be deduced?

- The chromosomes belong to metaphase stage.
 - The cell division was taking place in mature red blood cells.
 - Parts of the chromatids were exchanged by crossing over.
 - The different colours of the two sister chromatids confirm that DNA replication is semi-conservative.
- (a) I, III and IV (b) II and IV only
 (c) I and IV only (d) I, II and III (INBO 2015)
15. Natural selection can act on characters with quantitative variations in ways as depicted in A, B and C.



This can lead to the results depicted in the graphs X, Y and Z.



The bold lines show the distribution of phenotypes in the population before and the broken lines show the effect of the selection.

The changes in the phenotypic traits observed in X, Y and Z are respectively due to

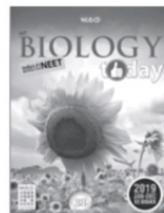
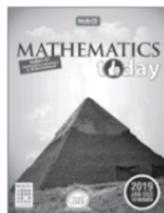
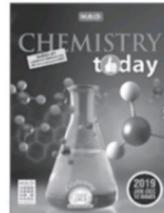
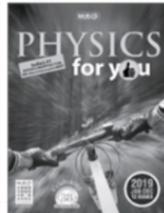
- (a) A, B and C (b) C, A and B
 (c) B, C and A (d) C, B and A (INBO 2015)

ANSWER KEY

- | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1. | (b) | 2. | (a) | 3. | (d) | 4. | (d) | 5. | (b) |
| 6. | (a) | 7. | (b) | 8. | (a) | 9. | (b) | 10. | (c) |
| 11. | (c) | 12. | (a) | 13. | (c) | 14. | (a) | 15. | (c) |



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MONTHLY TEST DRIVE

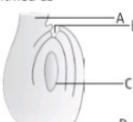


This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160

- Reproduction in Organisms
- Sexual Reproduction in Flowering Plants

Time Taken : 40 Min.

1. Read the following statements and select the option containing only correct ones.
 - (i) Megasporogenesis involves formation of pollen grains from a pollen mother cell through meiosis.
 - (ii) Female gametophyte remains permanently embedded in the megasporangium or nucellus.
 - (iii) Megasporophyll represents the gametophytic phase.
 - (iv) Pollen tube is glandular, secretory and absorptive.
 - (a) (i) and (iii) only
 - (b) (i) and (iv) only
 - (c) (ii) and (iv) only
 - (d) (ii) only
2. The rudimentary second cotyledon in monocot embryo is called
 - (a) suspensor
 - (b) scutellum
 - (c) epiblast
 - (d) epicotyl.
3. In the given figure, parts labelled as A, B, C and D are respectively identified as
 - (a) Hilum, Micropyle, Filiform apparatus, Chalazal pole
 - (b) Funicle, Micropyle, Embryo sac, Chalazal pole
 - (c) Hilum, Funicle, Embryo sac, Filiform apparatus
 - (d) Funicle, Micropyle, Integument, Chalazal pole.
4. At the time of pollination, pollen grain is either
 - (a) 2-celled or 3-celled
 - (b) 2-celled or 4-celled
 - (c) 3-celled or 4-celled
 - (d) 1-celled or 3-celled.
5. The polycarpic plant that flowers throughout the year is
 - (a) apple
 - (b) mango
 - (c) orange
 - (d) China rose.
6. The organism, whose chromosome number in meiocytes ($2n$) and gamete (n) is 48 and 24 respectively, is
 - (a) potato
 - (b) maize
 - (c) rice
 - (d) onion.
7. Transverse binary fission is evident in
 - (a) *Paramecium, Planaria*
 - (b) *Amoeba, Diatoms*
 - (c) *Sycon, Plasmodium*
 - (d) *Planaria, Plasmodium*.
8. Select the correct option to fill up the blanks in the following statements.
 - (i) In _____ animals, females give birth to young ones and the chance of survival is more.
 - (ii) _____ is pollination between two flowers of different plants.
 - (iii) Tapetum is of two types _____ and secretory.

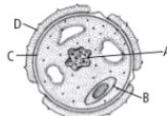
(i)	(ii)	(iii)
viviparous	Geitonogamy	glandular
viviparous	Xenogamy	amoeboid
oviparous	Geitonogamy	glandular
oviparous	Syngamy	parietal
9. Select the mismatched pair.
 - (a) Neoteny – *Ambystoma*
 - (b) Isogamy – *Microcystis*
 - (c) Homogamy – *Mirabilis*
 - (d) Zoophily – *Vallisneria*
10. In nuclear endosperm, the primary endosperm nucleus
 - (a) is followed by cytokinesis and the endosperm becomes cellular from the very beginning
 - (b) divides repeatedly without wall formation to produce a large number of free nuclei
 - (c) is followed by transverse cytokinesis to form two unequal cells
 - (d) produces an outer layer of protoderm.

11. Consider the following table for differences between chasmogamous and cleistogamous flowers.

	Chasmogamous flowers	Cleistogamous flowers
(i)	The flowers open, exposing anthers and stigmas.	The flowers remain closed so that anthers and stigmas are never exposed.
(ii)	The flowers undergo only self pollination.	The flowers may undergo self pollination or cross pollination.
(iii)	A pollinating agency is often required.	No external pollinating agency is required.
(iv)	The flowers are often prominent.	The flowers are not much distinguishable.

How many of the above differences is/are correct?

- (a) One (b) Two
 - (c) Three (d) All of these
12. Three chalazal cells of the embryo sac are called
- (a) polar nuclei (b) antipodal cells
 - (c) nucellar cells (d) synergid cells.
13. Turiots, the swollen buds which function as vegetative propagules are found in
- (a) *Potamogeton, Utricularia*
 - (b) *Clerodendron, Utricularia*
 - (c) *Croton, Potamogeton*
 - (d) *Tapioca, Clerodendron*.
14. Asexual reproductive structures found in some lower fungi and many algae are
- (a) zoospores (b) sucker
 - (c) runner (d) tuber.
15. Water hyacinth propagates vegetatively through
- (a) bulbs (b) offsets
 - (c) tubers (d) rhizomes.
16. Refer to the given figure and match the labelled parts with their characteristics and select the correct option.



- (i) It is made of a highly resistant fatty substance called sporopollenin.
- (ii) It is spindle shaped to spherical in outline with thin dense cytoplasm surrounding a prominent nucleus.
- (iii) It has a vacuolate cytoplasm which is rich in food reserve and cell organelles.
- (iv) It is pecto-cellulosic in nature.

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

17. In (i) germination, (ii) elongates so that the cotyledons come out of soil, while in (iii) germination, (iv) elongates, so that cotyledons remain in the soil.
- (a) (i) - epigeal, (iv) - hypocotyl
 - (b) (ii) - epicotyl, (iii) - hypogeeal
 - (c) (i) - hypogeeal, (iii) - epigeal
 - (d) (iii) - hypogeeal, (iv) - epicotyl

18. Match the items given in column I with those in column II and select the correct option.

Column I	Column II
A. Conidia	(i) <i>Bryophyllum</i>
B. Leaf buds	(ii) Sponge
C. Rhizome	(iii) <i>Penicillium</i>
D. Gemmules	(iv) Ginger
(a) A - (ii), B - (iii), C - (i), D - (iv)	
(b) A - (iii), B - (i), C - (iv), D - (ii)	
(c) A - (iv), B - (ii), C - (iii), D - (i)	
(d) A - (ii), B - (iv), C - (i), D - (iii)	

19. Which of the following states only the parts of an ovule?

- (a) Funicle, Hilum, Placenta, Raphe, Integuments
- (b) Stigma, Hilum, Polar nuclei, Synergids
- (c) Funicle, Polar nuclei, Style, Central cell, Hilum
- (d) Funicle, Raphe, Integuments, Thalamus, Hilum

20. Read the following statements and select the incorrect one.

- (a) Grafting is not successful in monocots as they do not have cambia.
- (b) In trench layering, the branch is pegged in a horizontal position in a trench.
- (c) Cross fertilisation occurs in many hermaphrodite animals like *Taenia* and earthworm.
- (d) Root cuttings are used in propagation of lemon, orange and raspberry.

21. Which of the following events takes place after fertilisation in some organisms?

- (a) Zygospore undergoes meiosis to produce haploid individuals.
- (b) Germinal cells undergo meiosis to produce haploid gametes.
- (c) Haploid spores produce haploid bodies called gametophytes.
- (d) Meiosis occurs in the zygote producing diploid organisms.

22. The period of growth between the birth of an individual upto reproductive maturity is called

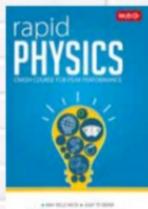
- (a) reproductive phase (b) maturity phase
- (c) juvenile phase (d) senescent phase.

23. Select the correct match.
- Seasonal breeders - Honey bee queen
 - Continuous breeders - Birds
 - Homothallic - *Rhizopus stolonifer*
 - Monoecious - Maize
24. Which among the following is not true for oestrus cycle?
- It consists of a short period of heat followed by passive period.
 - Female permits copulation only during heat period.
 - Sex urge is not increased during the cycle.
 - It occurs in non-primates such as cows, dogs, etc.
25. Select the correct combination for dioecious plants.
- Maize and coconut
 - Cucurbits and *Chara*
 - Maize and *Marchantia*
 - Data palm and papaya
26. The type of parthenogenesis in which parthenogenetic egg may develop into individual of any sex is
- amphitoky
 - complete arrhenotoky
 - thelytoky
27. The anther is a bilobed structure consisting of _____ microsporangia.
- 1
 - 2
 - 3
 - 4
28. The events in pollen-pistil interaction are given below.
- Pollen grain germinates to form pollen tube.
 - Pollen tube enters the ovule through micropyle.
 - Pollen grain reaches the stigma.
 - Pollen tube grows through the tissues of stigma and style and reaches the ovary.

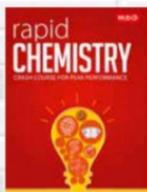
The sequential order of their occurrence is

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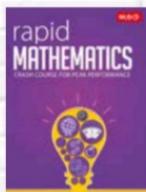
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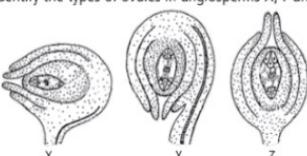
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- (a) (iii) → (i) → (iv) → (ii)
 (b) (ii) → (iv) → (iii) → (i)
 (c) (iii) → (iv) → (ii) → (i)
 (d) (ii) → (iii) → (i) → (iv).
- 29.** The mode of entry of pollen tube in the ovule through the integuments or funicle is
 (a) porogamy (b) mesogamy
 (c) chalazogamy (d) isogamy.
- 30.** Loss of viability of seeds is generally due to
 (a) damage to embryo
 (b) exhaustion of food around the embryo
 (c) denaturation of enzymes
 (d) all of these.
- 31.** The production and development of seedless fruits without pollination and fertilisation is
 (a) apomixis (b) parthenocarpy
 (c) parthenogenesis (d) polyembryony.
- 32.** In recurrent agamospermy, when the diploid embryo sac is formed directly from a nucellar cell, it is called
 (a) diplospory
 (b) diploid parthenogenesis
 (c) sporophytic budding
 (d) apospory.
- 33.** In monocot embryo, the portion of the embryonal axis above the level of attachment of the scutellum is called
 (a) hypocotyl (b) epicotyl
 (c) colearrhiza (d) radicle.
- 34.** The kidney-shaped brownish non-endospermic dicotyledonous seed is
 (a) maize seed (b) onion seed
 (c) castor seed (d) bean seed.
- 35.** Identify the types of ovules in angiosperms X, Y and Z.
- 

X	Y	Z
(a) Orthotropous	Hemitropous	Anatropous
(b) Hemitropous	Anatropous	Orthotropous
(c) Orthotropous	Anatropous	Hemitropous
(d) Hemitropous	Orthotropous	Anatropous

- 36.** Entomophilous flowers
 (a) are inconspicuous lacking non-essential floral whorls
 (b) usually possess edible pollens
 (c) are odourless, colourless and nectarless
 (d) always possess exerted stigmas and anthers.

37. Select the correct option.

Diocious	Monoeious
(a) Earthworm	Cockroach
(b) <i>Marchantia</i>	Leech
(c) Leech	Cockroach
(d) Tapeworm	<i>Marchantia</i>

- 38.** In a dicot embryo, the plumule
 (a) is terminal and lies in between two elongated cotyledons
 (b) appears lateral due to excessive growth of the single cotyledon
 (c) appears terminal due to excessive growth of single cotyledon
 (d) is lateral and lies in between two elongated cotyledons.

- 39.** The covering of fruit that develops from ovary wall is
 (a) pericarp (b) perisperm
 (c) integument (d) coleoptile.

- 40.** Read the following statements and select the option that correctly states true (T) and false (F) ones.
 (i) The mature embryo sac is 8-celled and 7-nucleate.
 (ii) Non-albuminous seed have no residual endosperm.
 (iii) Bisexual animals that possess both male and female reproductive organs are hermaphrodites.
 (iv) Testa is a pre-fertilised structure with living cells.

(i)	(ii)	(iii)	(iv)
(a) F	T	T	F
(b) F	F	T	F
(c) T	T	F	T
(d) T	F	T	F



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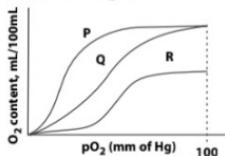
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CONCEPT booster

Concept booster reviews, reinforces and boosts your key biological concepts with a powerful structure. This section identifies the subject areas which need clear understanding of concepts for various exams and prepares you for the same by providing analytical questions with relevant hints and detailed solutions.

- 1) Haemoglobin molecules bind to oxygen and transport it across various tissues in animals. It shows a characteristic oxygen binding pattern at various partial pressures of oxygen. In the given graph, the oxygen binding pattern for three individuals P, Q and R is given.



- (a) What could be individuals P, Q and R?

.....
.....

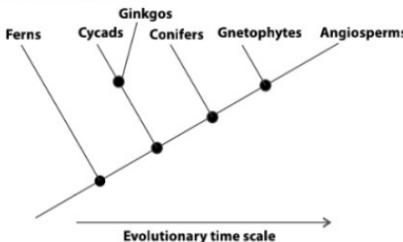
The oxygen binding capacity depends upon the number of haemoglobin molecules present in the blood.

- (b) What is the reason for the difference in oxygen binding patterns of the three individuals?

.....
.....

The number of RBC in blood may vary in case of adaptation or acclimatisation to a particular environment or any disease.

- 2) Refer to the given cladogram based on the evolutionary relationships between the various groups. Dots in the cladogram indicate common ancestors.



- (a) Explain the evolutionary relationship between the four groups viz. Cycads, Ginkgos, Conifers and Gnethophytes on the basis of given cladogram.

The descendants of a group share the most recent common ancestor.

- (b) Name any two plant groups in the given cladogram showing polyphyletic origin. Give reasons in support of your answer.

Members of polyphyletic group do not share most recent common ancestor.

SOLUTIONS

1. (a) P could be a person adapted to high altitudes.
Q could be a person adapted to sea level.
R could be an anaemic person.
(b) Each haemoglobin molecule has four heme groups which have an iron in ferrous form. The four molecules of oxygen combine with one molecule of haemoglobin. The amount of oxygen that can bind with haemoglobin is determined by oxygen tension which is expressed as a partial pressure of oxygen (pO_2).

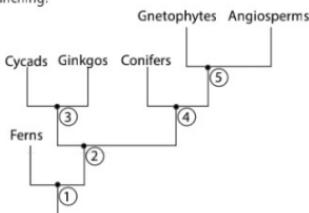
In the given graph, the individual P shows high oxygen binding at low pO_2 . Low value of pO_2 is found at higher altitudes hence the individual P is adapted to live at higher altitudes. Persons adapted to higher altitudes have more RBCs as compared to those adapted to sea level. More RBC number implies higher number of haemoglobin molecules available for oxygen binding. This accounts for greater oxygen transport via blood haemoglobin that compensates for higher oxygen requirement at high altitudes.

Individual Q shows minimal oxygen binding at low pO_2 whereas optimum binding occurs at comparatively higher pO_2 values (found at sea level). This implies that the individual Q is adapted to live at sea level, not at higher altitudes.

Individual R shows very low oxygen binding both at low values of pO_2 as well as at high values of pO_2 (as compared to P and Q). This implies that individual R is suffering from a disease where his haemoglobin oxygen binding capacity is affected. This is generally found in case of anaemia, where the sufferers have low RBC count due to which amount of haemoglobin is much reduced as compared to normal individuals.

2. (a) On the basis of the given cladogram, we can say that Cycads, Ginkgos, Conifers and Gnethophytes show paraphyletic origin i.e. they constitute a paraphyletic group. A paraphyletic group is a monophyletic group from which one or more subsidiary clades (monophyletic groups) are excluded to form a separate group i.e. the group does not

include all the descendants of the most recent common ancestor. Here Cycads, Ginkgos, Conifers, Gnethophytes and Angiosperms are originate from a most recent common ancestor. As angiosperms are excluded from this group, to form a separate group, this group is considered as a paraphyletic group. This can be illustrated by the given tree branching.



- (b) In the given cladogram, Ginkgos and Conifers show polyphyletic origin. A polyphyletic group is the one whose most recent ancestor is not cladistically a member of that group. The two do not share a recent common ancestor. Polyphyletic group's identifying features evolve convergently in two or more lineages. It is separated by more than one cut below the group, i.e., it represents more than one piece of a branch.



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

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BIO Digest

This article covers high yield facts of the given topic.

Principles of Inheritance and Variation

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

TERMS RELATED TO GENETICS

- Gene** is the inherited factor that determines the biological character of an organism. A pair of contrasting characters is called **allelomorph** or **allele**.
- Dominant allele** is one of the factors 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 allele pair which is unable to express its effect in the presence of its contrasting factor in a heterozygous state, e.g., t (dwarf in pea) in Tt.
- Wild allele** is the one which was originally present in the population and is **dominant** and **widespread**. The recessive allele is less common and is believed to be formed through mutation of wild allele and is called **mutant allele**.
- In **homozygous condition**, organisms have two similar genes or alleles for a particular character in a homologous pair of chromosomes, e.g., TT or tt.
- Organisms containing two different alleles or an individual containing both dominant and recessive genes of an allelic pair, e.g., Tt, is said to be in **heterozygous condition**.
- When only one allelic pair is considered in cross breeding, it is called **monohybrid cross**. When two allelic pairs are used for crossing, it is called **dihybrid cross**.
- Genotype** is the sum total of heredity or genetic make-up and **phenotype** is the external feature of an organism.

MENDELIAN GENETICS

- Gregor Johann 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 Tschermark** of Austria.

Mendel's Experiments

- Mendel had conducted several hybridisation experiments on **garden pea**, *Pisum sativum*. The number of characters studied by Mendel in pea plant were **seven**. The number of chromosomes in *Pisum sativum* is 14 (2n). Mendel restricted his experiments to one or few pairs of contrasting traits in each experiment.

Table: Seven pairs of contrasting traits of *Pisum sativum* and their inheritance pattern studied by Mendel

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

Inheritance of One Gene/Monohybrid Cross

- It is a cross made to study simultaneous inheritance of a single pair of Mendelian factors.

Mendel's principles of inheritance based on monohybrid cross

- Based on his observations on monohybrid crosses, Mendel proposed two general rules to consolidate his understanding of inheritance in monohybrid crosses. These rules are called the **Principles or Laws of Inheritance**: the First Law or **Law of Dominance** and the Second Law or **Law of Segregation**.

(i) **Law of dominance** states that only one factor expresses itself in F₁ generation. In a hybrid where both the contrasting alleles are present, only one factor/allele called **dominant** is able to express its effect while the other factor called **recessive** remains suppressed in F₁ generation. F₂ generation expresses both the dominant and the hidden recessive factors in the ratio of 3 : 1 in the monohybrid cross.

(ii) **Principle of segregation** states that when a pair of contrasting factors are brought together in a hybrid; these factors do not blend or mix up but simply associate themselves, remain together and separate at the time of gamete formation. This law is also known as "**law of purity of gametes**" because each gamete is pure in itself, i.e., having either T (i.e., gene for tallness) or t (i.e., gene for dwarfness).

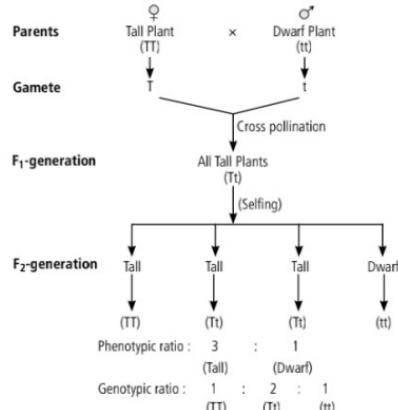


Fig. : Monohybrid cross in pea plant

Inheritance of Two Genes/Dihybrid Cross

- Dihybrid crosses are made to study the inheritance of two pairs of Mendelian factors or genes.

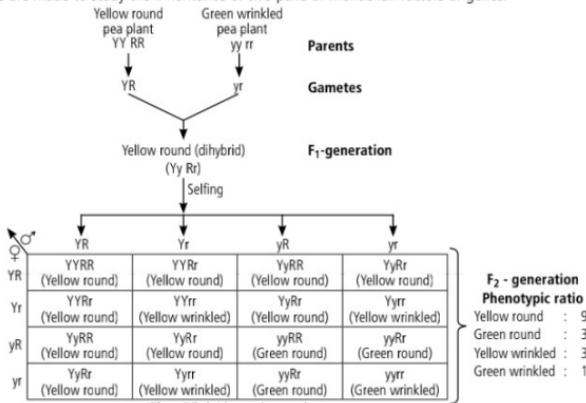


Fig. : Dihybrid cross in pea plant

Mendel's principle of inheritance based on dihybrid cross

- To verify his results of monohybrid crosses, Mendel crossed pea plants differing in two characters. Based upon this, Mendel proposed another set of generalisation called law of independent assortment.
- Law of independent assortment** states that the genes of different characters located in different pairs of chromosomes are independent of one another in their segregation during gamete formation. **Mendelian recombinations** were mainly due to independent assortment.

Reciprocal Cross, Back Cross and Test Cross

- The **reciprocal crosses** involve two crosses concerning the same characteristic, but with reversed sexes.
- A cross of F₁ hybrid with either of the two parents is known as **back cross**.
- Crossing of F₁ individual having dominant phenotype with its homozygous recessive parent is called **test cross**. The test cross is used to determine whether the individuals exhibiting dominant characters are homozygous or heterozygous.
- A cross between tall heterozygous F₁ hybrid with dwarf homozygous recessive, produces tall and dwarf in equal proportion indicating that F₁ hybrids are heterozygous.

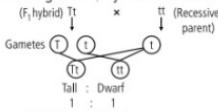
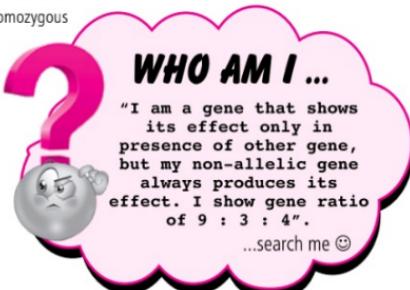


Fig.: Monohybrid test cross

Reasons for Mendel's Success

- Mendel chose garden pea that was easy to grow. 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 **genetic transmission**.



INTEXT PRACTICE QUESTIONS

1. Name the cross used to identify the genotype of a round seeded pea plant.
2. Which Mendel's law of inheritance was based on his study on dihybrid cross?

POST MENDELIAN GENETICS

- Mendel explained inheritance in terms of discrete hereditary factors (now called **genes**). However, all patterns of inheritance could not be explained on the basis of Mendel's principles alone.
- Though genes are inherited as units, many interact in different patterns to produce the trait. This is called **gene interaction**.

Gene Interaction

- Gene interaction is the influence of alleles and non-alleles on the normal phenotypic expression of genes. It is of following two types :

(i) Intragenic (Interallelic) 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, interact 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, etc.
- Incomplete dominance/Blending inheritance (Correns, 1903)** : It is the phenomenon where none of the two alleles of a gene is dominant over each other and new phenotype is formed which is intermediate between the independent expression of the two alleles. This was first studied in flower colour of *Mirabilis jalapa* or four O'clock plant. The phenotypic as well as genotypic monohybrid ratio in F_2 generation is **1 : 2 : 1** i.e., pure dominant: hybrid : pure recessive. F_1 generation expresses a phenotype which is intermediate between those of the parents, e.g.; pink flowers are obtained when red and white flowered plants are crossed.
- Codominance**: It is the phenomenon of two alleles lacking a dominant-recessive relationship and both of them express themselves together and equally in the organisms. The codominant alleles are able to express themselves independently when present alone. Examples : (i) The roan coat colour in cattle is an example of codominant alleles. If a cattle with black coat is crossed with a cattle with white coat, the F_1 hybrids possess neither black nor white coat colour, but have roan coat colour, where black and white patches appear separately. The effect is produced due to juxtaposition of small patches of black and white colour. The phenotypic ratio is **1 : 2 : 1**. (ii) ABO blood group in humans comprises four blood groups, controlled by three alleles I^A , I^B and I^O . Both alleles I^A and I^B are codominant themselves but are dominant to allele I^O .

- Multiple alleles** : These alleles are multiple forms (more than two alternatives) of a Mendelian factor or gene which occur on the same gene locus, distributed in different organisms in the gene pool with an organism carrying only two alleles and gamete only one allele. A well known and simplest example of multiple allelism is the inheritance of **ABO blood group** system in human beings (discovered by Dr. Karl Landsteiner). It is controlled by the gene I , that has three multiple alleles, I^A , I^B and I^O , out of which any two are formed in a person.

- Lethal genes** : They are genes which control some vital function of the organism and cause death of the organism either in homozygous recessive or homozygous dominant condition. Types of lethal genes - (i) Dominant lethal genes are lethal in homozygous condition and produce some defective phenotype in heterozygous condition (e.g., sickle cell anaemia, Huntington's chorea). (ii) Recessive lethal genes produce lethal effect only in homozygous condition and heterozygotes are normal (e.g., Tay Sach's disease, albinism in corn). With the death of homozygous lethal, the **monohybrid ratio comes to 2 : 1**.

(ii) Intergenic (Non-allelic) gene interaction

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

- Complementary genes**: Two genes present on different loci produce the same effect when present alone but interact to form a new trait when present together, are called complementary genes. E.g., in sweet pea (*Lathyrus odoratus*), there are two varieties controlled independently by two different genes *C* and *P*. The dominant alleles of both the genes are required for expression of flower colour. Complementary gene ratio is 9 : 7.
- Supplementary genes**: These are two non-allelic genes in which one type of gene produces its effect whether the other is present or not and the second (supplementary) gene produces its effect only in the presence of the first, usually forming a new trait. E.g., in mice, two genes *C* and *A* govern the coat colour. In absence of dominant alleles of both genes, **albino** coat is produced. Gene *C*, in absence of *A* produces **black coat** colour but gene *A* in absence of *C* cannot express itself and produces **albino**. Gene *C* and gene *A* when present together supplement each other and produce a different phenotype called **agouti**. Supplementary gene ratio is 9 : 3 : 4.
- Epistasis**: It 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** and the one which is being prevented from exhibiting itself is known as **hypostatic gene**.

Types of Epistasis

Dominant epistasis

- A dominant epistatic gene suppresses the expression of another gene at different locus regardless of allele condition (dominant or recessive). Dominant epistasis ratio is 12 : 3 : 1.

Recessive epistasis

- A recessive epistatic gene suppresses the expression of non-allelic gene only when the former is in homozygous recessive state. Recessive epistasis ratio is 9 : 3 : 4.

Dominant-recessive epistasis

- Dominant allele at one locus and recessive allele at another locus give rise to the same effect. Dominant-recessive epistasis ratio is 13 : 3.

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.
- They produce the same phenotype whether present in homozygous or heterozygous state. As a result, dominant phenotype is more abundant. **F₂ ratio is 15:1**, e.g., fruit shape in Shepherd's purse.

Pleiotropic Genes

- When a single gene affects many aspects of phenotype or controls several phenotypes, it is said to be pleiotropic gene and this phenomenon is called **pleiotropy**. Pleiotropy is expressed in sickle cell anaemia, haemophilia, etc.

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 F₂ ratio is 1 : 6 : 15 : 20 : 15 : 6 : 1.

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

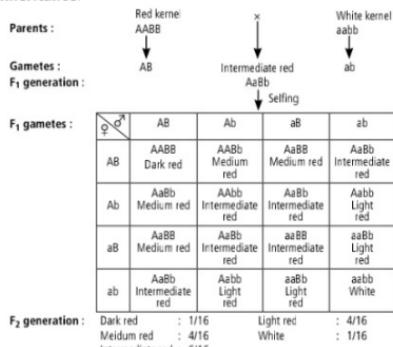


Fig.: Results of polygenic inheritance of kernel colour in wheat

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.

CHROMOSOMAL THEORY OF INHERITANCE

- The chromosomal theory of inheritance, proposed by **Walter Sutton** and **Theodore Boveri**, states that the Mendelian factors or genes are located at specific loci on the chromosomes and it is the chromosomes which segregate and assort independently during meiosis and recombine at the time of fertilisation in the zygote. **T.H. Morgan** confirmed the findings of Sutton and Boveri.

Salient Features of Chromosomal Theory of Inheritance

- It constitute bridge between one generation and the next through sperm and ovum. Both the sperm and egg contribute equally in the heredity of the offspring.
- Hereditary characters are governed by nuclear material and nucleus contains chromosomes, therefore chromosomes must carry the hereditary traits.
- Loss of a complete or part of the chromosome produces structural and functional deficiency in the organism.
- The chromosomes retain their number, structure and individuality throughout the life of an organism and from generation to generation.
- A gamete contains only one chromosome of a type and only one of the two alleles of a trait. The paired condition of both chromosomes as well as Mendelian factors is restored during fertilisation.
- Homologous chromosomes synapse during meiosis and then segregate independently into different cells which establishes the quantitative basis for segregation and independent assortment of hereditary factors.

LINKAGE

- Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to them 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 :
 - Linked genes occur in the same chromosome.
 - They lie in a linear sequence in the chromosome.
 - There is a tendency to maintain the parental combination of genes except for occasional crossovers.
 - 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 lower frequency if the distance is small.
- Genes that are present on the same chromosome make one **linkage group**.

Table: Differences between linked and unlinked genes

	Linked genes	Unlinked genes
(i)	These genes are placed on the same chromosome and do not show independent assortment at the time of gamete formation.	These genes are located on different chromosomes and undergo independent assortment (segregation).
(ii)	They show dihybrid ratio of 3 : 1.	They show dihybrid ratio 9 : 3 : 3 : 1.
(iii)	In dihybrid, they show test cross ratio of 1 : 1.	In dihybrid, they show a test cross ratio of 1 : 1 : 1 : 1.

Types of Linkage

Complete linkage

- 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. It is rare but has been reported in certain cases like male *Drosophila*

Incomplete linkage

- 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. Produces both parental and recombinant individuals. Incomplete linkage has been reported in female *Drosophila*, sweet pea, etc.

CROSSING OVER

- Crossing over is recombination of genes due to exchange of genetic material between two synapsed homologous chromosomes. It is the **mutual exchange** of segments of genetic material between **non-sister chromatids** of two homologous chromosomes, so as to produce recombinations of genes. The non-sister chromatids in which exchange of segments has occurred are called **recombinants** or **cross-overs**.

Significance of crossing over

- It brings new combinations of genes which are different from parents thus introduces variations. The variations are helpful in **struggle for existence** and **adaptability** to changes in the environment.
- Useful **recombinations** are picked up by breeders for development of improved varieties.
- The frequency of crossing over is used for building **linkage maps** or **chromosome maps**.

LINKAGE MAPS

- 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. 1% crossing over between two linked genes is known as 1 map unit or centi Morgan (cM). 100% crossing over is termed as Morgan (M).

SEX DETERMINATION

- Sex determination is the method by which the distinction between males and females is established in a species.
- It is usually under genetic control of specific chromosomes called **sex chromosomes** or **allosomes**.
- There are five main genetic mechanisms of sex determination :
 - (i) **XX-XY method** : XX – ♀, XY – ♂ e.g., mammals, some insects like *Drosophila*.
 - (ii) **XX-X0 method** : XX – ♀, X0 – ♂ e.g., roundworm, insects.
 - (iii) **ZW-ZZ method** : ZW – ♀, ZZ – ♂ e.g., birds, reptiles, fishes.
 - (iv) **Z0-ZZ method** : Z0 – ♀, ZZ – ♂ e.g., moths, butterfly.
 - (v) **Haploid-diploid method** : An unfertilised egg develops into a haploid male and a fertilised egg develops into a diploid female, e.g., honeybee.

SEX-LINKED INHERITANCE

- Sex-linked inheritance is the transmission of somatic characters and their determining genes alongwith sex determining genes present on the sex chromosomes, which are inherited together from one generation to the next.
- Most sex-linked genes are located on the X chromosome, forming **X-linkage**. A few genes occur on the Y chromosome, forming **Y-linkage**. The Y-linked traits are transmitted only through the male.
- Sex-linked traits are more apparent in males than in females. Females generally function as carriers of sex-linked disorders because recessive genes can express themselves in females only in the homozygous state, e.g., colour blindness, haemophilia, etc.
- Besides sex linked inheritance, sex limited characters and sex influenced traits have also been observed.
- **Sex limited traits** are those traits which are expressed in a particular sex though their genes also occur in the other sex, e.g., milk secretion in mammalian females.
- **Sex influenced traits** are the traits that are not due to particular genes but are by-products of sex hormones, e.g., low pitched voice, beard, moustaches and pattern baldness in males.

Criss-cross Inheritance

- It is a type of sex-linked inheritance where a parent passes the traits to the grandchild of the same sex through offspring of the opposite sex, that is, father passes the traits to grandson through his daughter (**diagynic**) while the mother transfers traits to her grand daughter through her son (**dia-andric**).
- It was first studied by **Morgan (1910)** in case of eye colour in *Drosophila*. Criss-cross inheritance is applicable to most sex-linked disorders in humans, e.g., red-green colour blindness, haemophilia.

MUTATION

- Mutation is the sudden inheritable discontinuous variation which appears in an organism due to permanent changes in their genotypes. Mutation theory was proposed by **Hugo de Vries**. Mutations bring about sudden and discrete changes in germplasm of organisms and add new variations in population. Depending upon the cause, mutations are of two types
 - chromosomal and gene mutation.

Chromosomal Mutations

- Chromosomal mutation is the change that occurs in the morphology of chromosome resulting in change in number or sequence of gene. It includes chromosomal aberration (changes in the chromosome structure) and genomic mutations (change in chromosome number).

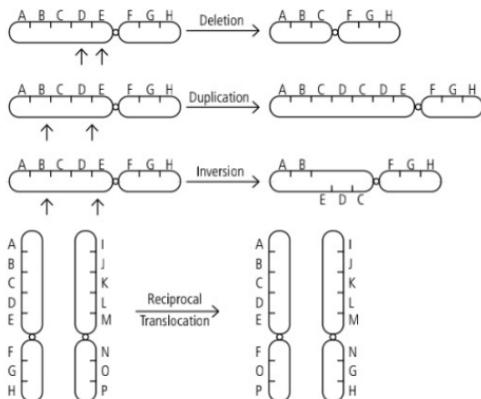


Fig.: Types of chromosomal aberrations

Chromosomal aberrations

- Deletion :** Loss of a segment (or part) from one or other end of chromosome (terminal) or within the chromosome (intercalary) followed by reunion of terminal segments.
- Translocation :** Kind of interchromosomal rearrangement in which there is mutual exchange of chromosomal segments between non-homologous chromosomes.
- Duplication :** Presence of same block of gene more than once in a haploid complement.
- Inversion :** Chromosome breaks at two points, the broken piece rotates through 180° and reunites in reverse order. When centromere is present in the inverted segment, it is called **pericentric** otherwise called **paracentric** inversion.

Genomic mutation

- Genomic mutations are change in the number of chromosomes.

Two types of genomic mutations

Euploidy

- An organism either loses a complete set or acquires one or more additional set of chromosomes over and above the two sets of diploid complement. It is of 2 types: **monoploidy** and **polyploidy**.

Aneuploidy

- Addition or loss of one or more chromosomes to/from complete diploid chromosome complement. It is of 4 types: **trisomy** ($2n+1$), **tetrasomy** ($2n+2$), **monosomy** ($2n-1$) and **nullisomy** ($2n-2$).

Gene Mutations

- The sudden stable change in the structure of a gene due to change in its nucleotide type or nucleotide sequence is called **gene mutation**.
- Gene mutations may occur naturally or automatically due to internal reasons. They are termed as **spontaneous mutations**. Others are produced by external factors or chemicals. They are known as **induced mutations**.
- Mutation which involves change in single nucleotide is called **point mutation**. Mutation from wild to new type is **forward mutation** and mutated gene to its wild form is **reverse or backward mutation**.
- Substitution mutation :** A nitrogenous base of triplet codon is replaced by another nitrogenous base or its derivative, thus, changing the codon. Replacement of a purine/pyrimidine by another purine/pyrimidine in a polynucleotide chain is called **transition**. Replacement of purine by a pyrimidine or *vice versa*, is called **transversion**.
- Frame-shift mutation :** The mutations caused by the addition or deletion of nitrogenous bases in the DNA or mRNA are known as frame-shift mutations because these shift the reading frame of codons from the site of change onwards. These

are of 2 types : **deletion mutation** caused due to the loss of one or more nucleotides and **insertion mutation** caused by the addition of one or more extra nucleotides in a DNA molecule at one or more places.

- **Nonsense, Mis-sense and Same-sense mutations :** A **nonsense mutation** stops synthesis of polypeptide by producing a nonsense (terminator) codon (UGA, UAG, UAA). A **mis-sense mutation** changes a codon which alters a specific amino acid in a polypeptide often making the latter non-functional. A **same-sense** mutation changes a codon which does not alter the amino acid of a polypeptide.

PEDIGREE ANALYSIS

- **Pedigree** is a chart showing a record of inheritance of certain traits for two or more ancestral generations of human being or domesticated animal in the form of a diagram or family tree.
- The individual from which a pedigree is initiated is called **proband** or **propositus**.
- Pedigree analysis is useful in many ways like it helps to fill up the possible genotypes by knowing the phenotypes only.
- It helps to study the pattern of inheritance of a dominant or a recessive trait. The possible genetic makeup of a person for a trait can also be known with the help of pedigree.



GENETIC DISORDERS

- Broadly, genetic disorders may be grouped into two categories— gene-related or Mendelian disorders and chromosomal disorders.

Gene-related/ Mendelian Disorders

- These disorders are mainly determined by alteration or mutation in the single gene. These disorders are transmitted to the offspring on the same lines as per the principle of inheritance.
- Most common Mendelian disorders are cystic fibrosis, sickle-cell anaemia, colour blindness, haemophilia, phenylketonuria, thalassemia, albinism, muscular dystrophy, etc.

Chromosomal Disorders

- The chromosomal disorders are caused due to absence or excess or abnormal arrangement of one or more chromosomes. Chromosomal anomalies or disorders arise in various ways as **non-disjunction** (an error in nuclear division which involves a pair of chromosomes that failed to separate and are carried to one pole), translocation, deletion, duplication and inversion.

Table : Some chromosomal abnormalities

	Syndrome	Dominant/ Recessive	Autosomal / Sex linked	Main clinical features
(i)	Down's syndrome	–	Autosomal, aneuploidy (Trisomy-21)	Rounded face, flat hands with small fingers, enlarged liver and spleen, mental retardation, broad forehead, permanently open mouth with large tongue.
(ii)	Edward's syndrome	–	Autosomal (Trisomy-18)	Multiple congenital malformations of many organs, receding mandible, small eyes, mouth and nose, severe mental deficiency, congenital heart defects and horseshoe or double kidney.
(iii)	Patau's syndrome	–	Autosomal (Trisomy-13)	Severe mental deficiency, small eyes, cleft lip and/or palate, deformed ears, extra fingers and toes, cardiac anomalies, brain anomalies and genitourinary abnormalities.
(iv)	Turner's syndrome	–	Sex chromosomal monosomy 44 + XO	Female with retarded sexual development, usually sterile, short stature, webbing of skin in neck region, cardiovascular abnormalities and hearing impairment.

(v)	Klinefelter's syndrome	-	Sex chromosomal aneuploidy (Tri/tetrasomy of X chr.); 44 + XYY, 44 + XXXY	Male infertile with undeveloped testes, may have enlarged breast, taller than average stature, mild mental deficiency, long limbs and delayed puberty.
(vi)	Sickle-cell anaemia	Recessive	Autosomal, gene on chromosome 11	Aggregation of erythrocytes, more rapid destruction of erythrocytes leading to anemia. Abnormal haemoglobin in RBCs.
(vii)	Phenylketonuria	Recessive	Autosomal, gene on chromosome 12	Failure of brain to develop in infancy, mental retardation, defective form of enzyme phenylalanine hydroxylase.
(viii)	Cystic Fibrosis (CF)	Recessive	Autosomal, gene on chromosome 7	Excessive thick mucus clogging in lungs, liver and pancreas anomalies. Failure of chloride ion transport mechanism through cell membrane.
(ix)	Huntington's Diseases (HD)	Dominant	Autosomal, gene on chromosome 4	Gradual degeneration of brain tissue in middle age, loss of motor control. Production of an inhibitor of brain cell metabolism.
(x)	Haemophilia A/B	Recessive	Sex-linked, gene on X-chromosome	Failure of blood to clot, defective form of blood clotting factor VIII/IX.
(xi)	Colour blindness	Recessive	Sex-linked, gene on X-chromosome	Failure to discriminate between red and green colour. Defect in either red or green cone cells of retina.

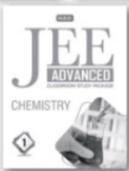


INTEXT PRACTICE QUESTIONS

- Name the type of mutation caused by insertion of 1 nucleotide base in DNA.
- Which organism shows XX-XO method of sex determination?

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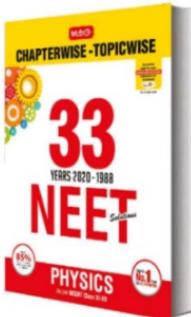
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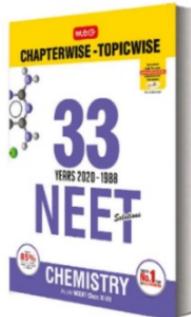
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