Must Know Facts to Score More

- Human Reproduction-I
- Primary & Secondary Growth in Plants

GLANCE AROUND

AIIMS SPECIAL
Assertion & Reason

Concept Map
QUICK GRASP ON Human Skeleton

You Ask ? We Answer ✓
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89 Crossword
SECTION - A

1. Which factor stimulates the secondary oocyte to complete the suspended second meiotic division in humans?

2. Mention the role of ethidium bromide (EtBr) during agarose gel electrophoresis of DNA.

3. A person suffering from cancer is being treated using α-interferons. Give reason.

4. Why are statins used as blood-cholesterol lowering agents?

5. What is the use of polyblend which is prepared from modified plastic waste?

SECTION - B

6. In an aquatic food chain amount of DDT in water is 0.003 ppb. What will be its probable amount in fish eating birds? Give reason.

7. Why is the mechanism of obtaining parthenocarpic fruits becoming important these days?

8. (a) If the distance between genes A and B is 3 map units, between genes B and C is 2 map units, between genes A and D is 5 map units and between genes C and D is 10 map units, find out the order of genes on a linkage map.

(b) Why is RNA less suitable as a genetic material than DNA. Give reason.

9. Secondary immune response is more accelerated and intense than the primary immune response. Justify.

10. How is mycorrhizal association beneficial to the plant?

SECTION - C

11. (a) Why are pollen grains of angiosperms well preserved as microfossils?

(b) What is the significance of corpus luteum?

12. Explain the experiment performed by Miller (1953) to provide an evidence for the abiogenic molecular evolution of life.

13. (a) What are the symptoms of common cold and its mode of infection?

(b) Name the drugs used to reduce the symptoms of allergy.

14. Refer to the given figure showing stages of spermatogenesis and answer the accompanying questions.

OR

10. How does human body compensate low oxygen availability at high altitudes?
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HIGHLIGHTS

- Strictly based on Maharashtra 12th HSC Board syllabus
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- MCQs divided in three levels: Level- I (Topicwise easy and medium level questions) and Level - II (questions of higher standard) from entire chapters to make the students better equipped
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15. Karyotype of a human male showed the presence of an additional X chromosome. What is the condition called and what are the symptoms of such abnormality?

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

(a) What does the figure represent?
(b) Describe different types of such molecules.

17. (a) Genetic code is degenerate. How?
(b) hnRNA is the precursor of mRNA. Justify.

18. Give diagrammatic representation of regulation of gene expression in lac operon of E. coli.

19. Alien species cause loss of biodiversity. Justify your answer with two examples.

OR

(a) What are the main objectives behind biofortification?
(b) Name one variety each of wheat, Brassica and cauliflower that are resistant to diseases and name the diseases to which they are resistant.

20. Pyramid of numbers in case of forest ecosystem shows deflection from its regular shape. Discuss.

21. Refer to the given flow chart and answer the accompanying questions.

(a) Name the hormones A, B and C.
(b) How does hormone inhibin regulate male reproductive system?
(c) Mention the role of sertoli cells in male reproductive system.

22. With the help of diagrammatic representation only, explain pre-pollination development of a male gametophyte in angiosperms.

SECTION - D

23. Anuradha visited her grandparents who live in a village. On a visit to an agricultural field, she observed that farmers were using pesticides. She immediately asked her grandfather to organise a meeting with local farmers. In the meeting, she explained and discussed other alternate methods that farmers can use to control weeds and pests without harming the environment.

(a) What values are reflected here by Anuradha?
(b) Why did Anuradha ask her grandfather to organise the meeting?
(c) Which alternate methods is Anuradha talking about?
(d) Explain biopesticides with examples.

SECTION - E

24. With the help of suitable diagrams, describe the developmental stages of an embryo sac of angiosperms from a megaspore mother cell.

OR

Long molecules of DNA in eukaryotes are packed, so as to make it adjust in a tiny nucleus. How?

25. (a) In nature, populations of different species occur together. List any two interactions which they exhibit within a community?
(b) What type of behavioural response do desert lizards show in response to variations in the environment?

OR

What is DNA fingerprinting and what is its procedure?

26. Give diagrammatic representation of various steps of DNA technology.

OR

(a) Placenta acts as an intimate connection between the mother and the foetus as well as an endocrine tissue. Discuss.
(b) Why are IUDs considered as ideal contraceptives for women?

SOLUTIONS

1. Entry of sperm into ovum at the time of fertilisation stimulates the secondary oocyte to complete the suspended second meiotic division.

2. Ethidium bromide is used to stain DNA fragments followed by exposure to UV radiations. This gives bright orange colour to DNA fragments and helps in their separation.

3. Patients of cancer are given substances called biological response modifiers such as α-interferons which activate their immune system and help in destroying the tumour.
4. Statins competitively inhibit the enzyme \( \beta \)-hydroxy-\( \beta \)-methyl glutaryl CoA reductase responsible for synthesis of cholesterol and lower the blood-cholesterol level.

5. Polyblend is a fine powder of recycled modified plastic waste. It is mixed with bitumen to lay roads as it increases its water repellent properties.

6. Amount of DDT in fish eating birds will probably be 25 ppm. It is due to the accumulation of pesticide or toxicant at successive trophic levels of the food chain by the process of biomagnification.

7. Mechanism of obtaining parthenocarpic fruits is becoming important these days because (i) seeds are irritants during eating of the fruit, (ii) processing of fruits by food industry requires the removal of seeds which is quite difficult, and (iii) there is an increasing tendency to grow fruit bearing plants inside green houses, but reliable insect pollinators cannot be ensured in each and every case.

8. (a) RNA is less suitable as a genetic material than DNA because (i) presence of \( 2’ \)-OH group in its sugar makes it highly reactive, labile, unstable and easily degradable. (ii) presence of uracil makes it less stable and therefore, mutation rate is faster in RNA.

(b) Secondary immune response occurs at the second and subsequent exposures to the same antigen. Every new encounter with the same antigen results in a rapid proliferation of memory B-cells, this is called "booster response". The antibody titer after subsequent encounters is far greater than during a primary response and consists mainly of IgG antibodies. Antibodies produced during a secondary response have an even higher affinity for the antigen. Thus, secondary immune response is more accelerated and intense than the primary immune response.

OR

Mycorrhizal associations perform several functions for the plants— (i) absorption of water (ii) solubilisation of organic matter of the soil humus, release of inorganic nutrients, absorption and their transfer to root (iii) direct absorption of minerals from the soil over a large area and handing over the same to the root (iv) secretion of antimicrobial substances which protect the young roots from attack of pathogens.

10. At high altitudes, human body compensates low oxygen availability by increasing red blood cell production, decreasing the binding affinity of haemoglobin and by increasing breathing rate.

11. (a) Exine of pollen grains is made of a highly resistant fatty substance called sporopollenin. Sporopollenin is not degraded by any enzyme. It is not affected by high temperature, strong acid or strong alkali. Because of the sporopollenin, pollen grains are well preserved as microfossils.

(b) Corpus luteum secretes large amounts of progesterone which is essential for maintenance of the endometrium. Such an endometrium is necessary for implantation of the fertilised ovum and other events of pregnancy. Corpus luteum also secretes relaxin during later stages of pregnancy and helps to soften ligaments, especially those that hold the pubic symphysis together.

12. Miller (1953) circulated four gases: methane, ammonia, hydrogen and water vapour in an air tight apparatus and passed electrical discharges from electrodes at 800°C. The mixture was then passed through a condenser. The gases were circulated continuously in this way for one week and the chemical composition of the liquid inside the apparatus was analysed. He found a large number of simple organic compounds including some amino acids such as alanine, glycine and aspartic acid. He also found the substances like urea, hydrogen cyanide, lactic acid and acetic acid. He conducted this experiment to test the idea that organic molecules could be synthesised in a reducing environment.

13. (a) Common cold is characterised by nasal congestion and discharge, sore throat, hoarseness, cough, headache, tiredness, etc., which usually last for 3-7 days. Droplets resulting from cough or sneezes of an infected person are either inhaled directly or transmitted through contaminated objects.

(b) The use of drugs like anti-histamine, adrenalin and steroids quickly reduces the symptoms of allergy.

14. (a) Part labelled as ‘A’ is primary spermatocyte. It undergoes two successive divisions (maturation divisions). The first maturation division is reductional or meiotic. Hence, the primary spermatocyte divides into two haploid daughter cells called secondary spermatocytes. Both secondary spermatocytes undergo second maturation division to form four haploid spermatids. The spermatids are then transformed into spermatozoa by the process of spermiogenesis.

(b) Part labelled as ‘A’ represents primary spermatocyte and the part labelled as ‘B’ represents spermatid. Primary spermatocyte is diploid \( 2n = 46 \), in humans. It undergoes
meiosis-I and meiosis-II to give rise to spermatids, which are haploid (n = 23, in humans). So, when ‘A’ changes to ‘B’ chromosome number is reduced to half.

15. Genetic disorder caused due to the presence of an additional copy of X-chromosome resulting into a karyotype of 44 + XXY is called Klinefelter’s syndrome. Such an individual has overall masculine development, however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed. Such individuals are sterile with undeveloped testes, mental retardation, female like sparse body hair, knock knees, long limbs, feminine pitched voice, etc.

16. (a) The given figure represents the structure of an antibody molecule.

(b) IgA: It is the second most abundant class, constituting about 10 to 15 percent of antibodies of serum. It is mainly found in sweat, tears, saliva, mucus, colostrum and gastrointestinal secretions.

IgD: It is mainly found on the surface of B cells as antigen receptors, where it activates B cells for antigen recognition. It is about 0.2% of all antibodies in the blood.

IgE: It is less than 0.1% of all antibodies in the blood; located on mast cells and basophils releasing histamine from mast cells and basophils. It is involved in allergic and hypersensitivity reactions; provides protection against parasitic worms.

IgG: This is the most abundant class of Ig in the body constituting approximately 80% of the total Igs. It protects against bacteria and viruses by enhancing phagocytosis and complement activation. It is found in the blood, lymph and intestine.

IgM: IgM is about 5 to 10% of all antibodies in the blood. It is also found in lymph. It activates the B cells. It is the largest immunoglobulin and is the earliest to be synthesised by foetus.

17. (a) There are 64 triplet codons and only 20 amino acids. Thus the incorporation of some amino acids must be influenced by more than one codon. Only tryptophan (UGG) and methionine (AUG) are specified by single codons. All other amino acids are specified by two (e.g., phenylalanine –UUU, UUC) to six (e.g., arginine—CGU, CGC, CGA, CGG, AGA, AGG) codons. The latter are called degenerate or redundant codons.

(b) RNA formed after transcription contains both introns and exons and is called hnRNA. This hnRNA undergoes processing such as splicing, capping and tailing to form mRNA. Hence, hnRNA is the precursor of mRNA.

18. Diagrammatic representation of regulation of gene expression in lac operon of E.coli is as:

19. Exotic or alien species introduced inadvertently for their economic and other uses become invasive and drive away the local species. These species are considered to be second major cause of extinction of species. Exotic species have proved harmful to both aquatic and terrestrial ecosystems. Island ecosystems are the most vulnerable due to small size and small number of species. Examples: (i) Water hyacinth (*Eichhornia crassipes*) was introduced in Indian waters to reduce pollution. It has clogged water bodies including wetlands at many places resulting in death of several aquatic plants and animals. (ii) Nile perch (a predator fish) was introduced in lake Victoria of South Africa. It killed and eliminated ecologically unique assemblage of over 200 native species of small Cichlid fish.

OR

(a) Biofortification refers to breeding crops with higher levels of vitamins, minerals, proteins and healthier fats. Biofortification is undertaken with the objectives of improving:

(i) Protein content and quality

(ii) Oil content and quality

(iii) Vitamin content and

(iv) Micronutrient and mineral content.

(b) | Crop | Variety | Resistance to diseases |
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<tr>
<td>Wheat</td>
<td>Himgiri</td>
<td>Leaf and stripe rust, hill bunt</td>
</tr>
<tr>
<td>Brassica</td>
<td>Pusa swarnim</td>
<td>White rust</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Pusa shubhbra</td>
<td>Black rot and curl blight black rot</td>
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20. Pyramid of numbers is a graphic representation of the number of individuals per unit area at various trophic levels. In most cases it is upright however this is not applicable in all the cases. In a forest ecosystem, a single large sized producer like tree can provide nourishment to several herbivores (e.g., birds). The birds may support a still larger population of ectoparasites which may further support a still larger number of hyperparasites. Such a pyramid shall be inverted. Small sized herbivorous birds are usually eaten by falcon or eagle. The number of eagles is, however, very small. This type of pyramid of numbers shall be spindle-shaped.

21. (a) A - GnRH (Gonadotropin Releasing Hormone)
    B - LH (Luteinising Hormone)
    C - FSH (Follicle Stimulating Hormone)

(b) Inhibin is a protein hormone. It inhibits both hypothalamus and pituitary gland to suppress FSH secretion thereby affecting spermatogenesis.

(c) Sertoli cells support developing sperms and provide them with nutrition. Sertoli cells secrete androgen binding protein (ABP) that concentrates testosterone in the seminiferous tubules. Sertoli cells also secrete inhibin which suppresses FSH synthesis.

22. Diagrammatic representation of pre-pollination development of the male gametophyte (pollen grain) of angiosperms is as:

23. (a) Anuradha reflects the values of awareness and concern for the environment along with a good knowledge of biocontrol method.

(b) Anuradha wanted to make the farmers aware about the harmful effects of pesticides on human health and environment, and about the advantages of using biocontrol agents. So she asked her grandfather to organise the meeting.

(c) Anuradha is talking about the bio-control method. The natural method of pest and pathogen control involving use of viruses, bacteria and insects (which are their natural predators) is called bio-control (or biological control).

(d) Biopesticides are viruses, bacteria, protozoa, fungi, etc. that are used for control of weeds, insects and pathogens. These are of two types: bioherbicides and bioinsecticides. Bioherbicides are chemicals used for inhibiting the growth of plants in unwanted places e.g., Cactoblastis cactorum and Chrysolina beetles have checked the growth of their natural herbivores Opuntia and Hypericum perforatum respectively. Bioinsecticides are biological agents that are used to control harmful insects e.g., Baculovirus heliothis and Bacillus thuringiensis are effective against cotton bollworm and cabbage looper respectively.

24. Refer to answer 2, page no. 50, ‘MTG Excel in Biology’. OR

DNA packing in eukaryotes is carried out with the help of five types of histone proteins—H1, H2A, H2B, H3 and H4. The unit of compaction is nucleosome. Four of them (H2A, H2B, H3 and H4) occur in pairs to produce histone octamer, called nu body or core of nucleosome. Their positively charged ends (due to basic amino acids) are towards the outside. They attract negatively charged strands of DNA. About 166 bp of DNA is wrapped over nu body for 1 3/4 turns to form nucleosome of size 110 × 60Å (11 × 6 nm). DNA connecting two adjacent nucleosomes is called interbead or linker DNA, it bears H1 histone protein. Length of linker DNA is varied (about 145Å with 70bp). Nucleosome and

\[ \text{INFO SHOTS} \]

Manchineel (poison apple or poison guava), a tree of genus *Hippomane* of family Euphorbiaceae is considered as one of the most toxic trees. All parts of the tree contain toxins. It is native to coastal beaches and mangroves of South Florida, Caribbean, Central and Northern South America. It is a round-crowned tree that grows up to 12 m in height with 60 cm thick trunk. It produces yellow to reddish, sweet-scented fruits which contain toxins. When ingested, the fruit is pleasantly sweet with subsequent strange peppery feeling which gradually progresses to a burning sensation and tightening of throat thereby disabling the victim to swallow any food. Ingestion of toxic fruits may lead to the damage of digestive tract if not treated in time. Manchineel is so poisonous that smoke from its burning wood irritates eyes and latex from its leaves and bark causes skin inflammation.
linker DNA together constitute chromatosome. Nucleosome chain gives a beads on string appearance under electron microscope. The beaded string is coiled to form solenoid having 6 nucleosomes per turn. Actually the nucleosomal organisation has approximately 10nm thickness, which gets further condensed and coiled to produce a solenoid of 30nm diameter. This solenoid structure undergoes further coiling to produce a chromatin fibre of 30–80 nm and then a chromatid of 700 nm.

25. (a) Interspecific interactions arise from the interaction of populations of two different species. They could be beneficial, detrimental or neutral. Two examples of such interactions are:

(i) Mutualism: This interaction confers benefits on both the interacting species. Lichens represent an intimate mutualistic relationship between fungi and photosynthesising algae or cyanobacteria. Similarly, the mycorrhizae represent mutualistic associations between fungi and the roots of higher plants.

(ii) Commensalism: This is the interaction in which one species benefits and the other is neither harmed nor benefited. An orchid growing as an epiphyte on a mango branch, and barnacles growing on the back of a whale benefit while neither the mango tree nor the whale derives any apparent benefit.

(b) Desert lizards lack the physiological ability to deal with the high temperatures of their habitat, but manage to keep their body temperature fairly constant by behavioural means. They bask in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the ambient temperature starts increasing.

OR

Refer to answer 28, page no. 161, ‘MTG Excel in Biology’.

26. (a) Placenta acts as an intimate connection between the foetus and the uterine wall of the pregnant mother for the exchange of materials. The placenta is connected to the embryo through an umbilical cord which helps in the transport of substances to and from the embryo. It facilitates the supply of oxygen and nutrients to the embryo and also removal of carbon dioxide and excretory/waste materials produced by the embryo. Placenta also acts as an endocrine tissue as it produces several hormones like human chorionic gonadotropin (hCG), human chorionic somatomammotropin (hCS), relaxin, chorionic thyrotropin, chorionic corticotropin, estrogens, progestogens, etc.

(b) IUDs (Intrauterine contraceptive devices) are considered as ideal contraceptives for women. It is because these are long-acting, safer, easier to insert, incredibly effective and reversible. IUDs do not interfere with sex or daily activities, and can be easily removed if one wants to get pregnant.

OR

Refer to answer 3(ii), page no. 310, ‘MTG Excel in Biology’.

27. (a) 250000

(b) 100000

OR

Refer to answer 3(ii), page no. 310, ‘MTG Excel in Biology’.
एक सोच...........
जिसने बदल दी मेडिकल क्षेत्र में सफलता की परिभाषा
ब्रेन मास्टर्स............लगातार 11वें वर्ष...एक बार फिर सर्वश्रेष्ठ...

हम बार कर रहे हैं ‘ब्रेन मास्टर्स क्लासेस’ के अध्यक्ष के पंज ज्ञान, डॉ. पंज ज्ञान और डॉ. पंजीत ज्ञान की है।

जिन्होंने अपनी अनुभव व ईतिहास से इस स्तर के साथ कम-से-कम निजता बनाए रखा है कि क्यों न मेडिकल वित्त परिस्तिम में भरत की अपनी मदद करता है। मेडिकल प्रीमियर परिस्तिमों को लेकर विभिन्न प्रतियोगिताओं में जो जीत है सबसे खास किया जाता है। शिखर के दिशानिवेशकों को जो न जाने और उन्नत इंस्टांट पर उसे कर दिया जाता है उसके लिए AIPMT और AIIMS जैसे प्रशिक्षण मेडिकल कॉलेजों में प्रशिक्षण के दिशानिवेशकों की संख्या में बढ़ाने का प्रयास करना सही है।

CASE, ICSE के साथ-साथ सर्वश्रेष्ठ निर्माण के दिशानिवेशकों के लिए भी कहा जा रहा है। जिसके लिए AIPMT और प्रशिक्षण मेडिकल कॉलेजों की आसानी से पहुंच कर सके, इसी शीर्ष के साथ की गई है। गूगल के ज्ञान के साथ 2005 में हम ब्रेन मास्टर्स क्लासेस की स्थापना की और उसे जो आज तक लगभग हिस्टोरिया के सभी मेडिकल कॉलेजों में दिशानिवेशकों के दिशानिवेश प्रभाव का महत्त्वपूर्ण सुझाव दिया है।

ब्रेन मास्टर्स की सफलता का महत्त्वपूर्ण बिनु: 1. **Specialization** को दिए गए यह । आज हम देखते हैं कि आमतौर मेडिकल कॉटिंग कार्यक्रम अपने प्रबंधकों को है - इंडोर के लिए उनके लिए दी जाती है। इस प्रदर्शन में शिक्षा और विभिन्न कॉलेजों के लेखांकन का महत्त्व नहीं है।

1. **Specialization** को दिए गए यह । आज हम देखते हैं कि आमतौर मेडिकल कॉटिंग कार्यक्रम अपने प्रबंधकों को है - इंडोर के लिए उनके लिए दी जाती है। इस प्रदर्शन में शिक्षा और विभिन्न कॉलेजों के लेखांकन का महत्त्व नहीं है।

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- Dr. Parag Gupta (MBBS, MGM, Indore)
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*300 Selections in AIPMT 2015, Highest in M.P. & C.G.*
1. Which of the following is/are correct statement/s?
   (i) At high light intensity, chloroplast in mesophyll cells of leaf, lies perpendicular to incident light.
   (ii) In reduction steps of ‘Calvin Cycle’ to form one glucose molecule 12 ATP and 12 NADPH are consumed.
   (iii) Opuntia and sugarcane needs 30 ATP and 12 NADPH to produce one glucose molecule.
   (iv) In maize plant C_3-cycle operates in mesophylls of leaf.
   (v) Sorghum plant losses about half as much water as mustard plant loses for same amount of CO_2 fixed.
   (a) (ii), (iii), (iv) and (v)  
   (b) (i), (ii), (iii) and (iv)  
   (c) (ii), (iii) and (v)  
   (d) All of these

2. Which of the following statement is incorrect?
   (a) RuBisCO and PEPCO need Mg^{++} as a catalyst for their carboxylation action.
   (b) Mg^{++} and Cl^- is needed for photolysis of H_2O.
   (c) CO_2 is the major limiting factor for photosynthesis.
   (d) ‘Kranz anatomy’ is characteristic to plants showing ‘Hatch and Slack’ pathway.
   (a) (a)  
   (b) (b)  
   (c) (c)  
   (d) (d)

3. Site of photolysis of H_2O in plant is indicated as
   (a) stroma of chloroplast  
   (b) granaum  
   (c) outer surface of thylakoid membrane  
   (d) membrane of thylakoid facing the lumen.
   (a) (a)  
   (b) (b)  
   (c) (c)  
   (d) (d)

4. Quantum efficiency of photosynthesis is
   (a) 1/8  
   (b) 12.5%  
   (c) 0.125  
   (d) all of these.
   (a) (a)  
   (b) (b)  
   (c) (c)  
   (d) (d)

5. How many of the given plants are C_4?
   Maize, Sorghum, Opuntia, Helianthus, Mustard, Sugarcane, Bryophyllum, Pennisetum
   (a) 4  
   (b) 5  
   (c) 2  
   (d) 3

6. Identify P, Q, R and S in the given diagram.
   (a) P-Bundle sheath cell, Q-Regeneration, R-Decarboxylation, S-Carboxylation
   (b) P-Bundle sheath cell, Q-Regeneration, R-Decarboxylation, S-Fixation
   (c) P-mesophyll cell, Q-Regeneration, R-Decarboxylation, S-Carboxylation
   (d) P-Bundle sheath cell, Q-Regeneration, R-Carboxylation, S-Fixation

Contributed by: Harpal Singh, Harpal’s Biology Classes, Chandigarh, 09781124215
7. Energy required for ATP synthesis in Z-scheme comes from
   (a) electron gradient (b) oxidation of glucose
   (c) reduction of glucose (d) proton gradient.
8. Which of the following is a incorrect statement?
   (a) The correct sequence of electron ow in light reaction, at optimum light intensity and temperature,
      is PS-II, Phe, PQ, Cytochrome complex, PC, PS-I, Fd.
   (b) Dark reactions in photosynthesis are called, so, because they do not directly depend on light energy.
   (c) Chemosynthetic bacteria derive their required energy from infra red radiations.
   (d) Mg^{++}, Fe^{+++} and light are must for synthesis of chlorophyll.
9. During light reaction of photosynthesis the following compounds are formed
   (a) ATP, Hydrogen donor and O\textsubscript{2}
   (b) ATP and sugar
   (c) ATP, Hydrogen and O\textsubscript{2} donor
   (d) O\textsubscript{2}, hydrogen and sucrose.
10. Which of the following enzyme is not involved in photosynthesis of C\textsubscript{3} plant?
    (a) PEPcase  (b) RuBisCO
    (c) NADP reductase  (d) ATP synthase
    Which of the following is a false statement.
    (a) Photosynthetic quotient is always one in case of green plants.
    (b) Plant attain light compensation point twice in a day.
    (c) If a plant is maintained at CO\textsubscript{2} compensation point for long time, it survives but, does not grow.
    (d) Decreased rate of photosynthesis at high light intensity is solarisation.
11. Which of the following is a correct match?
    (a) Dark reaction – stroma of chloroplast at night
    (b) PS-II – Marginal region of grana
    (c) Krebs’ cycle – Matrix of plastid
    (d) ETC – Embedded in inner membrane of power house of the cell
12. Which of the following is a false statement?
    (a) Leaf of Zea mays shows dimorphism of chloroplast.
    (b) To produce one glucose molecule 6 turns of Calvin Cycle are required.
    (c) During one turn of PCO, 2ATP are consumed.
    (d) At high temperature and high O\textsubscript{2} concentration RuBisCO act as oxygenase and decreases net photosynthesis in C\textsubscript{3} plant.
13. Which of the following is a false statement?
    (a) Leaf of Zea mays shows dimorphism of chloroplast.
    (b) To produce one glucose molecule 6 turns of Calvin Cycle are required.
    (c) During one turn of PCO, 2ATP are consumed.
    (d) At high temperature and high O\textsubscript{2} concentration RuBisCO act as oxygenase and decreases net photosynthesis in C\textsubscript{3} plant.
14. Which of the following, according to Peter Mitchell, is/are cause/s of development of proton gradient across the thylakoid membrane?
    (a) Reduction of NADP\textsuperscript{+} on outer surface of thylakoids in stroma.
    (b) Shifting of H\textsuperscript{+} into lumen of thylakoid by functioning of Z-scheme.
    (c) Photolysis of water taking place on inner surface of thylakoid membrane.
    (d) All of the above
15. Which of the following plant shows high rate of photosynthesis in carbon dioxide rich environment i.e., > 360 ppm, in temperate area within a green house?
    (a) Sugarcane  (b) Sorghum
    (c) Bell pepper  (d) Both (a) and (b)
16. Moll’s half leaf experiment proves CO\textsubscript{2} is must for photosynthesis. Which of the following chemical has been used to make environment around part of leaf CO\textsubscript{2} free?
    (a) KI  (b) NaOH  (c) PMA  (d) KOH
17. 1\textsuperscript{st} acceptor CO\textsubscript{2} and 1\textsuperscript{st} stable product of calvin cycle is
    (a) 5 C, ketosugar RuBP and 3C, PGA
    (b) 5 C, aldosugar RuBP and 3C, PGA
    (c) 3 C, PEP and 4 C, OAA
    (d) 3 C, PEP and 4 C, malate.
18. Chlorophyll-a differs from chlorophyll-b by which of the following feature/s?
    (a) 3-C carries-CHO group
    (b) Being a primary photosynthetic pigment
    (c) Found in some photosynthetic eukaryotes only
    (d) All of these
19. Which of the following is a contribution of Jan Ingenhousz w.r.t. photosynthesis?
    (a) O\textsubscript{2} is released during photosynthesis, while working on Cladophora and aerobic bacteria.
    (b) Green parts of aquatic plant release O\textsubscript{2} in presence of light, so, light is must for photosynthesis.
    (c) Plant produce storage product of photosynthesis as starch.
    (d) Suggested that during photosynthesis O\textsubscript{2} should come from water.
20. LHC as PS-II has which of the following as reaction center?
    (a) P\textsubscript{700}  (b) P\textsubscript{880}
    (c) P\textsubscript{680}  (d) Any of these
21. Concentration of essential element below which plant growth is retarded is termed
   (a) toxic concentration
   (b) supra-optimum concentration
   (c) critical concentration
   (d) optimum concentration.

22. Which of the following is a wrong statement?
   (a) Cl⁻ along with K⁺ maintain anion-cation balance in the cell.
   (b) Nitrogen is the essential element required by the plant in the greatest amount, it is absorbed, mainly, in the form of NO₃⁻.
   (c) Sulphur is an important constituent of Coenzyme-A and cysteine.
   (d) Boron is important for uptake and utilisation of Ca⁺⁺.

23. Excess of Mn⁺⁺ induces the deficiency of
   (a) Fe  (b) Mg  (c) Ca  (d) all of these.

24. Which of the following is a micronutrient?
   (a) Mn  (b) Mg  (c) Ca  (d) K

25. Soil less culturing of plants in a mist of nutrient solution is
   (a) aeroponics  (b) sand culture
   (c) hydroponics  (d) horticulture.

26. Which of the following is a correct match
   (a) Zn⁺⁺ - an activator of alcohol dehydrogenase.
   (b) Mn⁺⁺ and Mo - an activator of PEPcase.
   (c) Fe⁺⁺⁺ - activator of succinate dehydrogenase
   (d) Cu - part of cyt a and cyt a₃

27. During N₂ fixation in root nodule to form NH₃ molecule. How many ATP are consumed?
   (a) 16  (b) 4  (c) 2  (d) 8

28. Leg-haemoglobin, a red pigment, in root nodule has very very important role as it
   (a) picks up hydrogen and transfers to N₂ for production of NH₃
   (b) helps in increasing availability of O₂ to nodule
   (c) help in creating and maintaining anaerobic conditions in root nodules
   (d) act as inhibitor of nitrogenase enzyme.

29. If half of the leaves of a herb are prunned then rate of transpiration
   (a) decreases to almost half
   (b) becomes almost double
   (c) remain unchanged but over all transpiration decrease
   (d) rate increases by about four times.

30. A mustard plant has its weight as 5 kg. It will absorb about how much water within a day?
   (a) 24 kg  (b) 10 kg  (c) 12 kg  (d) 100 kg

31. *Nepenthes, Utricularia* and *Drosera* all are
   (a) partial heterotrophs  (b) purely saprotrophic
   (c) autotrophic only  (d) facultative parasitic.

32. With respect to shown diagram, which of the following is true?

   ![Diagram of cell transport](image)

   (a) Facilitated diffusion  (b) Simple diffusion
   (c) Active transport  (d) Endosmosis

33. A cell under hypertonic solution shows incipient plasmolysis, then what will be present between cell wall and cell membrane?
   (a) Water with ψₘ₀ zero
   (b) Solution with same ψₘ₀ as solution out the cell
   (c) Water with slightly high ψₘ₀ as compare to solution outside the cell
   (d) Vacuum

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**Form IV**

1. Place of Publication: New Delhi
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5. Name and address of individuals who own the newspapers and partners or shareholders holding more than one percent of the total capital
   I, Mahabir Singh, here by declare that particulars given above are true to the best of my knowledge and belief.

Mahabir Singh
Publisher
34. Water will move from the root hair through cortex to xylem, if the water potentials ($\psi_w$) are

<table>
<thead>
<tr>
<th>Root hair</th>
<th>Cortex</th>
<th>Xylem</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 0</td>
<td>+1</td>
<td>+2</td>
</tr>
<tr>
<td>(b) +2</td>
<td>+1</td>
<td>0</td>
</tr>
<tr>
<td>(c) -2</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>(d) 0.5</td>
<td>-1</td>
<td>-2</td>
</tr>
</tbody>
</table>

35. Match Column-I with Column-II and select the correct option from the codes given below.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Vein ending</td>
<td>(i) Transpiration</td>
</tr>
<tr>
<td>B. Necessary evil</td>
<td>(ii) Osmosis</td>
</tr>
<tr>
<td>C. Semi-permeable membrane</td>
<td>(iii) Transpiration pull membrane</td>
</tr>
<tr>
<td>D. Cohesion and adhesion</td>
<td>(iv) Guttation</td>
</tr>
<tr>
<td>E. Stomata closure</td>
<td>(v) ABA</td>
</tr>
</tbody>
</table>

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

36. The given diagram a potato plant consuming food of old tubers (assume). Which route would be taken by most of the food at this time?

(a) 1 → 4 → 2 → 3  
(b) 7 → 5 → 2 → 3  
(c) 1 → 4 → 5 → 7  
(d) 6 → 5 → 4 → 3

37. Cause of guttation and bleeding is

(a) development of absorption lag  
(b) –ve root pressure early in the morning  
(c) +ve root pressure  
(d) high transpiration rate.

38. Which of the following is a wrong statement?

(a) Movement of water in plant is always unidirectional but translocation of sucrose may be bi-directional due to variable source and sink relation.  
(b) Sugar from mesophylls of leaf → companion cells → sieve tubes is translocated as sucrose by mass flow hypothesis, passively.  
(c) Newly formed root hair absorbs capillary water for the first time by imbibition.  
(d) Despite the absence of heart and circulatory system in plants, the ow of water upwards through xylem in plants can be achieved at fairly high rates, upto 15 meters per hours.

39. A cell is kept in hypotonic solution, after sometime its

(a) OP ↓ and $\psi_s$ ↑  
(b) $\psi_w$ ↑ and DPD ↓  
(c) $\psi_p$ and TP both ↑  
(d) all of the above.

40. Which of the following statements are true?

(i) In guard cells of dicots cellulose microfibrils are arranged tangentially.  
(ii) Osmosis is a diffusion of weaker solution into concentrated solution, when two solutions were separated by semi-permeable membrane.  
(iii) Plasma membrane is differentially permeable membrane.  
(iv) In a vacuolated cell $\psi_w = \psi_s$.  
(v) If a solution is applied with pressure from outside its $\psi_w$ decreases.

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

41. Arrange the events of opening of stomata in correct sequence and choose the correct option accordingly.

I. Lowering of $\psi_w$ of guard cells.  
II. Decline in guard cell solute.  
III. Rise of potassium ion level in guard cells.  
IV. Guard cells absorb water from neighbouring epidermal cells.  
V. Guard cells become accid.  
VI. Guard cells swells and make a pore between them.

(a) III, I, IV, V  
(b) I, II, III, IV, V, VI  
(c) III, I, IV, VI  
(d) III, I, IV, VI, II, V

42. A fresh twig, having flower and buds, is kept in minute amount of salt containing water. It remains fresh for a longer period due to

(a) exosmosis  
(b) absorption of small amount of water  
(c) electrolyte balance  
(d) decrease in transpiration rate.
43. Which of the following is a true statement?
   (a) *Nerium* has sunken stomata like *Cycas* to decrease rate of transpiration.
   (b) Hydrophilic proteins are better imbibant than agar.
   (c) Boron is must for translocation of starch from source to sink.
   (d) Lenticels and stomata are, mainly, meant for transpiration.

44. Minimum 'transpiration ratio' found in
   (a) emergent hydrophytes like lotus
   (b) halophytes like *Salsola*
   (c) xerophytes like *Aloe vera*
   (d) submerged hydrophytes like *Hydrilla*.

45. In Z-scheme to produce 4 NADPH₂ how many photons of light are required?
   (a) 12 (b) 8
   (c) 24 (d) 16

46. Which of the following are correct statements?
   (i) *Pinus* and orchid seeds can’t germinate and establish without the formation of mycorrhiza.
   (ii) Plants absorbs maximum water from the soil by passive absorption.
   (iii) In endodermis region of roots, water follow symplastic pathway.
   (iv) High O₂ concentration high light intensity induces photorespiration in sciophytes.
   (v) CoCl₂ paper used to compare transpiration from two surfaces of leaf.
   (a) j, k and m only (b) l, m and n only
   (c) j, k and n only (d) All of these

47. Which of the following is not an antitranspirant?
   (a) PMC (b) Aspirin
   (c) PMA (d) ABA

48. Which of the following instruments are correctly matched, except?
   (i) Potometer – Transpiration rate.
   (ii) Atmometer – Demonstrate transpiration pull.
   (iii) Auxanometer – Growth measurement.
   (iv) Ganog’s light screen – Measure light intensity.
   (v) Manometer – Demonstrate root pressure.
   (a) (iv) (b) (ii)
   (c) (iii) (d) None of these

49. Which of the following statement is true w.r.t. shown diagram?
   (a) B has > ψₕ than A
   (b) Solute moves from B to A
   (c) After an hour of setting the above system ψₕ of B increases and ψₕ of A decreases
   (d) All of these

50. Which of the following is false statement?
   (a) During alcoholic fermentation by yeast one glucose generates 8 ATP.
   (b) Fₒ – F₁ complex in ETC act as complex V.
   (c) Krebs’ cycle operates in matrix of mitochondrion.
   (d) RQ for carbohydrate is infinity, in anaerobic respiration.

51. Bridge reaction in aerobic respiration yields 2-C compound to be used in TCA. Bridge reaction is a
   (a) oxidative decarboxylation
   (b) oxidative carbon reduction
   (c) reductive decarboxylation
   (d) oxidative carboxylation.

52. Which of the following is incorrect w.r.t. respiration?
   (a) Connecting link between glycolysis and Krebs’ cycle in acetyl CoA.
   (b) One turn of Krebs’ cycle can generate, maximum, 12 ATP.
   (c) Cytochrome a₃, copper containing, shifts electron to oxygen.
   (d) In plants glucose on complete oxidation, always, generates 38 ATP.

53. In plants the end product of photosynthesis sucrose before entering respiration in plant is converted into glucose and fructose by ________ enzyme.
   (a) α-amylase (b) maltase
   (c) invertase (d) lyase

54. It is better to consider respiratory pathway as a/an
   (a) amphibolic pathway (b) anabolic pathway
   (c) catabolic pathway (d) confusing pathway.
55. Fermentation takes place under anaerobic conditions in many
(a) prokaryotes (b) unicellular eukaryotes
(c) germinating seeds (d) all of these.

56. \[2\text{C}_5\text{H}_{98}\text{O}_6 + \text{A} \text{O}_2 \rightarrow 8 \text{CO}_2 + 98\text{H}_2\text{O} + \text{Energy}\]
If above equation indicates aerobic oxidation of tripalmitin as a substrate. Find what A and B stands for?
(a) 102 and 145 respectively
(b) 145 and 102 respectively
(c) 45 and 102 respectively
(d) 145 and 98 respectively

57. Which of the following is a wrong statement?
(a) End product of oxidative phosphorylation is ATP and \(\text{H}_2\text{O}\).
(b) Last electron acceptor of ETC in aerobic respiration is proton.
(c) Glycolysis is a 10 stepped reactions taking place in cytoplasm.
(d) Succinate dehydrogenase enzyme of Krebs’ cycle found in inner membrane of mitochondrion.

58. Match Column I with Column II and select the correct option from the codes given below.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. R.Q.</td>
<td>(i) Chemiosmotic ATP synthesis</td>
</tr>
<tr>
<td>B. Mitchell</td>
<td>(ii) Muscle fatigue</td>
</tr>
<tr>
<td>C. Cytochromes</td>
<td>(iii) Inner mitochondrial membrane</td>
</tr>
<tr>
<td>D. Lactic acid</td>
<td>(iv) Alcoholic fermentation</td>
</tr>
<tr>
<td>E. Yeast</td>
<td>(v) Respirometer</td>
</tr>
</tbody>
</table>

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

59. Match Column I with Column II and select the correct option from the codes given below.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 2, 4 D</td>
<td>(i) Herring sperm DNA</td>
</tr>
<tr>
<td>B. ABA</td>
<td>(ii) Bolting</td>
</tr>
<tr>
<td>C. Ethylene</td>
<td>(iii) Stomatal closure</td>
</tr>
<tr>
<td>D. GA</td>
<td>(iv) Weed-free lawns</td>
</tr>
<tr>
<td>E. Cytokinin</td>
<td>(v) Ripening of fruits</td>
</tr>
</tbody>
</table>

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

60. ABA acts antagonistic to
(a) auxin (b) cytokinin
(c) gibberellic acid (d) all of these.

61. Which of the following is an incorrect statement?
(a) Coconut water is rich in kinetin.
(b) Monocarpic plants produce fruits once in their life.
(c) Photoperiodic stimulus is perceived by oral bud.
(d) To increase sugarcanes yield, these are sprayed by gibberellic acid.

62. Match Column I with Column II and select the correct option from the codes given below.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Natural auxin</td>
<td>(i) NAA</td>
</tr>
<tr>
<td>B. Synthetic auxin</td>
<td>(ii) Zeatin</td>
</tr>
<tr>
<td>C. Bakane disease of rice</td>
<td>(iii) IAA</td>
</tr>
<tr>
<td>D. Natural cytokinin</td>
<td>(iv) GA</td>
</tr>
<tr>
<td>E. Kinetin</td>
<td>(v)</td>
</tr>
</tbody>
</table>

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

63. Which of the following graph indicate progress in RGR in an organ like leaf from its inititation to maturity?

(a) [Graph A]
(b) [Graph B]
(c) [Graph C]
(d) [Graph D]

64. In tea and tobacco plantation farmer prune the plants regularly so that they attain bushy appearance scientific explanation to this is
(a) apical dominance breakage
(b) growth of apical bud
(c) suppression of lateral buds and activation of apical bud
(d) both (a) and (b).
65. Which one is paired incorrectly?
(a) Auxin – Isolated in pure form from human urine.
(b) Zeatin – Isolated from corn kernels.
(c) Gibberellins – Isolation from fungus Gibberella fujikori
(d) Abscisic acid – Isolated from ripened oranges

66. Growth at cellular level, is principally a consequence of increase in the amount of
(a) protoplasm (b) DNA
(c) water (d) cell organelles.

67. A primary root grows from 10 cm to 30 cm in a day. Calculate the Absolute Growth Rate (AGR) and Relative Growth Rate (RGR) over the period.

\[
\begin{array}{ll}
\text{AGR} & \text{RGR} \\
(\text{a}) & 20 \text{ cm} \\
(\text{b}) & 10 \text{ cm} \\
(\text{c}) & 20 \text{ cm} \\
(\text{d}) & 20 \text{ cm} \\
\end{array}
\]

68. Developmental heterophylly found in all, except
(a) larkspur (b) cotton
(c) coriander (d) all these.

69. Credit for discovery of first plant growth hormone is given to
(a) E. Kurosawa (b) F. Skoog
(c) F.W. Went (d) Yabuta.

70. 2, 4 D widely used herbicide, kill
(a) monocot weeds
(b) dicot weeds
(c) algal and gymnospermous weeds
(d) all of these.

71. How many of the following statements are true?
(i) Triple response bioassay is for ABA.
(ii) GA3 used to speed up malting process in brewing industry.
(iii) Natural cytokinins are synthesised in meristems.
(iv) Synthetic auxins show non polar translocation.
(v) Ethylene promotes rapid internodal elongation in deep water rice plants.
(a) One (b) Three (c) Two (d) Four

72. Which of the following PGR is called stress hormone?
(a) ABA (b) Ethylene (c) IAA (d) 2, 4 D

73. Which of the following is not caused by ethylene?
(a) Initiates flowering and synchronise fruit setting in pineapple.
(b) Promotes female flower of cucumber.
(c) Highly effective in fruit ripening.
(d) Breaks seed dormancy in pomes.

74. Hormone mainly responsible for morphogenesis is/are
(a) auxin (b) cytokinin
(c) ABA (d) both (a) and (b).

75. Which of the following is LDP?
(a) Wheat (b) Cotton (c) Maize (d) Rice

76. In potato plant if dark period is interrupted by flash of light the yield of crop
(a) increases
(b) decreases
(c) remain unaffected
(d) vary according to the season.

77. Which of the following is true about plant movement shown by Mimosa pudica on touch?
(a) Seismonastic movement
(b) Movement of turgor variation
(c) One type paratonic movement
(d) all these.

78. Active form of phytochrome is
(a) Pr (b) Pf (c) P680 (d) P700.

79. Callus is supplied with slightly more concentration of cytokinin than auxin it will
(a) regenerate only (b) regenerates shoot
(c) regenerates roots (d) remains callus indefinitely.

80. Which of the following is a wrong statement?
(a) Kinetin is chemically N-6 furfuryl amino purine.
(b) Bolting is artificially induced by G.A. treatment.
(c) Cytokinins causes bolting.
(d) In tomato parthenocarpy is induced by Auxin.

DIRECTIONS (Question No. 81 to 90)
These questions consists of two statements each, printed as Assertion and Reason. While answering these questions you are required to choose any one of the following four responses.

(a) If both Assertion & Reason are true and the Reason is a correct explanation of the Assertion.
(b) If both Assertion & Reason are true but Reason is not a correct explanation of the Assertion.
(c) If Assertion is true but the Reason is false.
(d) If both Assertion & Reason are false / if assertion is false but reason is true.

81. Assertion: Water that enters into a plant cell through diffusion makes it turgid.
Reason: Entry of water into the cell through diffusion develops wall pressure inside the cell.
82. **Assertion:** Movement of materials inside phloem is bidirectional i.e., it can be both upwards or downwards.  
**Reason:** Movement of molecules inside xylem is unidirectional i.e., always upwards.

83. **Assertion:** Protons produced by photolysis of water accumulate in the lumen of thylakoids.  
**Reason:** Photolysis of water takes place on inner surface of thylakoid membrane.

84. **Assertion:** Plant growth, as a whole, is indefinite.  
**Reason:** Plants retain the capacity of continuous growth throughout their life.

85. **Assertion:** Excess Mn in soil, can adversely decrease Mg, Fe and Cu concentrations in the soil.  
**Reason:** Mn increases rate of photosynthesis, thereby increasing absorption of Mg, Fe and Ca from soil.

86. **Assertion:** On plotting increase in length of the root against time, a linear curve is obtained.  
**Reason:** An elongating root exemplifies arithmetic growth.

87. **Assertion:** The photosynthetic efficiency of C_4 plant is more than those of C_3 plant.  
**Reason:** C_4 plants are more efficient in picking CO_2.

88. **Assertion:** Glucose is the favoured respiratory substrate.  
**Reason:** When glucose is used as respiratory substrate. It is completely oxidised and RQ is 1.

89. **Assertion:** Deficiency symptoms of N, K and Mg are first visible in the senescent leaves.  
**Reason:** Biomolecules containing these elements are broken down in the older leaves, making these elements, available for mobilising to younger leaves.

90. **Assertion:** Photospiration interferes with the successful functioning of Calvin Cycle.  
**Reason:** Photospiration oxidises ribulose-1,5 biphosphate which is an acceptor of CO2 in Calvin Cycle.

91. How many of the following statements are false?  
(a) Smallest unit of ecological hierarchy is population.  
(b) Term ecology was coined by Ernst Haeckel.  
(c) Climate is a property of the atmosphere, in which changes occur from time to time over short period. It determines flora and fauna of a place.  
(d) The most ecologically relevant environment factor affecting biota is water.  
(e) Eel is a euryhaline organism.  
(f) Inherent capacity of the population to reproduce under existing ideal conditions  
(g) Capacity of individuals to fit among the natural environment  
(h) Capacity of population to reproduce and competitiveness  
(i) Capacity of resource base to support maximum number of individuals.  

92. **Assertion:** How many are stenothermal from the given organisms?  
**Scelolodon, Polar bear, Coconut, Sun ower, Toad, Lizard, Neophron, Apes and Crocodile**  
(a) 2  (b) 3  (c) 4  (d) 5

93. Which of the following statements are true except?  
(a) Stage of suspended development is called diapause.  
(b) Smaller mammals and bird species are never found at polar region due to, their high surface to volume ratio.  
(c) Phenotypic variants of species due to change in environment is called ecotypes.  
(d) Mammals of cold climate generally have short snout, ears and limbs to minimise heat loss.

94. From the given graph of population growth select the correct option having correct value of 'r'.  
(a) r = +ve  
(b) r = 0  
(c) r = -ve  
(d) r = 0

95. In an area, there are 200 Parthenium herbs and a single huge banyan tree. Which of the conclusion(s) is/are correct?  
I. Population density of banyan is low.  
II. Population cover area of banyan is high.  
III. In above case the percentage of cover of biomass is more meaningful than population size.  
(a) Only I  (b) I and II  
(c) II and III  (d) All of these

96. Carrying capacity refers to  
(a) Inherent capacity of the population to reproduce under existing ideal conditions  
(b) capacity of individuals to fit among the natural environment  
(c) capacity of population to reproduce and competitiveness  
(d) capacity of resource base to support maximum number of individuals.

97. Which of the following 'standard symbols of ecology' is wrongly match?  
(a) \( K - N \) = environmental resistance  
(b) \( K \) = carrying capacity
98. In an exponential growth, where each symbol has its usual meaning in ecology, \( \frac{dN}{dt} = \)

(a) \( rN \left( \frac{K - N}{K} \right) \) 
(b) \( rN \) 
(c) \( (d - b)N \) 
(d) both (b) and (c).

99. Find \( \frac{dN}{dt} \) when population size is 600 individuals and carrying capacity 800 and intrinsic growth is 0.02 when population growth follow logistic growth and exponential growth, respectively.

(a) 3 and 12 
(b) 3 and 6 
(c) 6 and 12 
(d) 12 and 3

100. Monarch butterfly is highly distasteful to its predators because

(a) it produces poisonous chemicals from nectar, on which it feeds
(b) it has special poisonous chemicals in its body, which it acquires by feeding upon poisonous weeds in its larval stage.
(c) it feeds upon poisonous weeds in adulthood and develops cardiac glycosides
(d) its ovipositor releases poisonous and abnoxious nectar like droplets.

101. How many of the following is/are wrong statement(s)?

(j) Ramdeo Mishra is revered as the Father of Ecology in India.
(k) Keolado National Park in Rajasthan hosts thousand of migratory birds from extremely cold southern regions of the world.
(l) Resemblance of one species with another in order to obtain advantage, especially against predation is cryptis.
(m) Bell shaped age pyramid indicates stable population.

(a) 2 
(b) 3 
(c) 1 
(d) 4

102. 'Competitive exclusion principle' is best defined as

(a) no two members of same species share same niche.
(b) two competing species show resource partition for their survival
(c) two competing species can’t share same niche.
(d) none of the above.

103. Match the following columns.

<table>
<thead>
<tr>
<th>Column I (Population Interaction)</th>
<th>Column II (Examples)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Mutualism</td>
<td>(i) Ticks on dogs</td>
</tr>
<tr>
<td>B. Commensalism</td>
<td>(ii) Balanus and Chathamalus</td>
</tr>
<tr>
<td>C. Parasitism</td>
<td>(iii) Sparrow and seed</td>
</tr>
<tr>
<td>D. Competition</td>
<td>(iv) Epiphyte on a mango branch</td>
</tr>
<tr>
<td>E. Predation</td>
<td>(v) Orchid Ophrys and Colpa aurea</td>
</tr>
</tbody>
</table>

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

104. Asymptote stage of the population growth is the stage of population in which the population is

(a) drastically fluctuating 
(b) decreasing 
(c) increasing 
(d) stabilising.

105. Behavioural adaptation to environment in desert lizards are

I. Burrowing the soil
II. Losing heat during high temperature
III. Active during morning and evening
IV. Insulating body due to thick fatty dermis

Select the correct pair.

(a) I and II 
(b) III and IV 
(c) I and III 
(d) II and IV

106. The birth and death rates of four countries are given below. Which one will have the least population growth rate?

<table>
<thead>
<tr>
<th>Country</th>
<th>Birth rate/1000</th>
<th>Death/1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>N</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>O</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>P</td>
<td>58</td>
<td>51</td>
</tr>
</tbody>
</table>

(a) P 
(b) O 
(c) N 
(d) M

107. How many of the following statements are incorrect?

(j) ‘The Evil Quartet’ is the sobriquet used to describe four important causes of biodiversity loss.
(k) Biodiversity hot spots occupy < 2% earth’s land, their protection can decrease mass extinction by 30%.
(l) India has three biodiversity hot spots out of 34 of the world.
(m) If Log A = 4, Z = 0.3 and log C = 0.8. Then log of species richness is 2.
(n) World’s Summit on Sustainable Development held in year 2002 in South Africa.
(a) 3  (b) 2  (c) 4  (d) None of these

108. IUCN Red List 2004 documents extinction of how many species in last 500 years?
(a) 1550  (b) 486  (c) 847  (d) 784

109. Reserpine derived from *Rauvolfia vomitoria* used to control hypertension is derived from
(a) immature seeds  (b) bark of stem  (c) roots  (d) dried leaves and bark.

110. ‘World Biodiversity Day’ is celebrated annually on
(a) 5<sup>th</sup> June  (b) 16<sup>th</sup> September  (c) 22<sup>nd</sup> May  (d) 29<sup>th</sup> December.

111. Which of the following are wrong statements, except?
(a) Biosphere reserves developed in India under the MAB programme of UNESCO are “area maintained by government for the betterment of wildlife” only.
(b) “Rivet popper hypothesis” was proposed by Paul Ehrlich which indicates removal of “keystone species” will destabilise the ecosystem drastically.
(c) Most important cause of extinction of species is “human greed over its need” where certain animals have been over exploited.
(d) Introduction of cichlid fish in Lake Victoria leads to extinction of Flamingo in few years.

112. Given below are pie diagrams I, II and III related to the proportionate number of species of major taxa of invertebrates, vertebrates and plants respectively. Critically study and fill in the blanks A, B, c and D.

(a) a-Angiosperms, B-Fungi, c-Molluscs, D-angiosperms
(b) a-Angiosperms, B-Fungi, c-Fungi, D-angiosperms
(c) a-Fungi, B-Angiosperms, c-Molluscs, D-Fungi
(d) a-Hexapoda, B-Angiosperms, c-Fungi, D-angiosperms

113. Tropical rain forests, example ‘Amazon forest’ popularly called “lungs of planet earth”, occupy how much land of earth?
(a) About 14%  (b) About 20%
(c) About 6%  (d) < 2%

114. Which of the following are true statements, except?
(a) Photoperiodism was discovered in a variety of tobacco plant.
(b) Endosperm digestion test is a bioassay for G.A.
(c) Kinetin a synthetic ck chemically N<sub>6</sub> furfuryl amino purine a derivative of adenine.
(d) Wheat is a LDP and cotton SDP.

115. Rapid internodal elongation, in deep water rice plant, is promoted by
(a) ethylene  (b) GA
(c) cytokinin  (d) either (b) or (c).

116. Which of the following is a true statement?
(a) Shoot initiation in callus is promoted by higher auxin/cytokinrin ratio.
(b) ABA is antagonistic of C<sub>2</sub>H<sub>4</sub>.
(c) Spray of GA can extend marketing period of some fruit crops by delaying senescence.
(d) Auxin was isolated by F W Went in agar block from tip of coleoptiles of *Phalaris*.
117. Which of the following is a wrong match?
(a) Bolting in rosette plant – GA₃.
(b) *Avena* curvature test – IAA.
(c) Induction of immediate stomatal closure – ABA
(d) Induction of growth in axillary buds – Ethephon.

118. If dark period of ‘corn plant’ is interrupted by flash of light. Yield of crop will
(a) increase
(b) become zero
(c) reduced
(d) remain unchanged.

119. Environmental heterophyll is shown by
(a) coriander
(b) buttercup
(c) larkspur
(d) cotton.

120. How many of the following is/are wrong statement/s?
(j) Gibberellins are derivative of carotenoids.
(k) Movement shown by “touch me not plant” on touch is a paratonic, turgor and seismonasty. It is due to outward movement of K⁺ from pulvinus of compound leaf.
(l) Photoperiodic stimulus was picked up by shoot apical meristem.
(m) Hormone used to maintain weed free grass lawns is 2, 4D.
(n) Stress hormone is ABA.
(a) 2 (b) 3 (c) 1 (d) 5

121. A plant flower thrice an year in july, october and december. The plant will be
(a) photosensitive and thermoinsensitive
(b) photoin sensitive and thermosensitive
(c) photo and thermosensitive
(d) photo and thermo insensitive.

122. If an organism shows limited growth then which of the following graphs indicates its RGR progression?
(a) ![Graph A](image1.png)
(b) ![Graph B](image2.png)
(c) ![Graph C](image3.png)
(d) ![Graph D](image4.png)

123. To find RQ in a set respirometer where water level falls the RQ will be
(a) < 1 (b) > 1 (c) = 1 (d) zero.

124. Instrument used to measure growth in plants is
(a) phytotron
(b) crescograph
(c) clinostat
(d) heliotropic chamber.

125. On the basis of correlation, find the correct option from columns.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
<th>Column III</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Foolish plant</td>
<td>A. Volatile hormone</td>
<td>1. Induces dormancy</td>
</tr>
<tr>
<td>II. Induces senescence</td>
<td>B. GA</td>
<td>2. Ripens fruit</td>
</tr>
<tr>
<td>C. Zeatin</td>
<td>3. Usually sterile plant</td>
<td></td>
</tr>
</tbody>
</table>

126. Four coleoptiles are taken for experiment as shown below.

Which coleoptiles will not bend toward the light? Choose the correct option.
(a) A and B
(b) C and D
(c) A, B and C
(d) C and B

127. Which of the following is incorrectly matched?
(a) Explant → Excised plant part used for callus formation
(b) ABA → Root initiation in callus
(c) Somatic embryo → Embryo produced from a vegetative cell
(d) Anther culture → haploid plants

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

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Zeatin</td>
<td>1. Flowering hormone</td>
</tr>
<tr>
<td>B. Florigen</td>
<td>2. Synthetic auxin</td>
</tr>
<tr>
<td>C. IAA</td>
<td>3. Cytokinin</td>
</tr>
<tr>
<td>D. NAA</td>
<td>4. Natural auxin</td>
</tr>
<tr>
<td>(a) A-3, B-4, C-1, D-2</td>
<td>(b) A-2, B-1, C-4, D-2</td>
</tr>
<tr>
<td>(c) A-1, B-2, C-3, D-4</td>
<td>(d) A-3, B-1, C-4, D-2</td>
</tr>
</tbody>
</table>
129. Which of the following are false statements?
1. Respiratory climacteric is related to ethane, a gaseous hormone.
2. Micropropagation is assisted by ethephon and kinetin.
3. Cytokinin shows “Richmond Lang effect” by promoting nutrient mobilisation.
4. Earlier ABA was identified as inhibitor-B, dormin and abscission II.
5. Apical dominance is caused by CK.
(a) 1 and 5 (b) 1 and 4 
(c) 3 and 5 (d) 1, 2 and 5

130. Chemical used to increase production of cucumber crop is 
(a) ABA (b) PMA 
(c) ethephon (d) GA3.

131. In S-shaped curve, the growth is highest in which phase?
(a) Lag phase (b) Asymptote phase 
(c) Exponential phase (d) None of these

132. If to form Bonsai, half of the roots of a plant are removed, then its transpiration will 
(a) increased to double (b) becomes almost half 
(c) abruptly increases by many folds (d) remain unchanged.

133. Root nodules maintain O\textsubscript{2} free environment by which of the following chemicals?
(a) Porphyrin (b) Leghaemoglobin 
(c) Leghaemocyanin (d) Nitrogenase

134. Which of the following is a true statement?
(a) Mn\textsuperscript{++} is a macronutrient. 
(b) In root nodule of legume to form one NH\textsubscript{3} 16 ATP are consumed. 
(c) Nitrobacter is a denitrifying chemoautotroph.
(d) Some marshy plants eat insects as a source of N\textsubscript{2} because marshes are rich in Pseudomonas and Thiobacillus.

135. Most important mineral for nitrogen fixation is 
(a) Mn\textsuperscript{++} (b) Mg\textsuperscript{++} 
(c) Mo (d) none of these

136. Soyabean transport ureides from root nodules to various plant parts as fixed nitrogen, which 
(a) is a nitrogen and phosphorus rich compounds  
(b) carries high NO\textsubscript{3} than carbohydrates 
(c) carries high N : C ratio 
(d) is highly soluble in organic compounds, so, transported through xylem.

137. Anaerobic nitrogen fixing bacteria is 
(a) Rhodospirillum (b) Azotobacter 
(c) Beijerinckia (d) Aulosira

138. Which of the following is a wrong statement?
(a) Boron is required for Ca\textsuperscript{++} uptake and utilisation. 
(b) Excess Mn\textsuperscript{++} induces deficiency of Fe and Mg. 
(c) Zn\textsuperscript{++} is an activator of alcohol dehydrogenase. 
(d) Cysteine is a sulphur containing essential amino acid.

139. Which of the following is a wrong match?
(a) Whiptail of crucifers – Mo deficiency 
(b) Exanthema of citrus – Cu deficiency 
(c) Fe and Mo – Tracer elements (d) Ca\textsuperscript{++} - Non-mobile mineral

140. Common symptom due to deficiency of Ca, Mg, Cu and K is 
(a) chlorosis followed by anthocyanin synthesis 
(b) stunting and leaf curling 
(c) necrosis in leaf tissue 
(d) none of these.

141. Which of the following is a wrong statement?
(a) In etiolation plant become abnormally tall and yellow due to deficiency of Mg\textsuperscript{++} and Fe\textsuperscript{++}. 
(b) Most critical element for plant growth is nitrogen. 
(c) Root nodule formation is stimulated by auxin produced by plant and CK produced by bacteria. 
(d) Limiting nutrient for both natural and agricultural ecosystem is nitrogen.

142. Which one of the following symptoms is not due to manganese toxicity in plants?
(a) Calcium translocation in shoot apex is inhibited. 
(b) Deficiency in both iron and nitrogen is induced. 
(c) Appearance of brown spot surrounded by chlorotic veins. 
(d) None of these

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Identify the labels in the given diagram which links the major nitrogen pools.

(a) A-Nitrification, B-Ammonification, C-Nitrobacter, D–Nitrosomonas, E-Denitrification
(b) A-Ammonification, B-Denitrification, C-Nitrification, D–Nitrosomonas, E-Nitrobacter
(c) A-Denitrification, B-Nitrobacter, C-Nitrification, D–Ammonification, E-Ammonification
(d) A-Nitrobacter, B-Denitrification, C-Nitrosomonas, D–Ammonification, E-Nitrification

Which of the following statements are correct about mineral absorption in plants?
(a) In the initial phase, ions are taken up into the outer space of cells, the apoplast. It is a passive process.
(b) In the final phase, ions are taken slowly into the inner space, the symplast of cells and it is an active process.
(c) Passive movement of the ions into the apoplast occurs through ion channels, transmembrane proteins, which acts as selective pores.
(d) All of the above

Match the following columns.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Water splitting reaction</td>
<td>(i) Boron</td>
</tr>
<tr>
<td>(b) Uptake and utilisation of Ca$^{2+}$</td>
<td>(ii) Copper</td>
</tr>
<tr>
<td>(c) Synthesis of auxin</td>
<td>(iii) Cl$^-$</td>
</tr>
<tr>
<td>(d) Redox reaction</td>
<td>(iv) Zinc</td>
</tr>
</tbody>
</table>

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

The source of nitrogen for plants is
(a) atmospheric nitrogen
(b) nitrogen present in soil as NO$_3^-$
(c) nitrogen that comes from water
(d) nitrogen fixed by microbes only.

How many of the following statements are true, except?
(i) During photosynthesis H$_2$O undergoes oxidation and CO$_2$ undergoes reduction.
(ii) In Hatch and Slack pathway Mg$^{2+}$ is required for carboxylation step.
(iii) Assimilatory power of Z-scheme used in Blackman’s reaction is ATP and NADH.
(iv) Maize, wheat and mustard are C$_4$ plants.
(v) RuBisCO act as oxygenase at high temperature and high O$_2$ concentration in C$_3$ plants.
(a) 2 (b) 3 (c) 1 (d) 5

The first step in photosynthesis is the
(a) joining of 3-carbon atom to form glucose
(b) formation of ATP
(c) ionisation of water
(d) excitation of an electron of chlorophyll by photon of light.

Choose the correct combination of labelling in Calvin cycle.

(a) A-RuBP, B-Triose phosphate, C-PGA
(b) A-PGA, B-RuBP, C-Triose phosphate
(c) A-PGA, B-Triose phosphate, C-RuBP
(d) A-RuBP, B-PGA, C-Triose phosphate

Which of the following is an incorrect statement?
(a) C$_4$ cycle was discovered in sugarcane.
(b) Kranz anatomy is found in Bryophyllum and maize
(c) 1$^{st}$ acceptor of CO$_2$ in C$_3$ cycle is RuBP, a ketosugar.
(d) Sciophytes need 18 ATP and 12 NADPH for synthesis of glucose molecule.
151. How many of the following is/are false statement/s w.r.t. photorespiration?
(i) One ATP is consumed in this cycle.
(ii) It is almost nil in most heliophytes.
(iii) Main organ is chloroplast, other organs peroxisome and mitochondria are required for their completion.
(iv) High light intensity and high temperature promote it.
(v) Out of total carbon entering the cycle 75% will be regenerated.
(a) 1 (b) 3 (c) 2 (d) None of these

152. If half of the leaf of a potted plant is kept in a glass bottle, through split cork, containing KOH. After keeping this apparatus in light for one day leaf is taken out of bottle and iodine test was performed. What can be observed from this ?
(a) Outer half turns blue black (b) Inner half remain yellow (c) Whole leaf turns blue black (d) Both (a) and (b)

153. Which of the following are true statements?
1. Best light for photosynthesis is white, due to its photosynthetic enhancement effect.
2. Quanta required photosynthesis is 1/8.
3. Chlorophyll-b contain CHO group attached to its 3rd carbon.
4. Law of limiting factor enunciated by Blackman.
5. In Z-scheme Fd found both in PS I and PS II.
(a) 1, 2, 3 and 4 (b) 1, 3, 4 and 5 (c) 2 and 4 (d) 1, 3 and 4

154. Radioisotopes used in photosynthetic research are
(a) $^{32}$P and $^{35}$S (b) $^{18}$O and $^{14}$C (c) $^{15}$N and $^{14}$C (d) $^{14}$N and $^{15}$N

155. In case of sweet potato for storage of food in root tuber, it is translocated mainly through
(a) sieve cells as sucrose (b) sieve tubes as starch (c) sieve cells as starch (d) sieve tubes as sucrose.

156. Which of the following statements is true?
(a) Plasmamembrane is a permeable membrane.
(b) Curtis called transpiration as a “necessary evil”.
(c) Kranz anatomy of C4 leaf show large chloroplast in mesophylls and smaller ones in bundle sheath.
(d) Vallisnaria plant has value of transpiration ratio more than banyan tree.

157. Which of the following is false about C4 pathway?
(a) The primary CO2 acceptor is PEP.
(b) Bundle sheath cells contain PEPcase.
(c) Enzyme for final CO2 fixation is RuBisCO.
(d) Mesophyll cells lack RuBisCO.

158. To form one glucose molecule in C3 cycle. How much energy is used for its reduction part?
(a) 12 ATP and 12 NADH (b) 18 ATP and 12 NADPH (c) 18 ATP and 12 NADH (d) 12 ATP and 12 NADPH

159. How many of the following statements are true?
(j) C4 plants need 12 ATP more than C3 plants for formation of one glucose.
(k) Proteins enter aerobic respiration as organic acid after deamination of their amino acids.
(l) Bolting in biennial plants ‘in situ’ commonly takes after low temperature treatment, as in carrot.
(m) Last electron acceptor in ETC is oxygen.
(n) Mass ow in sieve tube is an active process.
(a) 4 (b) 3 (c) 2 (d) 5

160. Plants are removed from asthma patient’s room during night because
(a) they compete for O2 in room with the patients
(b) they release CO2 at night
(c) they produce CO2 all the time but release O2 only during day
(d) they do not photosynthesise at night so that they increase CO2 concentration at night.

161. Ratio between 2-carbon and 3-carbon intermediate having NH2 group formed in ‘photosynthetic carbon oxidation cycle’ is
(a) 2 : 1 (b) 1 : 1 (c) 3 : 2 (d) 3 : 4.

162. Which of the following is a false statement?
(a) CO2 is a major limiting factor for photosynthesis.
(b) Plant attains light compensation point twice during 24 hours.
(c) Plant kept at compensation point remains normal but do not grow.
(d) Chloroplasts of bundle sheath lacks properly developed grana, but, contain large starch grains.

163. Net gain of ATP in plants is 36 per glucose molecule consumed. How many of these ATP are produced in mitochondrion?
(a) 34 (b) 30 (c) 24 (d) 33
164. Choose the correct labelling from the given options.

![Glycolysis and Fermentation Process Diagram]

- (a) A-ethanol, B-CO₂, C-acetaldehyde
- (b) A-CO₂, B-acetaldehyde, C-ethanol
- (c) A-CO₂, B-ethanol, C-acetaldehyde
- (d) A-ethanol, B-acetaldehyde, C-CO₂

165. Match the columns.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
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</thead>
<tbody>
<tr>
<td>A. Oxaloacetate</td>
<td>(i) 6 C compound</td>
</tr>
<tr>
<td>B. Phosphoglycerate</td>
<td>(ii) 5 C compound</td>
</tr>
<tr>
<td>C. Isocitrate</td>
<td>(iii) 4 C compound</td>
</tr>
<tr>
<td>D. α-ketoglutarate</td>
<td>(iv) 3 C compound</td>
</tr>
<tr>
<td>(v) 2 C compound</td>
<td></td>
</tr>
</tbody>
</table>

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

166. Which of the following are false statements?

1. Aerobic respiratory pathway is appropriately called as amphibolic pathway.
2. RQ for carbohydrate as substrate is one, if respiration is anaerobic.
3. In one turn of Krebs cycle, 12 ATP equivalent useful energy is release, along with 3 CO₂ molecules released.
4. Components of ETS are attached to inner mitochondrial membrane on its m-side.
5. Cytochrome oxidase and succinate dehydrogenase are embedded in inner mitochondrial membrane.

| (a) 1 and 5 only | (b) 1 and 4 |
| (c) 2, 3 and 4 | (d) 2, 3, 4 and 5 |

167. Starting chemical of EMP pathway is a

- (a) reduced co-enzymes
- (b) pyruvate
- (c) hexose sugar
- (d) sucrose or starch.

168. In anaerobic respiration how much energy is released from one glucose molecule?

- (a) > 13% 
- (b) 40-50%
- (c) < 7%
- (d) 15-17%

169. Study the given figure and select the incorrect option regarding this.

![Chemiosmosis Figure]

(a) The figure represents chemiosmotic ATP synthesis by oxysomes where X is the mitochondrial matrix and Y is the inner mitochondrial membrane.
(b) Enzyme required for ATP synthesis is ATP synthase, considered to be the complex-V of ETS.
(c) The figure represents oxidative phosphorylation which is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced co-enzymes (NADH, FADH) produced in respiration.
(d) ATP synthase becomes active only when there is a proton gradient having higher concentration of protons (H⁺) on the F1 side as compared to the F0 side.

170. Which of the following exhibits the highest rate of respiration?

- (a) Growing shoot apex
- (b) Germinating seed
- (c) Root tip
- (d) Leaf bud

171. Rise in the water level from X to Y in the given experimental set-up demonstrates

(a) aerobic respiration
(b) anaerobic respiration
(c) photosynthesis
(d) RQ > 1

172. Two trees of same species and same size are grown at different places. One growing in Kota, Rajasthan and other growing at sea shore. Which of the two will lose more water in 24 hours?

- (a) Growing at sea shore
- (b) Growing at Kota
(c) Both will lose almost same water
(d) None of these

173. A plant cell is kept in hypotonic solution. Then its
(a) \( \psi_c \) = increases  (b) DPD = decreases
(c) WP = increases  (d) all of these.

174. Correct pathway of water movement in plant roots is
(a) Soil water \( \rightarrow \) Root hair cell \( \rightarrow \) Passage cells \( \rightarrow \) Cortical cells \( \rightarrow \) Xylem \( \rightarrow \) Pericycle
(b) Soil water \( \rightarrow \) Root hair cell \( \rightarrow \) Pericycle \( \rightarrow \) Cortical cells \( \rightarrow \) Passage cells \( \rightarrow \) Xylem
(c) Soil water \( \rightarrow \) Root hair cell \( \rightarrow \) Cortical cells \( \rightarrow \) Passage cells \( \rightarrow \) Pericycle \( \rightarrow \) Xylem
(d) Soil water \( \rightarrow \) Root hair cell \( \rightarrow \) Cortical cell \( \rightarrow \) Pericycle \( \rightarrow \) Passage cells \( \rightarrow \) Xylem

175. Cell is kept in hypertonic solution, if it shows incipient plasmolysis what will be present between cell wall and cell membrane?
(a) Dilute solution than outer solution
(b) Vacuum
(c) Hypertonic solution than the outer solution
(d) Same solution as outside the cell

176. Movement of water from higher water potential to lower water potential through a semi-permeable membrane is best depicted as
(a) osmosis  (b) diffusion
(c) plasmolysis  (d) imbibition.

177. Which of the following is/are true statement/s?
(a) ABA, aspirin and PMA are anti-transpirants.
(b) Tree will have least water content in cells in the afternoon.
(c) Cause of wilting is development of absorption lag.
(d) All of the above

178. Identify the correct statements and find out the correct combination?
1. Accumulation of \( K^+ \) ions in guard cells does not require energy.
2. Alkaline pH favours stomatal opening.
3. Movement of chloride ions into guard cells is in response to electrical difference created by \( K^+ \) ions.
4. With entry of several \( K^+ \) ions and chloride ions, water potential of guard cells increases.
(a) 1 and 3  (b) 1 and 2
(c) 2 and 3  (d) 3 and 4

179. A cell when dipped in 0.5 M sucrose solution has no effect but when the same cell is dipped in 0.5 M NaCl solution, it will
(a) increases in size
(b) remain unchanged w.r.t. size
(c) become turgid
(d) gets plasmolysed.

180. Main function of lenticels is
(a) transpiration only  (b) guttation
(c) bleeding  (d) gaseous exchange.

---

**ANSWER KEY**

| 1. | (c) | 2. | (b) | 3. | (d) | 4. | (d) | 5. | (a) | 6. | (c) | 7. | (d) | 8. | (c) | 9. | (a) | 10. | (a) |
| 11. | (c) | 12. | (d) | 13. | (c) | 14. | (d) | 15. | (c) | 16. | (d) | 17. | (a) | 18. | (b) | 19. | (b) | 20. | (c) |
| 21. | (c) | 22. | (b) | 23. | (a) | 24. | (d) | 25. | (a) | 26. | (a) | 27. | (d) | 28. | (c) | 29. | (b) | 30. | (a) |
| 31. | (a) | 32. | (a) | 33. | (b) | 34. | (d) | 35. | (b) | 36. | (c) | 37. | (c) | 38. | (b) | 39. | (d) | 40. | (a) |
| 41. | (c) | 42. | (d) | 43. | (a) | 44. | (d) | 45. | (d) | 46. | (d) | 47. | (a) | 48. | (a) | 49. | (c) | 50. | (d) |
| 51. | (a) | 52. | (d) | 53. | (c) | 54. | (a) | 55. | (d) | 56. | (b) | 57. | (b) | 58. | (a) | 59. | (a) | 60. | (d) |
| 61. | (c) | 62. | (a) | 63. | (d) | 64. | (a) | 65. | (d) | 66. | (a) | 67. | (c) | 68. | (d) | 69. | (c) | 70. | (b) |
| 71. | (d) | 72. | (a) | 73. | (d) | 74. | (d) | 75. | (a) | 76. | (a) | 77. | (d) | 78. | (b) | 79. | (b) | 80. | (c) |
| 81. | (c) | 82. | (b) | 83. | (a) | 84. | (a) | 85. | (d) | 86. | (a) | 87. | (a) | 88. | (a) | 89. | (a) | 90. | (a) |
| 91. | (c) | 92. | (d) | 93. | (c) | 94. | (d) | 95. | (d) | 96. | (d) | 97. | (d) | 98. | (b) | 99. | (a) | 100. | (b) |
| 101. | (a) | 102. | (c) | 103. | (d) | 104. | (d) | 105. | (c) | 106. | (a) | 107. | (d) | 108. | (d) | 109. | (c) | 110. | (c) |
| 111. | (b) | 112. | (b) | 113. | (c) | 114. | (d) | 115. | (a) | 116. | (c) | 117. | (d) | 118. | (d) | 119. | (b) | 120. | (a) |
| 121. | (d) | 122. | (d) | 123. | (b) | 124. | (b) | 125. | (c) | 126. | (a) | 127. | (b) | 128. | (b) | 129. | (d) | 130. | (c) |
| 131. | (c) | 132. | (b) | 133. | (b) | 134. | (d) | 135. | (c) | 136. | (c) | 137. | (a) | 138. | (d) | 139. | (c) | 140. | (c) |
| 141. | (a) | 142. | (b) | 143. | (b) | 144. | (d) | 145. | (b) | 146. | (b) | 147. | (a) | 148. | (d) | 149. | (d) | 150. | (b) |
| 151. | (d) | 152. | (c) | 153. | (d) | 154. | (b) | 155. | (d) | 156. | (b) | 157. | (b) | 158. | (b) | 159. | (a) | 160. | (a) |
| 161. | (b) | 162. | (c) | 163. | (a) | 164. | (d) | 165. | (c) | 166. | (c) | 167. | (c) | 168. | (c) | 169. | (d) | 170. | (b) |
| 171. | (a) | 172. | (a) | 173. | (d) | 174. | (c) | 175. | (d) | 176. | (a) | 177. | (d) | 178. | (c) | 179. | (d) | 180. | (d) |
**CHAPTER-8 : HUMAN HEALTH AND DISEASE**

**Multiple Choice Questions**

1. If a person shows production of interferons in his body, the chances are that he has got an infection of
   (a) tetanus  (b) malaria  (c) typhoid  (d) measles.

2. Fever in malaria is due to
   (a) entry of sporozoites into blood capillaries
   (b) entry of merozoites into liver cells
   (c) release of merozoites from red blood cells
   (d) entry of cryptomerozoites into red blood cells.

3. Which one of the following options gives the correct matching of a disease with its causative organism and mode of infection?
<table>
<thead>
<tr>
<th>Disease</th>
<th>Causative organism</th>
<th>Mode of infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Typhoid</td>
<td>Salmonella typhi</td>
<td>with inspired air</td>
</tr>
<tr>
<td>(b) Pneumonia</td>
<td>Streptococcus pneumoniae</td>
<td>droplet infection</td>
</tr>
<tr>
<td>(c) Elephantiasis</td>
<td>Wuchereria bancrofti</td>
<td>with contaminated water and food</td>
</tr>
<tr>
<td>(d) Malaria</td>
<td>Plasmodium vivax</td>
<td>bite of male Anopheles mosquito</td>
</tr>
</tbody>
</table>

4. Bladderworm stage of *Taenia solium* is
   (a) rostella  (b) strobila  (c) onchosphere  (d) cysticercus.

5. Just as *Xenopsylla* is to *Yersinia pestis*, so is
   (a) Glossina palpalis to *Wuchereria bancrofti*
   (b) Culex to *Plasmodium falciparum*
   (c) Homo sapiens to *Taenia solium*
   (d) Phlebotomus to *Leishmania donovani*.

6. Which of the following includes only bacterial diseases?
   (a) Malaria, mumps, polio
   (b) Cholera, typhoid, mumps
   (c) Tetanus, TB, malaria
   (d) Diphtheria, leprosy, plague

7. Roots of which of the following species contain valuable alkaloids that are useful in medicine?
   (a) Rauwolfia serpentina
   (b) Azadirachta indica
   (c) Emblica officinalis
   (d) Helianthus annus

8. Which of the following human parasites require mosquito to complete their life-cycle?
   (a) *Ascaris lumbricoides* and *Wuchereria bancrofti*
   (b) *Leishmania donovani* and *Plasmodium ovale*
   (c) *Ascaris lumbricoides* and *Leishmania donovani*
   (d) *Wuchereria bancrofti* and *Plasmodium ovale*

9. Memory cells are stored in
   (a) spleen
   (b) lymph nodes
   (c) a specialised area of brain tissue
   (d) both (a) and (b).
10. Which of the following best explains the difference between an epitope and an antigen?
(a) An epitope is any foreign substance; an antigen is a foreign protein.
(b) An epitope is the part of an antigen where an antibody or lymphocyte receptor binds.
(c) An antigen is the part of an epitope where an antibody or lymphocyte receptor binds.
(d) Antigens are recognized by B cells and antibodies; epitopes are recognized by T cells.

11. True or false
Schuffner's dots are seen in red blood corpuscles of man due to kala-azar.
12. Bacteria Clostridium botulinum, that cause botulism are obligate anaerobes.
13. HIV has a protein coat and a genetic material which is dsRNA.
14. Pertussis, anthrax and tetanus are bacterial diseases.
15. Opioids are drugs, which bind to specific opioid receptors present in the central nervous system and gastrointestinal tract.
16. IgM is so named as it is a microglobulin, five times smaller than IgG.
17. Chikungunya bacteria is transmitted by female Aedes aegypti mosquito.
18. Narcotic analgesics, anabolic steroids and diuretics are commonly used by sportspersons to increase muscle strength and enhance their performance.
19. Both the IgM and IgG antibodies are produced in equal concentration during the primary as well as secondary immune response to an antigen.
20. Alcohol is a stimulant which is quickly absorbed by the stomach and transferred to blood.

Match The Columns
21. Match Column-I with Column-II.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Allergy</td>
<td>(i) Activation of B-cells</td>
</tr>
<tr>
<td>B. Helper T - cells</td>
<td>(ii) Chemotherapy</td>
</tr>
<tr>
<td>C. AIDS virus</td>
<td>(iii) Carcinogens</td>
</tr>
<tr>
<td>D. X-rays</td>
<td>(iv) IgE</td>
</tr>
<tr>
<td>E. Treatment of cancer</td>
<td>(v) Single stranded RNA</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Typhoid</td>
<td>(i) Mary Mallon</td>
</tr>
<tr>
<td>B. Malaria</td>
<td>(ii) Haematoxylin</td>
</tr>
<tr>
<td>C. Pneumonia</td>
<td>(iii) Blue lips</td>
</tr>
</tbody>
</table>

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.

23. Assertion : Entamoeba histolytica is dimorphic and digenetic.
Reason : It occurs in two forms - larger, harmless, magna form in pig, and smaller, harmful, minuta form in man.
25. **Assertion**: Histamine causes constriction of blood capillaries resulting in inflammatory response.
   **Reason**: Administration of antihistamines results in the dilation of blood capillaries and provides relief from inflammation.

26. **Assertion**: In spite of exposure to large number of infectious agents, humans are resistive to diseases.
   **Reason**: Humans are able to defend against most of the foreign agents due to the ability to fight disease-causing organisms.

27. **Assertion**: IgG is the most abundant class of lgs in the body.
   **Reason**: IgG is mainly found in sweat, tears, saliva, mucus, colostrum and gastro intestinal secretions.

28. **Assertion**: Tobacco contains a large number of alkaloids including nicotine.
   **Reason**: Nicotine stimulates adrenal gland which decreases blood pressure and increases heart rate.

### Figure Based Questions

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

   ![Diagram of retro virus](image)

   (a) Identify the steps A, B, C, D and E labelled in it.
   (b) Describe briefly the mode of transmission of the virus mentioned in the figure.

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

   ![Diagram of somatic embryogenesis](image)

   (a) Name the parts labelled A, B and C.
   (b) What is the function of part labelled C?
   (c) What is the function of B?
8. A scientist wants to study the viral effects on plants. Which of the following part of the plant should be excluded?
   (a) Phloem    (b) Pith
   (c) Cortex    (d) Shoot apex

9. Kadiri-1, Kadiri-2 are the varieties of
   (a) rice hybrids   (b) red gram hybrids
   (c) sorghum hybrids   (d) groundnut hybrids.

10. The best stage to produce haploid through anther culture is
    (a) microspore mother cells   (b) microspores
    (c) 2- celled pollen grains   (d) all of the above.

True or False

11. Even though the plant is infected with a virus, the apical and axillary meristems are free of virus.

12. Proteins of cereals and millets are deficient in methionine and cysteine.

13. First successful pollen culture was done by M.S. Swaminathan.

14. India’s wheat yield revolution in 1960s was possible primarily due to quantitative trait mutations.

15. Triticale, the first man made crop as it is an artificial allopolyploid derived by crossing wheat and rice.

16. Microbes like *Spirulina* can be grown on waste water, animal manure and even sewage, to produce food for human consumption.

17. It is estimated that approximately 50 per cent of the world livestock population is in India and China, but contribute only 25 percent to world farm produce.

18. Hybrid between female ass and male horse is called mule.

19. Silk worm ceases to eat and start spinning silk around its body from outside to inside.

20. Proteins serine and fibroin are present in silk fibres.

Match The Columns

21. Match Column-I with Column-II.

   Column-I          Column-II
   A. Totipotency   (i) breeding crops with higher levels of nutrients
   B. Micropropagation   (ii) plant grown from hybrid protoplast
   C. Somaclone   (iii) producing a large number of plants through tissue culture

   D. Somatic hybrid   (iv) capacity to generate a whole plant from an explant
   E. Biofortification   (v) plants genetically identical to the original plant

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

   Column-I          Column-II
   A. Rice varieties   (i) Gir
   B. Milch breed   (ii) Jaya
   C. Bee enemies   (iii) Marwari
   D. SCP   (iv) *Fusarium graminearum*
   E. Goat breeds   (v) *G. mellonella*
   (vi) *Methylophilus methylotrophus*
   (vii) *Merops orientalis*
   (viii) Ratna
   (ix) Sahiwal
   (x) Malabari

Passage Based Questions

23.(A) Complete the given passage with appropriate words or phrases.
When breeding is between animals of the same breed it is called (ii), while crosses between different breeds are called (ii). Inbreeding refers to the mating of more closely (iii) individuals within the same breed for (iv) generations. The breeding strategy is as follows – superior males and superior females of the (vi) breed are identified and mated in (vi). The progeny obtained from such matings are (vii), and superior males and females among them are identified for (viii). A superior female, in the case of cattle, is the cow or buffalo that produces (ix) per lactation. On the other hand, a superior male is the bull, which gives rise to (x) progeny as compared to those of other males.

(B) Read the given passage and correct the errors, wherever present.
Outcrossing is the practice of mating animals of different breeds having common ancestors up to 2-3 generations. Offspring of such mating are known as cross breeds. It is the best breeding method for animals high in productivity. A single cross often helps to overcome breeding depression.
Assertion & Reason

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

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

24. **Assertion**: Hybrid seeds must be produced every year to obtain maximum advantage of heterosis.
   **Reason**: Heterosis is lost by inbreeding.

25. **Assertion**: Virus-free plants can be produced from virus infected plants by means of meristem tissue culture.
   **Reason**: The virus fails to grow during the growth of host tissue in the artificial medium.

26. **Assertion**: Somaclonal variations occur in tissue culture processes.
   **Reason**: Variations cannot occur in nature.

27. **Assertion**: Breeding, weeding, feeding and heeding are essential methods for livestock production.
   **Reason**: Livestock management deals with processes and systems that increase yield and improve quality of products.

28. **Assertion**: In MOET, hormones with progesterone-like activity are given to the cow for inducing super-ovulation.
   **Reason**: After mating, the embryos at 4-6 celled stage are recovered and transferred to surrogate mothers.

Figure Based Questions

29. Study the following flow chart and answer the following questions.

   (a) Identify labels 1, 2 and 3.
   (b) Describe briefly how the process is helpful in food production.

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

   (a) Identify A, B, C, D and E in the given figure.
   (b) Name any two plants obtained from the procedure described in the above figure.

CHAPTER-10: MICROBES IN HUMAN WELFARE

Multiple Choice Questions

31. Study the following statements regarding lactic acid bacteria (LAB) which are used to convert milk into curd.
   (i) They produce acids that coagulate and partially digest the milk proteins.
   (ii) A small amount of curd added to the fresh milk as an inoculum contains millions of LAB, which at suitable temperature, multiply and convert milk into curd.
   (iii) Conversion of milk into curd improves its nutritional quality by increasing vitamin B12.
   (iv) LAB may result in acidity in the stomach of human beings.

Which of the given statements are correct?
(a) (i) and (ii) (b) (ii) and (iii) (c) (i), (ii) and (iii) (d) (i), (ii), (iii) and (iv)
2. Which of the following statements regarding antibiotics is not correct?
   (i) Antibiotics are the attenuated microorganisms which in small concentration, can kill or retard the growth of other harmful microorganisms.
   (ii) Penicillin was the first antibiotic discovered by Alexander Fleming (1928) while working on bacterium *Staphylococcus aureus*.
   (iii) The full potential of penicillin as an effective antibiotic was established by Ernst Chain and Howard Florey.
   (iv) Fleming, Chain and Florey were awarded the Nobel Prize in 1945.
   (a) (i) only (b) (iii) only (c) (ii) and (iv) (d) (i), (iii) and (iv)

3. Wine and beer are produced directly by fermentation whereas brandy and whisky require both fermentation and distillation. This is because
   (a) fermentation is inhibited at an alcohol level of 10-18% (b) distillation prolongs storage (c) distillation improves quality (d) distillation purifies the beverage.

4. During the primary treatment of sewage, solid particles that settle down are called
   (a) flocs (b) primary sludge (c) activated sludge (d) anaerobic sludge.

5. When domestic sewage mixes with river water
   (a) small animals like rats will die after drinking river water (b) the increased microbial activity releases micronutrients such as iron (c) the increased microbial activity uses up dissolved oxygen (d) the river water is still suitable for drinking as impurities are only about 0.1%.

6. Cyanobacteria helps farmers by
   (a) reducing the alkalinity of the soil (b) reducing the acidity of the soil (c) neutralising the alkalinity of the soil (d) water logging.

7. Select the correct statement regarding activated sludge formed during secondary sewage treatment.
   (a) A small part of it is rapidly pumped back from sedimentation tank to aeration tank.
   (b) It absorbs pathogenic bacteria present in waste water while sinking to the bottom of the settling tank.
   (c) A major part of it is anaerobically digested.
   (d) Both (a) and (c)

8. Mycorrhizal associations do not help the host plant in
   (a) enhancing its phosphorus uptake capacity (b) increasing its tolerance to salinity and drought (c) enhancing its resistance to root borne pathogens (d) increasing its resistance to insects.

9. Activated sludge should have the ability to settle quickly so that it can
   (a) be rapidly pumped back from sedimentation tank to aeration tank (b) absorb pathogenic bacteria present in waste water while sinking to the bottom of the settling tank (c) be discarded and anaerobically digested (d) absorb colloidal organic matter.

10. Which of the following is a wrong matching of a microbe and its industrial product, while the remaining three are correct?
    (a) Yeast – statins (b) *Acetobacter aceti* – acetic acid (c) *Clostridium butyricum* – lactic acid (d) *Aspergillus niger* – citric acid

**True or False**

11. Vinegar is obtained from molasses with the help of *Rhizopus*.

12. Lactic acid bacteria convert milk into curd and improve the nutritional quality by enhancing vitamin B content.

13. Invertase converts glucose into alcohol.

14. The dough which is used for making foods such as *dosa* and *idli* is fermented by certain species of bacteria.

15. Biogas generation is a five stage aerobic digestion of animal and other organic wastes.

16. People recovering from long illness are often advised to include *Spirulina* in their diet as it is rich in protein.

17. Nitrogen fixation in root nodules of *Alnus* is carried out by *Frankia*.

18. *Bacillus thuringiensis* bacteria are available as dried spores which are mixed with water and sprayed onto vulnerable plants.

19. *Azotobacter* available under the trade name of Azotobactrin, not only increases yield, but also saves nitrogen fertilisers in fields of cotton, maize, jowar and rice.

20. Lipases are lipid dissolving enzymes obtained from *Saccharomyces fragilis* and *Torula cremoris*.

## Match The Columns

21. Match Column-I with Column-II.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. <em>Lactobacillus acidophilus</em></td>
<td>(i) Formation of Swiss cheese</td>
</tr>
<tr>
<td>B. <em>Saccharomyces cerevisiae</em></td>
<td>(ii) Bacitracin</td>
</tr>
<tr>
<td>C. <em>Propionibacterium shermanii</em></td>
<td>(iii) Single cell proteins</td>
</tr>
<tr>
<td>D. <em>Spirulina</em></td>
<td>(iv) Formation of milk into curd</td>
</tr>
<tr>
<td>E. <em>Bacillus licheniformis</em></td>
<td>(v) Formation of dough</td>
</tr>
</tbody>
</table>
22. Match Column-I with Column-II. (There can be more than one match for items in Column-I).

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Proteases</td>
<td>(i) Azospirillum</td>
</tr>
<tr>
<td>B. Gluconic acid</td>
<td>(ii) Mortierella renispora</td>
</tr>
<tr>
<td>C. Biocontrol agents</td>
<td>(iii) Nucleopolyhedrovirus</td>
</tr>
<tr>
<td>D. Chloramphenicol</td>
<td>(iv) Aspergillus niger</td>
</tr>
<tr>
<td>E. Biofertiliser</td>
<td>(v) Azotobacter</td>
</tr>
<tr>
<td></td>
<td>(vi) Bacillus species</td>
</tr>
<tr>
<td></td>
<td>(vii) Trichoderma</td>
</tr>
<tr>
<td></td>
<td>(viii) Penicillium</td>
</tr>
<tr>
<td></td>
<td>(ix) S. venezuelae</td>
</tr>
<tr>
<td></td>
<td>(x) S. lavendulae</td>
</tr>
</tbody>
</table>

Passage Based Questions

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

Microbes especially (i) have been used from time immemorial for the production of beverages like wine, beer, (ii), (iii), or (iv). Yeast (v) used for bread-making and commonly called brewer’s yeast, is used for fermenting malted cereals and fruit juices, to produce (vi). Depending on the type of the raw material used for fermentation and the type of processing (with or without distillation) different types of alcoholic drinks are obtained. Wine and beer are produced (vii) whereas whisky, (viii) and rum are produced by (ix) of the (x) broth.

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

Cyclosporin A is an six membered cyclic oligopeptide obtained through distillation of fungus Candida lipolytica. It is antifungal, having inflammatory properties. It inhibits activation of B-cells and helps in prevention of rejection reactions in organ transplantation. Statins are produced by activity of yeast Saccharomyces cerevisiae. It facilitates cholesterol synthesis and therefore, is used for increasing blood cholesterol.

Assertion & Reason

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

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

24. **Assertion**: The antibiotics produced by *Streptomyces* species have found greatest commercial application.

**Reason**: Some of the important life saving antibiotics such as penicillin and polymixin-B are produced by *Streptomyces*.

25. **Assertion**: Yeasts should not be used in brewing and baking industries.

**Reason**: Yeasts produce several harmful products during brewing and baking.

26. **Assertion**: Statins inhibit cholesterol synthesis and are used in lowering blood cholesterol.

**Reason**: Statins resemble mevalovate and are competitive inhibitors of HMG CoA reductase.

27. **Assertion**: Energy value of biogas is lower than that of organic matter.

**Reason**: Biogas minimises the chances of spread of fecal pathogens.

28. **Assertion**: Griseofulvin extracted from *P. griseofulvum* is used for ringworm treatment.

**Reason**: *Trichophyton, Epidermophyton*, etc. cannot grow well in presence of *Penicillium griseofulvum*.

Figure Based Questions

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

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

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

(a) Identify the parts labelled A, B, C and D.
(b) Describe how part labelled C is helpful in producing biogas.
CHAPTER-8 : HUMAN HEALTH AND DISEASE

1. (d) 2. (c) 3. (b) 4. (d) 5. (d)
6. (d) 7. (a) 8. (d) 9. (d) 10. (b)
11. **False** : Shuffner’s dots are seen in red blood corpuscles of man due to malaria.
12. **True**
13. **False** : HIV has a protein coat and a genetic material which is ssRNA.
14. **True**
15. **True**
16. **False.** IgM is so named as it is a macroglobulin, five times larger than IgG.
17. **False.** Chikungunya virus is transmitted by female *Aedes aegypti* mosquito.
18. **True**
19. **False.** IgM and IgG are produced during primary immune response while IgG mainly is responsible for secondary immune response.
20. **False.** Alcohol is not a stimulant. Rather it acts as sedative, analgesic and anaesthetic.
21. A-(iv), B-(i), C-(v), D-(iii), E-(ii)
22. A-(i, vi), B-(ii, x), C-(iii, vii), D-(iv, viii), E-(v, ix)
23. (A) (i) pathogen specific (ii) memory (iii) pathogen (iv) primary response (v) low (vi) high (vii) B-lymphocytes (viii) T-lymphocytes (ix) antibodies (x) B cells
24. (d) 25. (d) 26. (a) 27. (c) 28. (c)
29. (a) A - Viral RNA introduced B - Viral DNA C - Viral DNA incorporated into host genome D - New viral RNA E - New virus produced

(b) The above mentioned figure refers to the mode of action of AIDS virus. Virus of AIDS is transmitted via blood and semen by the following methods: (i) transfusion of infected blood or blood product, (ii) use of contaminated needles and syringes to inject drugs or vaccines, (iii) use of contaminated razors, (iv) use of contaminated needles for boring pinnae, (v) sexual intercourse with an infected partner without a condom, (vi) from infected mother to child through placenta, (vii) by artificial insemination, (viii) organ transplant.

30. (a) A - Lymph nodes B - Thymus C - Spleen
(b) ‘C’ refers to spleen. Spleen is a bean shaped organ which is the largest single mass of lymphoid tissue in the body. In foetus, it produces all types of blood cells but in adult, it only produces lymphocytes. Macrophages of spleen are phagocytic.
(c) B refers to thymus. Thymus is the site of T-lymphocyte maturation. Therefore, thymus helps in cellular immune response. It is situated near the heart and is quite large in size at the time of birth but keeps reducing with age.

CHAPTER-9 : STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

1. (d) 2. (a) 3. (a) 4. (a) 5. (c)
6. (b) 7. (b) 8. (d) 9. (d) 10. (b)
11. **True**
12. **False** : Proteins of cereals and millets are deficient in lysine and tryptophan.
13. **False** : First successful pollen culture was done by Guha and Maheshwari.
14. **True**
15. **False** : Triticale is derived by crossing wheat and rye.
16. **True**
17. **False.** More than 70 per cent of world’s livestock population is in India and China.
18. **False.** Hybrid between female ass and male horse is called hinny.
19. **True** 20. **True**
21. A-(iv), B-(iii), C-(v), D-(ii), E-(i)
22. A-(ii, viii), B-(i, ix), C-(v, vii), D-(iv, vi), E-(iii, x)
23. (A) (i) inbreeding (ii) outbreeding (iii) closely related (iv) 4-6 (v) same (vi) pairs (vii) evaluated (viii) further mating (ix) more milk (x) superior

(B) Outcrossing is the practice of mating animals in different same breeds having no common ancestors up to 4-6 generations. Offsprings of such mating are known as out-cross. It is the best breeding method for animals high in productivity. A single cross often helps to overcome inbreeding depression.

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

29. (a) 1– FSH, 2 – Super ovulation due to induced follicular maturation, 3-transfer to surrogate mother.
(b) High milk giving breeds of females and high quality meat (lean meat with less lipid) giving bulls have been breed successfully to obtain better breed in a short time by MOET.

30. (a) A - Cellulase and pectinase B - Protoplast C - Cell fusion D - Nuclear fusion E - Somatic hybrids
(b) The given figure describes the process of somatic hybridisation. Pomato is somatic hybrid between potato and tomato that belong to two different genera and bomato is somatic hybrid between brinjal and tomato. Somatic hybrids are also produced between rice and carrot. The hybrid plant bears both fruits and root tubers of the two parents.

CHAPTER-10 : MICROBES IN HUMAN WELFARE
1. (c) 2. (a) 3. (a) 4. (b) 5. (c)
6. (b) 7. (d) 8. (d) 9. (a) 10. (c)

11. False: Vinegar is obtained from molasses with the help of Acetobacter aceti.
12. True
13. False: Zymase converts glucose into alcohol.
14. True
15. False: Biogas generation is a three-stage anaerobic digestion of animals and other organic wastes.
20. False: Lipases are lipid dissolving enzymes obtained from Candida lipolytica and Geotrichum candidum.
21. A-(iv), B-(v), C-(i), D-(iii), E-(ii)

22. A-(ii, vi), B-(iv, viii), C-(iii, vii), D-(ix, x), E-(i, v)
23. (A) (i) yeast (ii) whisky (iii) branly (iv) rum (v) Saccharomyces cerevisiae (vi) ethanol (vii) without distillation (viii) brandy (ix) distillation (x) fermented
(B) Cyclosporin A is an eleven membered cyclic oligopeptide obtained through fermentative activity of fungus Candida lipolytica Trichoderma polysporum. It is antifungal, having anti-inflammatory properties. It inhibits activation of B-cells, T-cells and helps in prevention of rejection reactions in organ transplantation.

Statins are produced by activity of yeast Saccharomyces cerevisiae Monascus purpureus. It facilitates inhibits cholesterol synthesis and therefore, is used for lowering blood cholesterol.

24. (c) 25. (d) 26. (a) 27. (b) 28. (a)
29. (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. Lactic acid bacteria (LAB) like Lactobacillus are added to milk. It converts lactose sugar of milk into lactic acid. Lactic acid causes coagulation and partial digestion of milk protein casein and milk is then converted into curd, yogurt or cheese using different processes.

30. (a) A - Mechanical agitation B - Reduced BOD C - Activated sludge D - Anaerobic sludge digester
(b) ‘c’ refers to activated sludge. It is the sediment in settling tank. A part of it is used as inoculum in aeration tanks. The remaining is passed into a large tank called anaerobic sludge digesters. They are designed for continuous operation. The aerobic microbes present in the sludge get killed. Anaerobic microbes digest the organic mass as well as aerobic microbes (bacteria and fungi) of the sludge. They are of two types, nonmethanogenic and methanogenic. Methanogenic bacteria produce marsh gas which is a mixture of gases containing methane, H2S and CO2. The mixture also called biogas is inflammable and is a source of energy.
Human Reproduction-I

- Reproductive system is a collection of internal and external organs in both males and females that work together for purpose of producing a new generation of living organisms similar to their parents.
- Reproduction ensures survival of species and transmission of genetic information from one generation to next.
- Human beings reproduce sexually and are viviparous i.e., they give birth to young ones.
- Reproductive units are specialised cells called gametes, which are of two types: male gametes (spermatozoa) and female gametes (ova). These sex cells or gametes are formed in separate, paired organs of mesodermal origin, called gonads.
- The gonads that produce male gametes or sperms are called testes, while those producing female gametes or ova are termed as ovaries.
- Reproductive system of both the sex consist of organs which can be distinguished into primary and secondary sex organs.
- Organs which produce gametes or sex hormones are called primary sex organs. E.g. testes in males and ovaries in females.
- Organs which neither produce gametes nor secrete sex hormones but perform important functions in reproduction are termed as secondary sex organs. E.g. epididymis, vasa deferentia, penis, etc. in males and oviducts, uterus, etc. in females.
- Secondary sex characters are external features which provide distinctiveness to the two sexes. They have no direct role in sexual reproduction.
- The phenomenon when male and female individuals are differentiated externally is called sexual dimorphism.
- Major secondary sex characters of human males are facial hair, body hair, more height, more muscles, broadening of shoulders, low pitched voice, narrow but strong pelvis, etc.
Major secondary sex characters of human females are development of breasts, broader pelvis, rounded body contours, fat deposition in thighs, buttocks and face, high pitched voice, etc.

**Puberty** is defined as the state at which the gonads come to maturity relative to their endocrine and gametogenic potential. These changes occur in response to rising levels of gonadal hormones. It occurs sometime between 10 and 15 years.

**Adolescence** is the period between puberty and complete sexual maturity. Generally, it is considered to start with the development of secondary sexual characteristics and to end when physical growth of body slows down. In humans, age 11 to 20 years for boys and 10 to 18 years for girls is the adolescence period.

**Precocious puberty and delayed puberty**

Precocious puberty is defined as the premature appearance of secondary sex characteristics and is usually caused by an early increase in gonadal steroid production. This leads to an early onset of puberty growth spurt, maturation of skeleton, breast development (in girls) and enlargement of genitalia (in boys). Onset of puberty is considered delayed if menstruation fails to occur by the age of 17 or testicular development by the age of 20. It may arise due to absence of pituitary hormones or due to defect at the level of hypothalamus.

**MALE REPRODUCTIVE SYSTEM**

Male reproductive system consists of scrotum, a pair of testes, vasa efferentia, epididymides, vasa deferentia, ejaculatory ducts, urethra, penis and certain glands.

**Scrotum**

- It is a sac consisting of loose pouch of skin, muscles and connective tissue that hangs from the root i.e., attached portion of the penis.
- A septum divides the scrotum into two sacs. Each of these sacs contains one testis.

- The scrotum remains connected with the abdomen or pelvic cavity by two inguinal canals on each side of the scrotal septum. The spermatic cord, formed from the spermatic artery, vein and nerve bound together with connective tissue passes into the testis through inguinal canal.

**Scrotum as thermoregulator**

The scrotum acts as a thermoregulator and maintains testes at a temperature 2°C lower than the body. This temperature is required for normal sperm production. It is maintained and regulated by two mechanisms:

(i) Location of scrotum outside the pelvic body.

(ii) Contraction of the smooth involuntary dartos muscle which brings the testes closer to the pelvic cavity to get the warmth when the body is chilled.

**Testes**

- There is a pair of testes that are suspended in the scrotum by the spermatic cords. During early foetal life the testes develop in the abdominal cavity just below the kidneys and then they descend into the scrotum.

- A fibrous cord that extends from the caudal end of the testis to the scrotal wall is called **gubernaculum**.
The supporting, sustentacular or Sertoli cells were discovered by Italian histologist, Enrico Sertoli. Sertoli cells are large, elongated and pyramidal cells which have bases adhering to basal lamina (basement membrane) and apices projecting into the lumen of the seminiferous tubules providing attaching sites to spermatocytes and spermatids. Sertoli cells secrete androgen binding protein (ABP) that concentrates testosterone in the seminiferous tubules. Sertoli cells also secrete another protein called inhibin which suppresses FSH synthesis. They secrete spermatogenic substances for nourishing and differentiation of cells undergoing spermatogenesis, therefore, Sertoli cells are also called nurse cells.

Leydig’s cells are interstitial cells present in the connective tissue around the seminiferous tubules. These cells were discovered by German anatomist Franz Leydig. Leydig’s cells are endocrine in nature. Under the influence of luteinising hormone (LH) or interstitial cell stimulating hormone (ICSH), Leydig’s cells produce androgens, e.g., testosterone. The latter not only produce and maintain male characteristics but also stimulate germinal epithelium to undergo spermatogenesis.

Sertoli cells maintain blood-testis barrier which prevents many cells from entering or leaving seminiferous tubules. It also prevents sperms from diffusing into the blood. This is because sperms are immunogenic and can result in development of antibodies specific to them. This barrier develops at the time of puberty, just before beginning of spermatogenesis, and provides a protected environment for sperm development and maturation.

In some persons testes fail to descend in scrotum. The condition is called cryptorchidism. It results in sterility.

Testes perform two functions: (a) production of sperms and (b) secretion of male sex hormones.

Male accessory ducts

Rete testis, vasa efferentia, epididymides and vasa deferentia, (or vas deferens) are called the male accessory ducts. These ducts store and transport the sperms from the testis to the outside through urethra.

The seminiferous tubules are closed at one end but on the other side they join to a network the rete testis from where fine ciliated ductules, the vasa efferentia arise. Cilia help in conducting sperms.

Epididymis is a mass of long narrow closely coiled tube which lies along the inner side of each testis.

At the anterior end of the testis epididymis is called caput epididymis, in which the vasa efferentia opens. The middle part of the epididymis is known as corpus epididymis. The posterior end of the epididymis is called as cauda epididymis.

In the head of the epididymis, the sperms undergo physiological maturation, acquiring increased motility and fertilising capacity. In the tail of the epididymis sperms are stored before entering the vas deferens.

Epididymis is lined by pseudostratified epithelium that secretes nutrients required for maturation and nourishment of spermatzoa. Non-ejaculated sperms are reabsorbed in the vasa deferens.

The term testicle is used for both testis and epididymis.

The vas deferens is a continuation of the cauda epididymis which leaves the scrotal sac and enters the abdominal cavity through the inguinal canal.

The vas deferens loops over the urinary bladder where it is joined by duct from the seminal vesicle to form the ejaculatory duct. Vasa deferentia carry sperms.

### Table: Differences between vasa efferentia and vasa deferentia

<table>
<thead>
<tr>
<th>Vasa efferentia</th>
<th>Vasa deferentia</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) They arise from the rete testis.</td>
<td>They arise from the cauda epididymis.</td>
</tr>
<tr>
<td>(ii) They vary from 15 to 20 in number.</td>
<td>They are only 2 in number.</td>
</tr>
<tr>
<td>(iii) Vasa efferentia are fine.</td>
<td>Vasa deferentia are thick.</td>
</tr>
<tr>
<td>(iv) Their lining bears many ciliated cells.</td>
<td>Their lining has many stereocilia.</td>
</tr>
<tr>
<td>(v) They carry spermatzoa from the testis to the epididymis.</td>
<td>They carry spermatzoa from cauda epididymis to the ejaculatory duct.</td>
</tr>
</tbody>
</table>

### Ejaculatory ducts

- They are formed by the union of ducts from vas deferens and duct of seminal vesicle.
- In ejaculatory ducts, the sperms mix up with secretion of seminal vesicles. The walls of ejaculatory ducts are muscular to quickly conduct the ejaculate through urinogenital duct.
Urethra

- It is the urinary duct which originates from neck of urinary bladder and opens to exterior at the tip of penis. It also receives secretions of prostate and Cowper’s glands.
- It consists of prostatic urethra where prostate gland opens, membranous urethra at the urogenital diaphragm and the spongy penile urethra that passes through penis.
- The urethra has internal sphincter of smooth muscle fibres at its beginning and external sphincter of striated muscles fibres around its membranous part.

Penis

- The penis is a male copulatory organ used during mating.
- The penis, in addition to conducting urine from the body, transfers semen into reproductive tract of the female during sexual intercourse. The penis contains three cylindrical masses of erectile tissue—two dorsal corpora cavernosa and one ventral corpus spongiosum. These bodies are surrounded by fibrous tissue.
- The corpora spongiosum, through which the urethra extends, enlarges at its distal end to form a sensitive cone-shaped glans penis.
- The glans penis is covered by loose fold of skin, the prepuce or foreskin. During sexual arousal, the three bundles of tissue in the penis become engorged with blood and the pressure seals off the veins that drain these areas causing an erection, which is necessary for insertion of the penis into the woman’s vagina. Penis conducts urine as well as semen, but the two cannot pass through it at the same time.

Male accessory glands

Seminal vesicle

- These are paired, glandular, sac-like structures near the base of the bladder.
- Fluid secreted by seminal vesicles normally constitutes approximately **60% of the volume of semen**. It is a viscous and alkaline fluid, which helps to regulate pH of the tubular contents as sperms travel outside.
- The secretion also contains fructose that provides energy to the sperm and prostaglandins, which stimulate muscular contractions within the female reproductive organs.

Fructose in forensic test

Fructose, which is present in the seminal fluid and is not produced anywhere else in the body is used for confirmation of rape/sexual intercourse during forensic test.

Prostrate gland

- The prostate gland is a single large gland that surrounds the urethra. It produces a milky, slightly alkaline secretion which forms 25% of the volume of semen.
- It possesses enzymes (acid phosphatase, amylase, pepsinogen), prefibrolysin, clotting enzymes, prostaglandins and citric acid (a sperm nutrient).
- Secretion of the prostate gland nourishes and activates the spermatozoa to swim. The secretions of prostate gland also contain prostate specific antigen (PSA) which liquefies the clotted semen.

Bulbourethral (Cowper’s) gland

- A pair of bulbourethral glands or Cowper’s glands are present on either side of membranous urethra.
- These glands secrete an alkaline fluid. Their ducts open into the membranous urethra carrying the fluid that neutralizes acids from urine in the urethra.
- They also secrete mucus that lubricates the end of the penis and lining of the urethra. This decreases the number of sperms damaged during ejaculation.

Semen

- Semen is a collection of secretions from the seminal vesicles, prostate gland and Cowper’s glands and sperms from testes. Semen is ejected from the penis during ejaculation. A single ejaculation may contain 200 to 300 million sperms.
- Semen has a pH of 7.35 to 7.50 (alkaline).
- It provides fluid medium for sperm transmission, nourishes sperms and neutralises the acidity of the urine in the urethra of the male to protect sperms.

Hormonal control of male reproductive system

- The growth, maintenance and functions of the male reproductive organs are under the hormonal control.
- GnRH (gonadotropin releasing hormone) is secreted by the hypothalamus. It stimulates the anterior lobe of the pituitary gland to secrete and release LH and FSH.
- LH is also called interstitial cell stimulating hormone (ICSH). It is taken up Leydig’s cells and results in the secretion of androgens. Testosterone is the principle hormone.
- FSH stimulates production of androgen binding protein (ABP). It is inhibited by inhibin, secreted by Sertoli cells of seminiferous tubules. FSH acts on spermatogonia to stimulate sperm production.
Gametogenesis in males
- The process of formation of male gametes i.e., sperms is called spermatogenesis.
- It occurs in the seminiferous tubules of the testes. The seminiferous tubules are lined by germinal epithelium and Sertoli cells.
- The germinal epithelium consists largely of cuboidal primary or primordial germ cells.

Formation of spermatids
- Multiplication phase: The undifferentiated germ cells, divide mitotically again and again for a specified number of division cycles to form large number of spermatogonia.

Growth phase: Each spermatogonium actively grows to a larger primary spermatocyte by obtaining nourishment from the nursing cells. The phenomenon of formation of primary spermatocytes from spermatogonia, is called spermatocytogenesis.

Maturation phase: Each primary spermatocyte increases markedly in size and undergoes the first meiotic or reductional division to form two secondary spermatocytes. Each of which contains haploid set of (23 in humans) chromosomes. Each secondary spermatocyte undergoes the second meiotic or equational division to form spermatids. Thus, each primary spermatocyte, containing 46 chromosomes, produces four spermatids, each having 23 chromosomes.

Formation of spermatids
- The transformation of spermatids into spermatooza is called spermiogenesis or spermateleosis or differentiation phase.
- The different changes occurring during spermiogenesis are: (i) Formation of acrosome by Golgi apparatus. The latter then degenerates. (ii) Elongation and condensation of nucleus. (iii) Separation of centrioles. (iv) Formation of axial filament from distal centriole. (v) Development of mitochondrial spiral around upper parts of axial filament. (vi) Formation of flagellum.
- The entire process of spermatogenesis, from primary spermatocytes to mature spermatozoa (sperms) takes approximately 64 days in man. The normal human male manufactures nearly 30 million sperms per day. A very high rate of sperm production appears to be necessary to overcome the odds against internal fertilisation.
After their maturation, spermatozoa detach from Sertoli cells. The process is called spermiation. The released sperms are stored in epididymis and first portion of vasa deferentia for up to one month. Here they gain motility. Nutrition is provided by epithelium of epididymis.

**Sperm or Spermatozoon**

- Sperm is a microscopic structure composed of a head, neck, a middle piece and a tail. A plasma membrane envelops the whole body of sperm.
- The sperm head contains an elongated haploid nucleus, the anterior portion of which is covered by a cap-like structure, acrosome. It is derived from Golgi complex of the spermatid. Acrosome contains proteolytic and lysosomal enzymes popularly called sperm lysins, e.g., hyaluronidase, proteases, acid phosphatase. The surface of head contains adhesions (decapacitation factors) which have to be removed before it becomes capable of fertilising an ovum.
- The middle piece possesses numerous mitochondria, which produce energy for the movement of tail that facilitate sperm motility essential for fertilisation.

** Disorders of male reproductive system**

- **Prostatitis**
  - It is inflammation of prostate generally caused by infection. Prostatitis results in perineal or testicular discomfort, mild dysuria and symptoms of urinary obstruction.
- **Benign prostatic hypertrophy (BPH)**
  - This is the enlargement of the prostate gland. It compresses the urethra, causing frequent night urination (nocturia) or difficult or painful micturition.
- **Disorders of male reproductive system**
  - **Prostate carcinoma**
    - It is cancer of prostate. Some symptoms are dysuria, difficulty in voiding, increased frequency of urination or urinary retention.
- **Hydrocoele**
  - It is enlargement of testicle due to accumulation of fluid usually in tunica vaginalis.
- **Inguinal hernia**
  - Tearing of inguinal tissue may result in protrusion of a part of intestine into scrotum.
- **Impotence**
  - It is the inability of the adult male to achieve penile erection. It can be due to physiological, psychological or neuromuscular defects.
- **Sterility**
  - Sperms are unable to fertilise the ovum due to low count or less motility.
- **Cryptorchidism**
  - It is a failure of one or both of the testicles to descend into the scrotum. Cryptorchidism is caused by deficient secretion of testosterone by foetal testes. If spontaneous descent does not occur by the age of one year, hormonal injection is given. Retention of testes in the abdomen results in sterility.

**Intext Practice Questions**

1. Explain how blood-testis barrier provides a protective environment for sperm development?
2. Levels of testosterone regulate functioning of male reproductive system. Justify.
3. What is spermiogenesis and how does it take place?
**HUMAN SKELETON**

**CONCEPT MAP**

**AXIAL SKELETON**
- It lies along the longitudinal axis of the body, supports and protects the organs of the head, neck and trunk.
- It includes skull, vertebral column, sternum and ribs.

**APPENDICULAR SKELETON**
- It consists of the limbs, the pectoral and pelvic girdles and the bones of arms and legs.

**SKULL**
- Skull is the bony framework of the head.
- It consists of 29 bones, separated by sutures. These bones are cranial bones (8 flattened bones forming the brain box or cranium), facial bones (14 bones forming the front part of the skull), hyoid bone (single bone forming floor of the buccal cavity) and bones of middle ear (3 small bones and four coccygeal vertebrae).
- The bones of the cranium are: 1 frontal bone, 2 parietal bones, 2 temporal bones, 1 occipital bone, 1 sphenoid bone and 1 ethmoid bone.
- Temporal bone has a projection called mastoid process.
- The cranial has two small projections at the posterior end called occipital condyles, which articulate with the first vertebrae (atlas vertebra), thus, human skull is diocdylic.
- 14 bones form the skull of face viz. 2 zygomatic, 2 maxilla, 2 nasal, 2 lacrimal, 1 vomer, 2 palatine, 2 inferior nasal conchae and 1 mandible.
- The hyoid is a u-shaped bone which attaches tongue with the floor of buccal cavity. It does not articulate with any other bone.
- A large hole called foramen magnum at the base of skull allows the brain to continue into the spinal cord located in the backbone.
- Skull protects our brain, it bears jaws which help in mastication of food, etc.

**VERTEBRAL COLUMN**
- It is also called backbone or spine. It is curved, vertical rod, about 70 cm long, in the mid-dorsal line of the neck and trunk. It consists of 33 vertebrae. However it consists of 26 bones, because five sacral vertebrae are fused to form one sacrum and four coccygeal vertebrae are fused to form one coccyx.
- A typical vertebra has a large, disc-like anterior, flattened portion, the centrum or body and a posterior portion, the neural arch. The latter encloses the spinal cord. The hole formed by the neural arch is the vertebral foramen. The vertebral foramina of all twenty-four vertebrae form the vertebral canal or neural canal.
- Vertebrae are categorised into five groups: cervical (7), thoracic (12), lumbar (5), sacral (5) and coccygeal (4).
- Vertebral column displays four curves to enhance balancing powers and firmness for upright posture of the body. These curves are cervical, thoracic, lumbar and pelvic (=sacral).
- Between the centre of adjacent vertebrae there are elastic pads of fibrocartilage, the intervertebral discs which provide mobility to the vertebrae, check undue flexions and take up shocks.
- Vertebral column carries the weight of the body in motion and when the organism is standing up.

**STERNUM**
- This is a flat bone which is present just under the skin in the middle of the front of the chest. It is about 15 cm long.
- Its shape like a dagger and consists of three parts—the manubrium is the uppermost part, the body is the middle portion and the xiphoid process is the tip of the bone.
- The true ribs (7 pairs) are attached to the sternum.
- It protects the internal organs in the thoracic region and helps in the respiratory mechanism.

**RIBS**
- The ribs are thin, flat, curved bones that form a protective cage around the organs in the upper body.
- Ribs comprise of 24 bones arranged in 12 pairs. Each rib remains attached to the respective thoracic vertebra.
- The first seven pairs of ribs are attached directly with the sternum and are called true ribs. The 8th, 9th and 10th pairs of ribs do not articulate directly with sternum, but join the seventh rib by hyaline cartilage. These are called vertebrochondral ribs or false ribs. The last two (11th and 12th) pairs of ribs remain free anteriorly and are not attached either to sternum or cartilage of another ribs, and are called floating ribs.
- A typical rib consists of 2 parts: vertebral and sternal. The vertebral part is long and bony. It articulates with the thoracic vertebrae.
- The sternal part is short and cartilaginous. It articulates with the sternum or sternal part of its upper rib.

**PELVIC GIRDLE**
- Each pectoral girdle consists of two bones: 1 clavicle and 1 scapula. The scapula (shoulder blade) consists of a sharp ridge, the spine and a triangular body. The end of the spine projects as a flattened and expanded process called acromion. This process articulates with the clavicle.
- At the lateral end of the superior of the scapula is a projection of the anterior surface called the coracoid process, to which the tendons of the muscles attach. At the point where the superior and lateral borders of the scapula meet there is the lateral angle which presents a shallow articular surface termed as glenoid cavity into which the humerus is inserted.
- The primary function of the pectoral girdle is to provide an attachment point for the numerous muscles that allow the shoulder and elbow joints to move.

**FORELIMBS**
- Each arm has 30 bones, which constitute 1 humerus (upper arm), 1 radius and 1 ulna (lower arm), 8 carpals (wrist), 5 metacarpals (palm) and 14 phalanges (digits).
- The humerus is the longest bone in the upper extremity.
- At the bottom of the humerus, are two depressions where it connects to the ulna and radius of the forearm.
- Together, the humerus and the ulna make up the elbow, ulna is longer than the radius. Radius, however, contributes more to the movement of the wrist and hand than the ulna.
- Each wrist is composed of eight carpal bones which are arranged in two rows: scaphoid, lunate, triquetrum and pisiform in proximal row and trapezium, trapezoid, capitate and hamate in distal row.
- The forelimbs give support to the shoulders by articulating the head of the humerus with the glenoid cavity of the pectoral girdle.

**APPENDICULAR SKELETON**
- It is situated at the lateral sides which actually extend outwards from the principal axis.
- It consists of two girdles, the pectoral and pelvic girdles and the bones of arms and legs.

**PELLVIC GIRDLE**
- The pelvic girdle, also called the hip girdle, is composed of two coxal (hip) bones.
- The coxal bones are also called the osa coxae or inseminated bones.
- Each coxal bone consists of three separate parts: the ilium (short and straight bone), the ischium (lower elongated bone, running parallel to vertebral column) and the pubis (inner, smaller bone).
- On its outer surface it has a deep depression called the acetabulum which, with almost spherical head of the femur, forms the hip joint.
- It supports the weight of the body from the vertebral column. It also protects and supports the lower organs, including the urinary bladder, the reproductive organs, and the developing fetus in case of a pregnant woman.

**HINDLIMBS**
- Each leg has 30 bones which constitute 1 femur, 1 patella, 1 tibia, 1 fibula, 7 tarsals, 5 metatarsals and 14 phalanges.
- Femur, tibia and fibula bones together support the shank of the leg. The tarsals form the ankle, metatarsals form the sole and phalanges form the digits of the foot.
- The femur is the longest, largest, and strongest bone in the body whose head fits into the acetabulum of hip girdle.
- The tibia connects to the femur to form the knee joint and with the talus, a foot bone, to allow the ankle to flex and extend.
- The tibia is larger than the fibula because it bears most of the weight, while the fibula serves as an area for muscle attachment.
- The fibula is shorter, thinner and slender.
- Each ankle is composed of seven tarsals which are calcaneum, talus, cuboid, navicular and first, second, third cuneiforms.
- The leg bones carry the weight of the body and are involved in propulsion and support.
**FEMALE REPRODUCTIVE SYSTEM**

- The female reproductive system consists of a pair of ovaries, a pair of Fallopian tubes (oviducts), uterus, vagina, external genitalia or vulva and breasts. A pair of breasts or mammary glands are intergrated to it for child care. Out of these only ovaries are primary sex organs. Oviducts, uterus, cervix and vagina are female accessory ducts.

**Ovaries**

- Ovaries are the *primary sex organs* in human female. They are paired structures located in the upper pelvic cavity.
- Each ovary is held in place within peritoneal cavity by several ligaments. The **ovarian ligament** anchors the ovary medially to the uterus. The **suspensory ligament** anchors it laterally to the pelvic wall and **mesovarium** suspends it in between. Both suspensory ligament and the mesovarium are parts of broad ligament which supports uterine tubes, uterus and the vagina.

**Structure of the ovaries**

- Anatomically, it is differentiated into four parts—germinal epithelium, tunica albuginea, cortex and medulla.
  (i) **Germinal epithelium** is the outermost layer of the ovary which is formed of simple squamous and cuboidal cells. It forms oogonia in the foetus.
  (ii) **Tunica albuginea** is poorly differentiated sheath of dense connective tissue that lies below the germinal epithelium and outside the cortex. Tunica albuginea provides greyish colour to ovary.
  (iii) **Ovarian stroma** consist of dense outer layer called cortex and less dense inner portion the medulla.
- At birth, the ovaries contain an estimated total of 2 to 4 million oogonia (egg mother cells). No more oogonia are formed and added after birth.

**Follicular growth and atresia**

- Only one ovarian follicle matures and ovulates in an adult woman in every menstrual cycle, alternatively by the two ovaries. So, only 450 of the total follicles mature during the entire reproductive span. The rest of them degenerate at different times. The degenerating process is called **follicular atresia**. This is an example of programmed cell death or apoptosis.
- One result of this developmental pattern is that the eggs ovulated near age 50 are 35 to 40 years older than those ovulated just after puberty. It is possible that certain chromosomal defects or abnormalities common among children born to older women are the result of ageing changes in the eggs.

**Follicular development**

- During foetal life, all the oogonia develop into primary oocytes, which then begin a first meiotic division by replicating their DNA. They do not, however, complete the division in the fetus.
- Accordingly, all the eggs present at birth are primary oocytes containing 46 chromosomes, each with two sister chromatids. The cells are said to be in a state of meiotic arrest.
- This state continues until puberty and the onset of renewed activity in the ovaries.

Only those primary oocytes destined for ovulation complete the first meiotic division which occurs just before the mature follicle is ovulated. The second meiotic division occurs in Fallopian tube after ovulation, but only if the secondary oocyte is fertilised *i.e.*, penetrated by a sperm.

- The dormant primary oocyte, in the ovary of a newborn female, is surrounded by a single layer of squamous follicular cells. This
dormant follicle is called the **primordial follicle**. It remains like this (the primary oocyte is arrested at the diplotene of the first meiotic division) till the onset of puberty.

- At puberty, oogenesis is resumed. The squamous follicular cells around the primary oocyte become cuboidal. This follicle is known as **primary follicle**.
- In the primary follicle, development proceeds, the follicular cells keep dividing to form several layers around the primary oocyte and at this stage these cells are known as the granulosa cells.
- The primary oocyte secretes an acellular glycoprotein layer that the oocyte is suspended in this fluid-filled cavity by a stalk of granulosa cells. At this stage the follicle is known as an **antral follicle** or the **secondary follicle**.
- Around the granulosa cells connective tissue of ovarian stroma get differentiated into two layers: a vascular theca interna and a fibrous theca externa.
- Blood vessels in the thecal layer cannot transverse the membrane so the granulosa layer is completely avascular.
- The antrum keeps enlarging with the developing oocyte so that the oocyte is suspended in this fluid-filled cavity by a stalk of granulosa cells surrounding this oocyte. These are known as the cumulus oophorous.
- The innermost layer of granulosa cells around the zona pellucida consists of columnar cells and is known as the **corona radiata**.

**Dominant follicle**

The progression of some primordial follicles to the preantral and early antral stages occurs throughout infancy and childhood, and then during the entire menstrual cycle. Therefore, although most of the follicles in the ovaries are still primordial, nearly constant number of preantral and early antral follicles are also always present. At the beginning of each menstrual cycle, 10 to 25 of these preantral and early antral follicles begin to develop into larger antral follicles. About one week into the cycle, a further selection process occurs: only one of the larger antral follicles, the dominant follicle, continues to develop. The exact process by which a follicle is selected for dominance is not known, but it is likely related to the amount of estrogen produced locally within the follicle. (This is probably why hyperstimulation of infertile women with gonadotropin injections can result in the development of many follicles.) The nondominant follicles (in both ovaries) that had begun to enlarge undergo atresia.

**Ovulation**

- The fully formed mature dominant follicle with a large antrum is called Graafian follicle. It has a primary oocyte, which is still in meiotic arrest. Just before ovulation this primary oocyte completes its first meiotic division to form a haploid secondary oocyte and a polar body.
- Only meiosis I is complete, meiosis II is initiated but arrested at the metaphase stage.
- This secondary oocyte, along with its cumulus oophorous, is released in the peritoneal cavity at ovulation from where it is picked up by the fimbriae of the oviduct.
- The ovulated secondary oocyte is carried into the Fallopian tube where fertilisation occurs.
- The remnants of the ovulated follicle in the ovary form the corpus haemorrhagicum that has a blood clot in the centre due to rupture of the blood vessels supplying the thecal layer.
- This clot is dissolved later and the granulosa and thecal cells of the ruptured follicle are transformed and converted into lutein cells having yellow carotene pigment or lutein. These transformed cells form corpus luteum which secretes the hormones progesterone and estrogen.
- The corpus luteum is maintained for about 20 days.
- If fertilisation occurs and a conceptus is formed, the corpus luteum receives a signal from the conceptus and the corpus luteum is maintained for a long time to support pregnancy.
- In the absence of any such signal from the conceptus, the corpus luteum degenerates. This degenerating corpus luteum is known as the corpus albicans.
The function of the Fallopian tube is to convey the ovum from the ovary to the uterus. It is done by peristalsis. Fertilisation of the ovum generally takes place in the upper portion of the Fallopian tube (ampulla).

Each Fallopian tube (10-20 cm) consists of the parts as shown in the flowchart. The walls of the uterus are composed of three layers of tissues. The perimetrium is an outer thin covering of peritoneum. The myometrium is a middle thick layer of smooth muscle fibres which shows strong contraction during delivery of the baby. The endometrium is inner glandular layer that lines the uterine cavity. It is the endometrium that undergoes cyclical changes during menstrual cycle.

Morphologically uterus is differentiated into three regions fundus, body and cervix.

The vagina is a tube, about 10 cm long, that extends from the cervix to the outside of the body. It provides a passage for the menstrual flow, serves as the receptacle for sperm.
during intercourse, and forms part of the birth canal during labour.

- The opening of the vagina is called the **vaginal orifice**. It is partially covered in virgins by a perforate membrane called **hymen**. It often gets ruptured during vigorous physical exercise. In some it persists even after coitus. Therefore, its presence or absence is not a reliable proof of virginity.

**External genitalia**

- The female external genitalia include the **mons pubis**, **labia majora**, **labia minora**, **clitoris**, **vestibule of the vagina**, and **vestibular glands**. External genitalia are collectively called **vulva**.
- The **mons pubis** is the rounded fatty prominence over the junction of the pubic bones.
- The **labia majora**, the female homologue of the scrotum, are two prominent skin folds that form the outer lips of the vulva.
- The **labia minora** are small skin folds lying under the labia majora. They surround the urethral and vaginal openings, and the area thus enclosed is the vestibule.
- The **vaginal opening** lies behind the opening of the urethra.
- The **clitoris**, the female homologue of the penis, is an erectile structure located at the top of the vulva.

**Female accessory glands**

(i) **The lesser vestibular glands (Paraurethral glands or glands of Skene):** These are numerous minute glands that are present on either side of the urethral orifice (opening). These glands are homologous to the male prostate and secrete mucus.

(ii) **The greater vestibular glands (Bartholin’s glands):** They are a pair of small glands occurring one on each side of the vaginal opening. Secretion of this gland is thick, viscid and alkaline for lubrication during copulation and counteracting the urinary acidity. They correspond to Cowper’s gland.

**Mammary glands**

- Mammary glands or breasts are the modified sweat glands that lie over the pectoral muscles. They are also present in males but in a rudimentary form.
- Each breast has a broad **multiporous tip** called **nipple** for the release of milk. A circular pigmented area called **areola** is present around it.
- Internally, each breast consists of **15-25 lobes** that radiate around and open at the nipple.
- Within lobes of each mammary gland are present smaller unit called **lobules**, which contain glandular **alveoli** that produce milk in lactating woman.
- The alveoli open into **mammary tubules**. The tubules of each lobe join to form a **mammary duct**. Several mammary ducts join to form a wider **mammary ampulla** which is connected to lactiferous duct through which milk is sucked out.
- During pregnancy, the glands grow under the influence of oestrogen and progesterone. On the infant’s birth, the hormone **prolactin stimulates the production of milk** and the hormone **oxytocin causes release of milk** as the infant sucks the breast. After menopause, the glands atrophy.

**Hormonal control of female reproductive system**

- GnRH secreted by hypothalamus stimulates secretion of LH and FSH from anterior pituitary.
- FSH stimulates growth of the ovarian follicles and formation of estrogen.
- LH stimulates corpus luteum to secrete progesterone.
- Rising level of progesterone inhibits the release of GnRH, which, in turn, inhibits the production of FSH, LH and progesterone.
Gametogenesis in females

- The process of development and maturation of ovum is known as oogenesis.
- It consists of three phases: multiplication, growth and maturation phase.

Multiplication phase

- During multiplication phase, the cells of germinal epithelium divide and detach to produce oogonia.
- The oogonia multiply by mitotic divisions and project into the stroma as a cord, the egg tube of Pfluger, which later becomes a round mass, the egg nest. One cell in the egg nest grows and becomes the primary oocyte.
- Primary oocytes are diploid cells containing the same number of chromosomes as in the parent somatic cells. The primary oocytes cease to divide and enter the growth phase.

Growth phase

- This phase of the primary oocyte is very long. It may extend over many years.
- There is accumulation of food materials and other resources for nourishment of the oocyte.
- Meiosis begins in the primary oocytes soon after their formation. However, the oocytes are arrested in the early part of meiotic phase I (diplotene stage). This is the first resting stage. They undergo a round of DNA synthesis, and chromosome pairing takes place, but meiosis does not proceed further until years later.

Maturation phase

- After primary oocyte has finished its growth, there is two specialised nuclear divisions, first one of which is the reductional division.
- Beginning of puberty, a small number of primary oocytes are activated each month. However, only one continues meiosis I, producing two haploid cells of dissimilar size.
- The smaller cell is called first polar body and larger cell is called secondary oocyte.
- The secondary oocyte proceeds with meiosis II but the division gets arrested in metaphase II stage. This is the second resting stage. This is due to an activity called cytostatic factor which maintains arrest through preventing loss of Maturation Promoting Factor (MPF).
- MPF is a protein in cell cycle which stimulates M-phase of cell cycle.
- It is in this stage of oocyte that the ovum is shed during ovulation. It passes into oviduct, where in the ampulla part, cell cycle will resume only after the entry of sperm.
Ca²⁺ rise initiated by fertilising sperm results in degradation of regulatory unit of MPF through Anaphase Promoting Complex (APC) thus promoting completion of cell cycle.

- The first polar body may divide to form two-second polar bodies. Thus from one oogonium, one ovum and three polar bodies are formed.
- The ovum, is the actual female gamete. The polar bodies take no part in reproduction and soon degenerate due to lack of cytoplasm and food. The formation of non-functional polar bodies enables the egg to get rid of excess chromosomes.

**Menstrual cycle**

- The first menstruation begins at puberty and is called menarche. In human females, menstruation is repeated at an average interval of about 28/29 days, and the cycle of events starting from one menstruation till the next one is called menstrual cycle.
- The menstrual cycle can be functionally divided into four phases.
  
  **Menstrual phase**

- It lasts for roughly five days. The first day of menstruation marks day one of new cycle.
- Following the peak of activity on about Day 21, the corpus luteum regresses so that by Day 1 its hormonal production is greatly reduced.
- This rapid estradiol and progesterone (secreted by corpus luteum) withdrawal induces changes in endometrium.
- Blood vessels rupture, causing bleeding. The cast off uterine tissues, blood that oozes from the ruptured endometrial blood vessels, and tissue fluid from the endometrial surface pass out through the vaginal opening. This process is called menstruation, or menstrual flow which continues for 3-5 days.
- Lowered levels of progesterone and estradiol also cause release of FSH from the anterior pituitary. This initiates a new cycle.

**Follicular phase or proliferative phase**

- Reduced concentration of ovarian and gonadotropin hormones, stimulate the hypothalamus to produce GnRH.
- It activates anterior pituitary to produce gonadotropins. In the presence of FSH 6–12 ovarian follicles begin enlargement

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**Why is the timing of gametogenesis different in males and females?**

After primordial germ cells enter genital ridge (the area in vertebrate embryo that develops into gonads), they stop migration, undergo 2-3 further rounds of mitosis and enter a pre-meiotic stage. In the male genital ridge, sperms reverse this process and arrest. But in the female genital ridge, they enter meiotic prophase as primary oocyte and progress through meiosis until diplote stage, at this time, they arrest. It is suggested that all germ cells, regardless of their chromosomal constitution, are programmed to develop as oocytes and the timing of meiosis seems to be a cell-autonomous property. However, in males, the genital ridge prevents prenatal entry into meiosis. This can be because of a male meiosis inhibitor produced by Sertoli cells.

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**Fig:** Flow chart depicting gametogenesis in females.
through proliferation of their granulosa cells, addition of thecal covering on the outside.

- The FSH stimulates ovarian follicle to secrete estrogen. Estrogen stimulates the proliferation of the endometrium of the uterine wall.
- After about a week of development only one ovarian follicle (dominant follicle) continues growth while the rest begin to degenerate.
- New blood capillaries develop. Uterine glands elongate and get coiled. Epithelial lining of oviduct develops more cilia. The activity of secretory cells is enhanced. Muscles of the genital tract become more active. Cervix develops mucous strings which form channels for guiding movements of sperms.

**Ovulatory phase**
- The rapid rise in plasma LH level, known as the LH surge leads to final maturation of Graafian follicle.
- Follicle ruptures and a secondary oocyte is released on about Day 14.
- Shortly after onset of midcycle LH surge, plasma estradiol levels drop and a further rise in plasma progesterone occurs.

**Luteal phase or secretory phase**
- It represents time between ovulation and the onset of next menses.
- Following ovulation, LH stimulates the remnants of ovulated follicle to develop into corpus luteum, which secretes progesterone and some estradiol.
- Both LH and progesterone help in further growth and thickening of endometrium. The major change is that the endometrial glands become secretory. Thickness of endometrium becomes 5-6 mm.
- The uterine wall becomes ready for nourishing and anchoring blastocyst if fertilisation takes place.
- Progesterone inhibits uterine movements as well as proliferation of new ovarian follicles. The phase lasts for about 10 days. If the oocyte is not fertilised, corpus luteum activity declines and it degenerates into corpus albicans.
- With decrease in ovarian hormones, release of GnRH, FSH, and LH occurs due to loss to of negative feedback suppression by ovarian hormones. This resumes follicular growth.

**Menopause**
- Menopause is a phase in woman’s life when ovulation and menstruation stop. During this condition, ovaries fail
to respond or may be resistant to FSH. In this case FSH levels are very high and the estrogen level very low. It occurs between 45 to 55 years (in some individuals it is between 40 to 50 years).

Table 1: Phases of menstrual cycle

<table>
<thead>
<tr>
<th>Phases</th>
<th>Days</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menstrual phase</td>
<td>1st-5th</td>
<td>Endometrium breaks down, menstruation begins. The cells of endometrium, secretions, blood and the unfertilised ovum constitute the menstrual flow. Progesterone production is reduced.</td>
</tr>
<tr>
<td>Follicular phase</td>
<td>6th-13th</td>
<td>Endometrium rebuilds, FSH secretion and estrogen’s secretion increase.</td>
</tr>
<tr>
<td>Ovulatory phase</td>
<td>14th</td>
<td>Both LH and FSH attain a peak level. Concentration of estrogen in the blood is also high and reaches its peak. Ovulation occurs.</td>
</tr>
<tr>
<td>Luteal phase (Secretory phase)</td>
<td>15th-28th</td>
<td>Corpus luteum secretes progesterone. Endometrium thickens and uterine glands become secretory.</td>
</tr>
</tbody>
</table>

- Since there are no developing follicles, the supply of estrogen and progesterone is reduced. This may lead to temporary depression, hot flushes and other physiological and psychological problems in menopause.

- Other common symptoms are fatigue, vaginal dryness and softening of bones due to loss of minerals particularly calcium.

- Menstrual cycle is controlled by FSH, LH, estrogen and progesterone.
- Dysmenorrhoea is painful menses.
- Menorrhagia is excessive menstruation.
- Oligomenorrhoea is sparse or infrequent menstruation.
- Amenorrhoea is non-occurrence of menses.
- Oestrus cycle is a series of cyclic changes that are found in the ovaries, reproductive tract and hormones of female nonprimate mammals, e.g., cows, dogs, cats, horse, buffalo. During this period the female receives the male. At the end of oestrus, the lining of reproductive tract is sloughed off. However, there is no menstruation. The sloughed off tissues are absorbed. Oestrus is followed by a passive period called anoestrus.

Disorders of female reproductive system

- Breast cancer
  - Breast cancer is rarely seen before the age of thirty. Its incidence increases after menopause.

- Cervical cancer
  - It is relatively slow-growing cancer. Its main risk is that it is unnoticed until it has invaded other tissues.

- Infertility
  - Infertility in women is the inability to become pregnant. It may be due to failure to ovulate or to some anatomical factor that prevents the union of egg and sperm.

- Endometriosis
  - It is the growth of endometrial tissue outside the uterus. Symptoms include premenstrual pain or unusual menstrual pain.

- Oophoritis
  - It is inflammation of ovary, usually caused by an infection.

- Oophorocystosis (Ovarian cysts)
  - Ovarian cysts are fluid filled tumours of the ovary. Such cysts sometimes rupture and regress (get smaller) during pregnancy.

- Ectopic pregnancy
  - It is implantation of embryo at a place other than uterus, generally in the oviduct.

Intext Practice Questions

4. Why children born to older women have high chances of chromosomal abnormality?
5. What is the role of granulosa cells in female reproductive system?
1. How many days does it take for spermatogenesis to take place?
   (a) 40 to 65 days  (b) 60 to 75 days  
   (c) 70 to 95 days  (d) 50 to 65 days
2. Sperms of an animal species 'A' cannot normally fertilise the ovum of another species 'B' because
   (a) fertilizin of 'A' and 'B' are not compatible  
   (b) antifertilizin of 'A' and fertilizin of 'B' are not compatible  
   (c) fertilizin of 'A' and antifertilizin of 'B' are not compatible  
   (d) none of these.
3. Onset of menstruation is due to
   (a) increase in level of progesterone  
   (b) increase in oestrogen level  
   (c) increase in FSH level  
   (d) decrease in oxytocin level.
4. Antrum is the cavity of
   (a) gastrula  (b) Graafian follicle  
   (c) ovary  (d) blastula.
5. Which one of the following events is correctly matched with the time period in a normal menstrual cycle?
   (a) release of egg : 5th day  
   (b) Endometrium regenerates : 5-10 days  
   (c) Endometrium secretes nutrients for implantation: 11-18 days  
   (d) Rise in progesterone level : 1-15 days
6. The function of the secretion of prostate gland is to
   (a) inhibit sperm activity  (b) attract sperms  
   (c) stimulate sperm activity  (d) none of these.
7. Ovulation in the human female normally takes place
   (a) at the mid secretory phase  
   (b) just before the end of the secretory phase  
   (c) at the beginning of the proliferative phase  
   (d) at the end of the proliferative phase.
8. The phase of menstrual cycle in humans that last for 7-8 days, is
   (a) follicular phase  (b) ovulatory phase  
   (c) luteal phase  (d) menstruation.
9. Which of these combinations is most likely to be present before ovulation occurs?
   (a) FSH, corpus luteum, estrogen, secretory uterine lining  
   (b) LH, corpus luteum, progesterone, secretory uterine lining  
   (c) FSH, follicle, estrogen, uterine lining becoming thick  
   (d) Luteinising hormone (LH), follicle, progesterone, thick uterine lining
10. In human females, meiosis-II is not completed until
    (a) uterine implantation  (b) birth  
    (c) puberty  (d) fertilisation.
11. If for some reason, the vasa efferentia in the human reproductive system get blocked, the gametes will not be transported from
    (a) testes to epididymis  (b) epididymis to vas deferens  
    (c) ovary to uterus  (d) vagina to uterus.
12. Sequence of hormones during menstrual cycle is
    (a) estrogen, progesterone and FSH  
    (b) progesterone, estrogen and FSH  
    (c) FSH, estrogen and progesterone  
    (d) FSH, progesterone and estrogen.
13. Which of the following statements is wrong?
    (a) Sertoli cells provide nutrition to the developing male germ cells.  
    (b) Leydig cells synthesise and secrete androgens.  
    (c) Secretions of the acrosome helps the sperm to enter into the cytoplasm of the ovum.  
    (d) Secondary spermatocytes are diploid.
14. The figure shows a section of human ovary. Select the option which gives the correct identification of either A or B with function/characteristic.
    (a) B- Corpus luteum - secretes progesterone  
    (b) A- Tertiary follicle - forms Graafian follicle  
    (c) B- Corpus luteum - secretes estrogen  
    (d) A- Primary oocyte - it is in the prophase-I of the meiotic division
15. In spermatogenesis, reduction division of chromosome occurs during conversion of
    (a) spermatogonia to primary spermatocytes  
    (b) primary spermatocytes to secondary spermatocytes  
    (c) secondary spermatocytes to spermatids  
    (d) spermatids to sperms.

**ANSWER KEY**
1. (b)  2. (b)  3. (a)  4. (b)  5. (b)  
6. (c)  7. (d)  8. (a)  9. (c)  10. (d)  
11. (a)  12. (c)  13. (d)  14. (a)  15. (b)
1. The sequence of nitrogenous bases in one strand of DNA are 3’ TAC GCG ACG 5’. The complementary DNA strand should have
   (a) 5’ AUG CGC TGC 3’  
   (b) 3’ ATG CGC TGC 5’
   (c) 5’ UAC GCG ACG 3’  
   (d) 5’ ATG CGC TGC 3’

2. Match the entries in Column I with those of Column II and choose the correct answer.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Restriction endo-</td>
<td>(i) Kohler and Milstein</td>
</tr>
<tr>
<td>nuclease</td>
<td></td>
</tr>
<tr>
<td>B. Polymerase chain</td>
<td>(ii) Alec Jeffreys</td>
</tr>
<tr>
<td>reaction</td>
<td></td>
</tr>
<tr>
<td>C. DNA fingerprinting</td>
<td>(iii) Arber</td>
</tr>
<tr>
<td>D. Monoclonal antibodies</td>
<td>(iv) Kary Mullis</td>
</tr>
<tr>
<td>(a) A-(iii), B-(iv), C-(ii), D-(i)</td>
<td></td>
</tr>
<tr>
<td>(b) A-(iii), B-(ii), C-(iv), D-(i)</td>
<td></td>
</tr>
<tr>
<td>(c) A-(ii), B-(iii), C-(iv), D-(i)</td>
<td></td>
</tr>
<tr>
<td>(d) A-(ii), B-(iv), C-(iii), D-(ii)</td>
<td></td>
</tr>
</tbody>
</table>

3. Match Column I with Column II and select the correct option.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Ascomycetes</td>
<td>(i) Ustilago</td>
</tr>
<tr>
<td>B. Phycomycetes</td>
<td>(ii) Saccharomyces</td>
</tr>
<tr>
<td>C. Basidiomycetes</td>
<td>(iii) Trichoderma</td>
</tr>
<tr>
<td>D. Deuteromycetes</td>
<td>(iv) Albugo</td>
</tr>
<tr>
<td>(a) A-(ii), B-(i), C-(iv), D-(iii)</td>
<td></td>
</tr>
<tr>
<td>(b) A-(iv), B-(iii), C-(ii), D-(i)</td>
<td></td>
</tr>
<tr>
<td>(c) A-(ii), B-(iv), C-(i), D-(ii)</td>
<td></td>
</tr>
<tr>
<td>(d) A-(iii), B-(iv), C-(i), D-(ii)</td>
<td></td>
</tr>
</tbody>
</table>

4. Given below is a simplified model of phosphorus cycling in a terrestrial ecosystem with four blanks (A-D). Identify the blanks.

   - Consumers
   - A
   - B
   - Soil solutions
   - Uptake
   - Run off
   - C
   - D

5. Match the microbial products listed under Column I with the related microbes given under Column II. Choose the appropriate option from the given choices.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Citric acid</td>
<td>(i) Methanobacterium</td>
</tr>
<tr>
<td>B. Cyclosporin A</td>
<td>(ii) Monascus purpureus</td>
</tr>
<tr>
<td>C. Statin</td>
<td>(iii) Aspergillus niger</td>
</tr>
<tr>
<td>D. Gobar gas</td>
<td>(iv) Trichoderma polysporum</td>
</tr>
<tr>
<td>(v) Clostridium butylicum</td>
<td></td>
</tr>
<tr>
<td>(a) A-(ii); B-(iv); C-(i); D-(iii)</td>
<td></td>
</tr>
<tr>
<td>(b) A-(iii); B-(iv); C-(ii); D-(i)</td>
<td></td>
</tr>
<tr>
<td>(c) A-(iii); B-(iv); C-(i); D-(v)</td>
<td></td>
</tr>
<tr>
<td>(d) A-(v); B-(vi); C-(iv); D-(iii)</td>
<td></td>
</tr>
</tbody>
</table>

6. During which phase(s) of cell cycle, amount of DNA in a cell remains at 4C level if the initial amount is denoted as 2C?

   (a) G₀ and G₁ 
   (b) G₁ and S 
   (c) G₂ 
   (d) G₂ and M

7. Match the following and choose the correct combination from the options given.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical compounds</td>
<td>Example</td>
</tr>
<tr>
<td>A. Nitrogen base</td>
<td>(i) RNA</td>
</tr>
<tr>
<td>B. Nucleoside</td>
<td>(ii) Thymidylic acid</td>
</tr>
<tr>
<td>C. Nucleotide</td>
<td>(iii) Cytidine</td>
</tr>
<tr>
<td>D. Nucleic acid</td>
<td>(iv) Uracil</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Nitrogen base</td>
<td>(i) RNA</td>
</tr>
<tr>
<td>B. Nucleoside</td>
<td>(ii) Thymidylic acid</td>
</tr>
<tr>
<td>C. Nucleotide</td>
<td>(iii) Cytidine</td>
</tr>
<tr>
<td>D. Nucleic acid</td>
<td>(iv) Uracil</td>
</tr>
</tbody>
</table>

   (a) A-(iv); B-(ii); C-(i); D-(v)
8. Which of the following characters are not applicable to the anatomy of dicot stem and choose the correct statements given below?
A. Collenchymatous hypodermis
B. Exarch xylem
C. Pith is absent
D. Open vascular bundle
E. Presence of medullary rays
Of these
(a) A, D and E only (b) B and C only
(c) B and E only (d) A, B and C only

9. In dicotyledonous stem, which of the following is the sequence of tissues from inside to outside?
(a) Pith, phloem, cambium, protoxylem, metaxylem, pericycle, parenchyma, collenchyma, endodermis and epidermis
(b) Pith, cambium, phloem, protoxylem, metaxylem, pericycle, endodermis, parenchyma, collenchyma and epidermis
(c) Pith, phloem, protoxylem, metaxylem, cambium, pericycle, endodermis, parenchyma, collenchyma and epidermis
(d) Pith, protoxylem, metaxylem, cambium, phloem, pericycle, endodermis, parenchyma, collenchyma and epidermis

10. The kind of coelom represented in the diagram given below is characteristic of
(a) round worm  (b) earthworm
(c) tape worm  (d) cockroach.

11. Identify the given figure and select the correct option.
(a) Neutrophil - phagocytic cell which destroy foreign organisms entering the body.
(b) Eosinophil - their number increases during allergic infection.
(c) Lymphocyte - small sized non-motile and non-phagocytic.
(d) Monocyte - motile and phagocytic in nature.

12. Which of the following groups of algae belongs to Class Rhodophyceae?
(a) Laminaria, Fucus, Porphyra, Volvox
(b) Gelidium, Porphyra, Dictyota, Fucus
(c) Gracilaria, Gelidium, Porphyra, Polysiphonia
(d) Volvox, Spirogyra, Ulithrix, Sargassum

13. Read the following statements and identify the correct options given.
A. Angiosperms range in size from microscopic Wolffia to tall trees of Eucalyptus.
B. In angiosperms, the seeds are enclosed by fruits.
C. Double fertilisation is an event unique to angiosperms.
D. In angiosperms, each cell of an embryo sac is diploid.
E. In angiosperms, the zygote develops into an endosperm.
Of the above statements
(a) A, B and D alone are correct.
(b) A, B and E alone are correct.
(c) A, B and C alone are correct.
(d) B, C and D alone are correct.

14. Refer the given figure of nephron.
Identify A, B, C and D and select the correct option regarding them
(a) A-Glomerulus - a tuft of capillaries formed by afferent arteriole.
(b) B-PCT-reabsorption of HCO$_3^-$ and selective secretion of H$^+$ and K$^+$ occurs here.
(c) C-DCT-almost all glucose, amino acids, water, Na$^+$, K$^+$ and uric acid are absorbed here.
(d) D-Collecting duct-extends from the cortex of the kidney to the inner parts of medulla. Large amount of water is secreted in this region.

15. Choose the wrongly matched pair.
(a) Portion of myofibril  - Sarcomere between two ‘Z’ lines
(b) Isotropic band  - Actin
(c) Anisotropic band  - Myosin
(d) Central part of I-band  - M-line

16. Which of the following statement(s) about taxonomical aids is/are true?
I. Keys are used to identify plants and animals based on similarities and dissimilarities.
II. Flora contains the account of habitat and distribution of plants in a given area.

III. Flora provides an index to the plant species found in a particular area.

IV. Monographs provide information for identifying the species found in an area.

(a) I and II only  (b) I, II and III only
(c) I and IV only  (d) I only

17. Match the mineral in column I with the enzyme activated by it in column II and choose the correct option.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Magnesium</td>
<td>I. Alcohol dehydrogenase</td>
</tr>
<tr>
<td>B. Molybdenum</td>
<td>II. Phosphoenol pyruvate carboxylase</td>
</tr>
<tr>
<td>C. Zinc</td>
<td>III. Nitrogenase</td>
</tr>
</tbody>
</table>

(a) A - II, B - II, C - I
(b) A - I, B - II, C - III
(c) A - II, B - I, C - III
(d) A - III, B - II, C - I

18. A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind?

(a) 25%  (b) 0%
(c) 50%  (d) 75%

19. If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain?

Plant → Mice → Snake → Peacock

(a) 0.02 J  (b) 0.002 J
(c) 0.2 J  (d) 0.0002 J

20. Label the parts marked in the human skull and select the correct option.

(a) A - temporal bone; B - parietal bone; C - sphenoid bone; D - frontal bone; E - zygomatic bone; F - occipital bone
(b) A - frontal bone; B - zygomatic bone; C - occipital bone; D - sphenoid bone; E - parietal bone; F - temporal bone
(c) A - sphenoid bone; B - occipital bone; C - zygomatic bone; D - parietal bone; E - frontal bone; F - temporal bone
(d) A - sphenoid bone; B - zygomatic bone; C - occipital bone; D - frontal bone; E - temporal bone; F - parietal bone

21. Match the items listed under column-I with those given under column-II. Choose the appropriate option from the given choices.

<table>
<thead>
<tr>
<th>Column-I</th>
<th>Column-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Residual volume (RV)</td>
<td>p. 4000 mL - 4600 mL</td>
</tr>
<tr>
<td>B. Inspiratory Reserve Volume (IRV)</td>
<td>q. 1100 mL - 1200 mL</td>
</tr>
<tr>
<td>C. Vital capacity (VC)</td>
<td>r. 1000 mL - 1100 mL</td>
</tr>
<tr>
<td>D. Expiratory Reserve Volume (ERV)</td>
<td>s. 3000 mL - 3500 mL</td>
</tr>
<tr>
<td>E. Inspiratory capacity (IC)</td>
<td>t. 2500 mL - 3000 mL</td>
</tr>
</tbody>
</table>

(a) t q s r p  (b) q r s t p  (c) q t r s p  (d) r p q s t

22. Which of the following is correct?

(a) Population change = (Birth + immigration) – (death + emigration)
(b) Population change = (Birth + immigration) + (death + emigration)
(c) Population change = (Birth + emigration) + (death – immigration)
(d) Population change = (Birth – immigration) – (death + emigration)

23. In this diagram showing the L.S. of an embryo of grass, identify the answer having the correct combination of alphabets with the right part.

(a) A - Epiblast, B - Scutellum, C - Coleoptile, D - Radicle, E - Coleorhiza, F - Shoot apex
(b) A - Root cap, B - Coleoptile, C - Scutellum, D - Coleorhiza, E - Epiblast, F - Shoot apex
(c) A - Epiblast, B - Radicle, C - Coleoptile, D - Scutellum, E - Coleorhiza, F - Shoot apex
(d) A - Shoot apex, B - Epiblast, C - Coleorhiza, D - Scutellum, E - Coleoptile, F - Radicle

24. Given is the diagrammatic representation of the sectional view of cochlea. Select the correct option regarding it.

(a) A - Organ of corti-responsible for maintenance of balance of the body and posture.
(b) B - Scala vestibuli-filled with endolymph that ends at the oval window.
(c) C - Scala tympani - terminates at the round window which opens to the middle ear.
(d) D - Basilar membrane - nerve impulses are generated against it.

25. Identify the hormones 'A', 'B' and 'C' that are labelled in the given flow chart.

```
Hypothalamus
   |   |
   A   B
   \   |
       Pituitary
          |
         Ovary
         |
       C
   |

(a) A-GnRH,  B-PRL,  C-ICSH
(b) A-GnRH,  B-ICSH,  C-ISH
(c) A-GnRH,  B-FSH,  C-LH
(d) A-GH,  B-FSH,  C-LH
```

26. The figure shows blood circulation in humans with labels A to D. Select the option which gives correct identification of label and functions of the part.

```
A
   |
   B
   |
   C
D

(a) B - Capillary-Thin without muscle layer and wall two cell layers thick.
(b) C - Vein-Thin walled and blood flows in jerks/spurts
(c) D - Pulmonary vein-Takes oxygenated blood to heart, \( P_{O_2} = 95 \text{ mmHg} \)
(d) A - Artery-Thick walled and blood flows evenly
```

27. Match the items in Column I with those in Column II, and choose the correct answer.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Control of weeds</td>
<td>(i) Gibberellin</td>
</tr>
<tr>
<td>B. Induction of germination</td>
<td>(ii) Cytokinin</td>
</tr>
<tr>
<td>C. Ripening of fruit</td>
<td>(iii) 2, 4-D</td>
</tr>
<tr>
<td>D. Delaying of senescence</td>
<td>(iv) Ethylene</td>
</tr>
</tbody>
</table>

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

28. Select the plants pollinated by water.

A. Water hyacinth  B. Zostera
C. Amorphophallus  D. Vallisneria
E. Yucca

(a) A, D and E only
(b) B and E only
(c) B and D only
(d) B, C and D only

29. Out of 38 molecules of ATP produced upon aerobic respiration of glucose, the break up in ATP production in glycolysis (P), pyruvate to acetyl-CoA formation (Q) and Krebs’ cycle (R) is as follows:

(a) P = 2, Q = 6, R = 30
(b) P = 8, Q = 6, R = 24
(c) P = 8, Q = 10, R = 20
(d) P = 2, Q = 12, R = 24

30. Identify the DNA segment which is not a palindromic sequence.

(a) 5’GGATCC 3’
(b) 5’GAATTC 3’
(c) 5’GGGGGCGG 3’
(d) 5’CCCGGG 3’

31. The figure shows a section of human ovary. Select the option which gives the correct identification of either A or B with function/characteristic.

```
A
   |
   B
   |
```

(a) B- Corpus luteum - Secretes progesterone
(b) A- Tertiary follicle - Forms Graafian follicle
(c) B- Corpus luteum - Secretes testosterone
(d) A- Primary oocyte - It is in the prophase-I of the meiotic division

32. Put the following parts of a reflex arc in the correct order beginning with the sensory receptor.

A. Motor neuron  B. Interneuron
C. Effector      D. Sensory neuron
E. Sensory receptor.

(a) E, D, B, A, C  (b) E, D, A, B, C
(c) A, B, C, D, E  (d) A, E, D, B, C
33. Find the wrongly matched pair.
   (a) Endemism - Species confined to one region and not found anywhere else
   (b) Hotspots - Regions with species richness
   (c) Alien species to India - *Clarias gariepinus*
   (d) *In situ* conservation - IVF

34. Select the option which correctly matches the endocrine gland with its hormone and its function.

<table>
<thead>
<tr>
<th>Endocrine</th>
<th>Hormone</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Placenta</td>
<td>Estrogen</td>
<td>Initiates secretion of the milk</td>
</tr>
<tr>
<td>(b) Corpus luteum</td>
<td>Estrogen</td>
<td>Essential for maintenance of endometrium</td>
</tr>
<tr>
<td>(c) Leydig's cells</td>
<td>Androgen</td>
<td>Initiates the production of sperms</td>
</tr>
<tr>
<td>(d) Ovary</td>
<td>FSH</td>
<td>Stimulates follicular development and the secretion of estrogens</td>
</tr>
</tbody>
</table>

35. Some of the steps of DNA fingerprinting are given below. Identify the correct sequence from the options given.

A. Electrophoresis of DNA fragments
B. Hybridisation with DNA probe
C. Digestion of DNA by RENs
D. Autoradiography
E. Blotting of DNA fragments to nitrocellulose membrane

(a) C – A – B – E – D  (b) C – A – E – B – D
(c) A – E – C – B – D  (d) A – C – E – D – B

36. Which of the following is not vestigial organ in human beings?

(a) Rudimentary ear muscles and third molars
(b) Coccygeal (tail) vertebrae and scalp muscles
(c) Vermiform appendix and nictitating membrane of the eye
(d) Ear pinna, patella, olecranon process

37. Some of the steps of DNA fingerprinting are given below. Identify the correct sequence from the options given.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Phylum</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parapodia</td>
<td>Annelida</td>
<td>? A</td>
</tr>
<tr>
<td>? B</td>
<td>Ctenophora</td>
<td>Locomotion</td>
</tr>
<tr>
<td>? C</td>
<td>Mollusca</td>
<td>Raping organ</td>
</tr>
<tr>
<td>Malpighian tubules</td>
<td>Arthropoda</td>
<td>? D</td>
</tr>
<tr>
<td>Cnidoblasts</td>
<td>Coelenterata</td>
<td>? E</td>
</tr>
</tbody>
</table>

From the above table find out the missing organ or function- A, B, C and E respectively

(a) A-swimming, B-comb plates, C-radula, D-excretion, E-defense
(b) A-defense, B-radula, C-comb plates, D-excretion, E-swimming
(c) A-defense, B-radula, C-comb plates, D-swimming, E-excretion
(d) A-protection, B-parapodia, C-visceral mass, D-locomotion, E-excretion

38. Each 100 mL of human arterial blood carries 'P' mL of O₂ and 'Q' mL of CO₂ whereas each 100 mL of venous blood carries 'R' mL of O₂ and 'S' mL of CO₂. Choose the correct value of P, Q, R, and S.

(a) P - 48 mL, Q - 19-20 mL, R - 52 mL, S - 14-15 mL
(b) P - 19-20 mL, Q - 48 mL, R - 14-15 mL, S - 52 mL
(c) P - 14-15 mL, Q - 52 mL, R - 19-20 mL, S - 48 mL
(d) P - 52 mL, Q - 14-15 mL, R - 48 mL, S - 19-20 mL

39. In the following human pedigree, the filled symbols represent the affected individuals. Identify the type of given pedigree.

(i) (ii)
(iii) (iv)

(a) Autosomal recessive  (b) X-linked dominant
(c) Autosomal dominant  (d) X-linked recessive

40. Match the items in Column I with those in Column II, and choose the correct answer.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. Mitosis</td>
<td>(i) Occurs in diploid cells only</td>
</tr>
<tr>
<td>Q. Meiosis</td>
<td>(ii) Occurs in both haploid and diploid cells</td>
</tr>
<tr>
<td></td>
<td>(iii) Daughter and parent cells have same chromosome numbers</td>
</tr>
<tr>
<td></td>
<td>(iv) Synapsis of homologous chromosomes</td>
</tr>
</tbody>
</table>

(a) P-(i), Q-(ii)  (b) P-(ii), Q-(iii)
(c) P-(iii), Q-(iv)  (d) P-(iv), Q-(i)

41. Which of the following statements about plasmolysis is/are true?

I. Plasmolysis occurs when water moves into the cell.
II. Cells shrink in hypotonic solutions.
III. If the external solution balances the osmotic pressure of the cytoplasm, it is said to be isotonic.

(a) I only  (b) II only
(c) III only  (d) I and II only
42. Match the following and select the correct option.

<table>
<thead>
<tr>
<th>Column - I</th>
<th>Column - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Pteris</td>
<td>(i) Gymnosperm</td>
</tr>
<tr>
<td>B. Cycas</td>
<td>(ii) Bryophyte</td>
</tr>
<tr>
<td>C. Sphagnum</td>
<td>(iii) Algae</td>
</tr>
<tr>
<td>D. Sargassum</td>
<td>(iv) Pteridophyta</td>
</tr>
</tbody>
</table>

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

43. \(\left(\frac{1}{2}T + \frac{1}{2}t\right)^2\) is the binomial expansion of

(a) \(\left(\frac{1}{2}T + \frac{1}{4}t\right)^2\)
(b) \(\left(\frac{1}{4}T + \frac{1}{4}t\right)^2\)
(c) \(\left(\frac{1}{4}T + \frac{1}{2}t\right)^2\)
(d) \(\left(\frac{1}{2}T + \frac{1}{4}t\right)^2\)

44. Choose the wrong pair.

(a) Divergent evolution - Forelimbs of whales, bats, cheetah, and human
(b) Convergent evolution - Flippers of penguins and dolphins
(c) Homologous structures - Vertebrate hearts
(d) Analogous structures - Tendrils of Bougainvillea and thorns of Cucurbita

45. Read the statements.

(i) IgE antibodies are produced in an allergic reaction.
(ii) B-lymphocytes mediate cell mediated immunity.
(iii) The yellowish fluid colostrum has abundant IgE antibodies.
(iv) Spleen is a secondary lymphoid organ.

Of the above statements

(a) (i) and (iv) are correct
(b) (i) and (ii) are correct
(c) (ii) and (iv) are correct
(d) (i) and (iv) are correct

46. In the ribose of RNA, unlike DNA, every nucleotide residue has an additional

(a) COOH group in the 2' position
(b) OH group in the 5' position
(c) OH group in the 2' position
(d) Phosphate group in the 2' position

47. Progestasert is an IUD which makes the uterus unsuitable and cervix hostile to the sperms as they are

(a) hormone releasing IUDs
(b) copper releasing IUDs
(c) ideal contraceptive
(d) non-medicated IUDs

48. Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of

(a) omega 3
(b) vitamin A
(c) vitamin B
(d) vitamin C

49. Triticale is an example of

(a) autopolyploidy
(b) allopolyplody
(c) aneuploidy
(d) none of these

50. Maximum absorption of light by chlorophyll \(a\) occurs in which regions of the absorption spectrum?

A. Blue  B. Red
C. Green  D. Yellow

(a) A and B only  (b) B and C only
(c) A and D only  (d) B and D only

51. Identify the correctly matched structure and its secretion.

(a) Brunner’s gland - Salivary amylase
(b) Intestinal mucosa - Insulin
(c) Gall bladder - Bile
(d) Salivary gland - Lysozyme

52. Which of the following statements does not apply to eutrophication?

(a) It is the natural aging of a lake by nutrient enrichment of its water.
(b) In a young lake the water is cold and clear and supports less life.
(c) The nutrients such as sulphur and phosphorus encourage the growth of aquatic organisms in the lake.
(d) Pollutants released by man radically accelerate the aging process of a lake.

53. Given here is a pie chart representation of the extent of global diversity of invertebrates. What groups the four portions (A-D) represent respectively?

A B C D

(a) Insects  Crustaceans  Other animal groups  Molluscs
(b) Crustaceans  Insects  Molluscs  Other animal groups
(c) Molluscs  Other animal groups  Crustaceans  Insects
(d) Insects  Molluscs  Crustaceans  Other animal groups

54. Match the following and select the correct answer.

A. Centriole  (i) Infoldings in mitochondria
B. Chlorophyll  (ii) Thylakoids
C. Cristae  (iii) Nucleic acids
D. Ribozymes  (iv) Basal body of cilia or flagella

A B C D

(a) (iv)  (ii)  (i)  (iii)
(b) (i)  (ii)  (iv)  (iii)
(c) (i)  (iii)  (ii)  (iv)
(d) (iv)  (iii)  (i)  (ii)
55. Match the hormones secreted by various endocrine structures and choose the correct option.
   I. Hypothalamus    A. Melanocyte stimulating hormone
   II. Pars intermedia B. Aldosterone
   III. Pineal gland   C. Gonadotrophin releasing hormone
   IV. Adrenal medulla D. Melatonin
   V. Adrenal cortex  E. Catecholamines
   (a) I - E, II - A, III - D, IV - B, V - C
   (b) I - E, II - D, III - A, IV - B, V - C
   (c) I - B, II - D, III - A, IV - C, V - E
   (d) I - C, II - A, III - D, IV - E, V - B

60. Which one of the following organelle in the figure correctly matches with its function?
   (a) Golgi apparatus, formation of glycolipids
   (b) Rough endoplasmic reticulum, protein synthesis

61. Identify the tissue shown in the diagram and match with its characteristics and its location.
   (a) Smooth muscles, show branching, found in the wall of the heart.
   (b) Cardiac muscles, unbranched muscles, found in the walls of the heart.
   (c) Striated muscles, tapering at both-ends, attached with the bones of the ribs.
   (d) Skeletal muscles show striations and are closely attached with the bones of the limbs.

63. Which of these is/are not a property of facilitated transport?
   A. Requires special membrane proteins
   B. High selectivity
   C. Uphill transport
   D. Requires ATP energy
   (a) A and B only (b) C and D only
   (c) A and C only (d) B and C only

65. Protein encoded by gene cry1Ab controls the infestation of which of the following insects?
   (a) cotton boll worm
   (b) anopheles mosquito
   (c) corn borer
   (d) aedes mosquito.
67. Which of the following statements is correct?
(a) Sporopollenin can be degraded by enzymes.
(b) Sporopollenin is made up of inorganic materials.
(c) Sporopollenin can withstand high temperatures as well as strong acids and alkalis.
(d) Sporopollenin can withstand high temperatures but not strong acids.

68. Starting from the maximum, arrange the following male reproductive accessory organs in the correct order, based on the amount of secretion.
(i) Prostate gland
(ii) Seminal vesicle
(iii) Bulbourethral gland
(a) (i) > (ii) > (iii)  (b) (iii) > (ii) > (i)
(c) (ii) > (iii) > (i)  (d) (ii) > (i) > (iii)

69. Read the following statements and choose the correct option.
A. Increase in melanised moths after industrialisation in Great Britain is a proof for natural selection.
B. When more individuals of a population acquire a mean character value, it is called disruption.
C. Changes in allelic frequency in a population will lead to Hardy-Weinberg equilibrium.
D. Genetic drift changes the existing gene or allelic frequency in future generations.
(a) B alone is correct.
(b) D alone is correct.
(c) A and D alone are correct.
(d) A and C alone are correct.

70. Photochemical smog formed in congested metropolitan cities mainly consists of
(a) ozone, peroxyacyl nitrate and NOx
(b) smoke, peroxyacyl nitrate and SO2
(c) hydrocarbons, SO2 and CO2
(d) hydrocarbons, ozone and SOx.

71. Which of the following statements about productivity is true?
(a) The annual net primary productivity of the whole of the biosphere is 17 billion tons (dry weight) of organic matter.
(b) Net primary productivity is the amount of biomass available for consumption by carnivores.
(c) Secondary productivity is defined as the rate of formation of new organic matter by decomposers.
(d) Primary productivity depends on the plant species inhabiting a particular area.

72. The three boxes in this diagram represent the three major biosynthetic pathways in aerobic respiration. Arrows represent net reactants or products.

![Pathway Diagram]

Arrows numbered 4, 8 and 12 can all be
(a) H2O  (b) FAD+ or FADH2
(c) NADH  (d) ATP.

73. Match the entries in Column - I with those of Column - II and choose the correct answer given below.

<table>
<thead>
<tr>
<th>Column - I</th>
<th>Column - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Cytokinins</td>
<td>(p) Stress hormone</td>
</tr>
<tr>
<td>(B) Auxins</td>
<td>(q) Ripening of fruits</td>
</tr>
<tr>
<td>(C) Abscisic acid</td>
<td>(r) Apical dominance</td>
</tr>
<tr>
<td>(D) Ethylene</td>
<td>(s) Bolting</td>
</tr>
<tr>
<td>(t) Richmond Lang effect</td>
<td></td>
</tr>
</tbody>
</table>

(a) A - (t), B - (r), C - (p), D - (q)
(b) A - (t), B - (r), C - (p), D - (s)
(c) A - (r), B - (s), C - (q), D - (p)
(d) A - (q), B - (q), C - (t), D - (r)

74. The two reducing powers of light reaction are used in dark reaction during formation of
(a) 3-phosphoglycerate from ribulose-1, 5-bisphosphate
(b) glyceraldehyde 3-phosphate from 3-phospho-glycerate
(c) sucrose from triose phosphate
(d) ribulose-1, 5-bisphosphate from triose phosphate.

75. Read the following statements and select the correct option.
A. Circulatory system in arthropods is of closed type.
B. Parapodia in annelids help in swimming.
C. Phylum Mollusca is the second largest animal phylum.
D. Aschelminthes are dioecious.
(a) A and C alone are wrong
(b) A alone is wrong
(c) C alone is wrong
(d) C and D alone are wrong

76. Global warming can be controlled by
(a) increasing deforestation, slowing down the growth of human population.
(b) increasing deforestation, reducing efficiency of energy usage.
(c) reducing deforestation, cutting down use of fossil fuel.
(d) reducing reforestation, increasing the use of fossil fuel.
77. The restriction endonucleases are used in genetic engineering, because
(a) they can cut DNA at specific base sequences
(b) they are nuclease that cut DNA at variable sites
(c) they can degrade harmful proteins
(d) they can join different DNA fragments

78. Which of the following is correctly labelled for the given figure?
(a) A : PS II ; B : PS I ; C : e– acceptor; D: LHC
(b) A : LHC; B : e– acceptor; C : PS I; D : PS II
(c) A : PS I ; B : PS II ; C : e– acceptor; D : LHC
(d) A : e– acceptor; B : LHC; C : PS II; D : PS I

79. Consider the following statements with respect to respiration.
A. Glycolysis occurs in the cytoplasm of the cell.
B. Aerobic respiration takes place within the mitochondria.
C. Electron transport system is present in the outer mitochondrial membrane.
D. C51H98O6 is the chemical formula of Tripalmitin, a fatty acid.
E. Respiratory quotient = Volume of O2 evolved / Volume of CO2 consumed
Of the above statements
(a) A, B and D alone are correct
(b) A, C and D alone are correct
(c) C, D and E alone are correct
(d) B, D and E alone are correct

80. Choose the wrong statement.
(a) Lipases and nucleases are not present in pancreatic juice.
(b) Goblet cells secrete mucus.
(c) Brunner’s glands are sub-mucosal glands.
(d) Carboxypeptidase catalyses conversion of proteins, peptones and proteoses to dipeptides.

81. For a plasmolysed cell which equation is correct?
(a) DPD = OP + TP
(b) DPD = –TP
(c) DPD = OP
(d) DPD = OP – TP.

82. Cortisol is secreted by the adrenal cortex in response to stress. In addition to its function in a stress response, it functions in negative feedback by
(a) inhibiting the hypothalamus so that corticotropin releasing hormone (CRH) secretion is reduced.
(b) inhibiting the anterior pituitary’s ability to respond to CRH by reducing the pituitary’s sensitivity to CRH.
(c) both (a) and (b) are correct.
(d) none of these.

83. Which of the following statement(s) regarding coelenterates is/are wrong?
I. Cnidocytes are present on the tentacles and on the body.
II. Diploblastic with cellular level of organization.
III. Polyp forms are free swimming.
IV. Exhibits metagenesis.
V. Polyps produce medusae sexually and medusae form polyps asexually.
(a) I and IV only
(b) III and V only
(c) I, II and III only
(d) II, III and V only

84. Which of these is/are wrongly matched?
I. Alkaloid – Codeine
II. Lectin – Morphine
III. Toxin – Abrin
IV. Terpene – Curcumin
(a) I and II only
(b) II and III only
(c) II and IV only
(d) III and IV only

85. Match Column - I with Column - II and choose the correct option from below.

<table>
<thead>
<tr>
<th>Column - I</th>
<th>Column - II</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Marginal placentation</td>
<td>(i) Sunflower</td>
</tr>
<tr>
<td>B. Axile placentation</td>
<td>(ii) Mustard</td>
</tr>
<tr>
<td>C. Parietal placentation</td>
<td>(iii) Lemon</td>
</tr>
<tr>
<td>D. Basal placentation</td>
<td>(iv) Pea</td>
</tr>
</tbody>
</table>

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

86. According to the modern concept of cellular membranes the structure of the cell membrane is as follows
(a) there is a continuous lipid bilayer with interspersed proteins on the outside as well as some on the inside
(b) there is a continuous lipid bilayer with continuous protein layer on the outside
(c) there is a continuous lipid bilayer with continuous protein layer on the inside
(d) both (b) and (c).
87. Match the name of the animal (Column I), with one characteristic (Column II), and the phylum / class (column III) to which it belongs.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
<th>Column III</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Limulus</td>
<td>Body covered by chitinous exoskeleton</td>
<td>Pisces</td>
</tr>
<tr>
<td>(b) Adamsia</td>
<td>Radially symmetrical</td>
<td>Porifera</td>
</tr>
<tr>
<td>(c) Petromyzon</td>
<td>Ectoparasite</td>
<td>Cyclostomata</td>
</tr>
<tr>
<td>(d) Ichthyophis</td>
<td>Terrestrial</td>
<td>Reptilia</td>
</tr>
</tbody>
</table>

88. Select the wrong statement.

(a) In Oogamy, female gamete is smaller and motile, while male gamete is larger and non-motile.
(b) Chlamydomonas exhibits both isogamy and anisogamy and Fucus shows oogamy.
(c) Isogametes are similar in structure, function and behaviour.
(d) Anisogametes differ either in structure, function or behaviour.

89. Which of the following is correctly matched without exception in regard to plant classification?

(a) Family – Poaceae – ae
(b) Division – Pteridophyta – phyla
(c) Class – Bryopsida – sida
(d) Genus – Solanum – um

90. (i) They help in respiration.
   (ii) They help in cell wall formation.
   (iii) They help in DNA replication.
   (iv) They increase surface area of plasma membrane.

Which of the following prokaryotic structures has all the above roles?

(a) Ribosome
(b) Mesosome
(c) Lysosome
(d) Polysome

91. Match Column I with Column II.

<table>
<thead>
<tr>
<th>Column I</th>
<th>Column II</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. Pollen grains</td>
<td>(i) Photochemical smog</td>
</tr>
<tr>
<td>Q. PAN</td>
<td>(ii) Particulate pollution</td>
</tr>
<tr>
<td>R. CO₂</td>
<td>(iii) Global warming</td>
</tr>
<tr>
<td>S. Cadmium</td>
<td>(iv) Itai itai disease</td>
</tr>
</tbody>
</table>

(a) P-(ii), Q-(i), R-(iii), S-(iv)
(b) P-(iv), Q-(ii), R-(i), S-(iii)
(c) P-(i), Q-(iii), R-(ii), S-(iv)
(d) P-(iii), Q-(i), R-(ii), S-(iv)

92. IUDs which are used by females
(a) are implanted under the skin and they release progestogen and estrogen
(b) act as spermicidal jellies
(c) release copper ions in the uterus that increase phagocytosis of sperm
(d) block the entry of sperms into vagina.

93. Entry of pollen tube through micropyle is termed as

(a) mesogamy
(b) porogamy
(c) syngamy
(d) chalazogamy

94. Lindeman for the first time gave energy transfer law, which states that

(a) only 20% of the energy is transferred to each trophic level
(b) only 10% of the energy is transferred to each trophic level
(c) only 30% of the energy is transferred to each trophic level
(d) only 50% of the energy is transferred to each trophic level.

95. Which of the following statements about enzymes is wrong?

(a) Enzymes are denatured at high temperatures.
(b) Enzymes are mostly proteins but some are lipids also.
(c) Enzymes are highly specific.
(d) Enzymes require optimum pH and temperature for maximum activity.

96. Find the wrongly matched pair.

(a) Unicellular glandular cells – Goblet cell
(b) Fusiform fibres – Smooth muscle
(c) Cartilage – Areolar tissue
(d) Intercalated discs – Cardiac tissue.

---

**EXAM DATES 2016**

- MGIMS Wardha: 17th April
- Kerala PMT: 27th & 28th April
- AP EAMCET: 29th April
- AIPMT: 1st May
- K-CET: 4th & 5th May
- COMEDK: 8th May
- J & K: 14th & 15th May
- WBJEE: 17th May
- AIIMS: 29th May
- JIPMER: 5th June
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97. The solid linear cytoskeletal elements having a diameter of 6 nm and made up of a single type of monomer are known as
(a) microtubules  (b) microfilaments  
(c) intermediate filaments  (d) lamins.

98. In most simple type of canal system of porifera, water flows through which one of the following ways?
(a) Ostia → Spongocoel → Osculum → Exterior 
(b) Spongocoel → Ostia → Osculum → Exterior 
(c) Osculum → Spongocoel → Ostia → Exterior 
(d) Osculum → Ostia → Spongocoel → Exterior.

99. In the gastrointestinal tract the Meissner’s plexus and the Auerbach’s plexus occur respectively in the
(a) lamina propria and muscularis mucosa  
(b) submucosa and muscularis externa  
(c) submucosa and mucosa  
(d) mucosa and muscularis externa.

100. Select the wrong statement.
(a) The term ‘contagium vivum fluidum’ was coined by M. W. Beijerinck.  
(b) Mosaic disease in tobacco and AIDS in human being are caused by viruses.
(c) The viroids were discovered by D.J. Ivanowsky.  
(d) W.M. Stanley showed that viruses could be crystallised.

ANSWER KEY
1. (d)  2. (a)  3. (c)  4. (c)  5. (b)
6. (c)  7. (c)  8. (b)  9. (d)  10. (a)
11. (a)  12. (c)  13. (c)  14. (a)  15. (d)
16. (b)  17. (a)  18. (c)  19. (a)  20. (c)
21. (c)  22. (a)  23. (c)  24. (c)  25. (c)
26. (c)  27. (b)  28. (c)  29. (b)  30. (a)
31. (a)  32. (a)  33. (d)  34. (c)  35. (b)
36. (d)  37. (a)  38. (b)  39. (a)  40. (c)
41. (c)  42. (b)  43. (a)  44. (d)  45. (a)
46. (c)  47. (a)  48. (b)  49. (b)  50. (a)
51. (d)  52. (c)  53. (d)  54. (a)  55. (d)
56. (a)  57. (b)  58. (a)  59. (d)  60. (b)
61. (d)  62. (a)  63. (b)  64. (d)  65. (c)
66. (b)  67. (c)  68. (d)  69. (c)  70. (a)
71. (d)  72. (d)  73. (a)  74. (a)  75. (b)
76. (c)  77. (a)  78. (a)  79. (a)  80. (a)
81. (c)  82. (c)  83. (d)  84. (c)  85. (a)
86. (a)  87. (c)  88. (a)  89. (a)  90. (b)
91. (a)  92. (c)  93. (b)  94. (b)  95. (b)
96. (c)  97. (b)  98. (a)  99. (b)  100. (c)

Unscramble the letters using the given clues.

<table>
<thead>
<tr>
<th>Scrambled letters</th>
<th>Clues</th>
<th>Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FSMAOIROTCBINI</td>
<td>Deals with storage and analysis of DNA and protein data with the help of computers.</td>
<td></td>
</tr>
<tr>
<td>2. EOVRSTTIUR</td>
<td>Replicate through the process of reverse transcription.</td>
<td></td>
</tr>
<tr>
<td>3. OPETRMR</td>
<td>Binding site of DNA for RNA polymerase.</td>
<td></td>
</tr>
<tr>
<td>4. MUNFDBRIJLUMI</td>
<td>It collects ovum after it is released from the ovary.</td>
<td></td>
</tr>
<tr>
<td>5. YMOAAUTG</td>
<td>Pollination of a flower by its own pollen.</td>
<td></td>
</tr>
<tr>
<td>6. AIGANN</td>
<td>Acute pain chest in due to lack of oxygen in heart muscles.</td>
<td></td>
</tr>
<tr>
<td>7. DRCGOOPYPYHN</td>
<td>Growing of plants in a mineral nutrient solution in complete absence of soil.</td>
<td></td>
</tr>
<tr>
<td>8. RHCNEDA</td>
<td>Arrangement in a vascular bundle where protoxylem lies towards the pith and metaxylem lies towards periphery.</td>
<td></td>
</tr>
<tr>
<td>9. SPNOI</td>
<td>A photosensitive protein present in human eyes.</td>
<td></td>
</tr>
<tr>
<td>10. DRTEILN</td>
<td>Modification of stem developed from axillary buds.</td>
<td></td>
</tr>
</tbody>
</table>

Readers can send their responses at editor@mtg.in or post us with complete address by 25th of every month to win exciting prizes. Winners’ names will be published in next issue.
Primary and Secondary Growth in Plants

- Growth in an organism consists of a permanent and an irreversible increase in size, commonly accompanied by an increase in solid matter, dry mass and amount of cytoplasm. Growth in living beings is intrinsic or internal in contrast to extrinsic growth observed in non-living objects.
- Plant growth is generally indeterminate i.e., continued throughout life. In lower plants, growth is diffused i.e., every cell can divide and enlarge but in higher plants, special body regions called meristems cause body growth.
- Plant growth takes place in three phases – formative, enlargement and differentiation.
  (i) Formative phase: It is the phase of cell division. As the formation of new cells requires biosynthetic activity, the respiration rate of cells is high in this phase.
  (ii) Phase of enlargement: In it, the newly formed cells produced in formative phase undergo enlargement. In many parts cell enlargement may occur in all directions, e.g., isodiametric parenchymatous cells. In many parts, cell enlargement takes place prominently in the linear direction, so much so that this phase is also called phase of cell elongation.
  (iii) Phase of differentiation or maturation: In this phase the enlarged cells develop into special or particular type of cells by undergoing structural and physiological differentiation.
- Growth can be arithmetic (cells divide in such a fashion that one daughter cell divides again while the other cell differentiates) or geometric (each daughter cell divides). Geometric growth causes rapid increase in size, weight, etc. and is generally observed in unicellular organisms or at early embryonic stage.
ROLE OF MERISTEMS IN PLANT GROWTH

- Meristems are the regions of growth in plants. Cells of the meristematic region have the capacity to divide and self-perpetuate. They produce cells which lose the capacity to divide and undergo differentiation to form particular tissues and organs.
- The meristem which is consumed in the formation of an organ is called determinate meristem. The meristem which continues its activity throughout life of the plant is called indeterminate meristem.
- Depending on their origin, meristems are of two types: primary and secondary.
- Primary meristems are those meristematic tissues which are derived directly from the meristems of the embryo. They are divided into apical meristems, intercalary meristems and lateral meristems depending upon their position in body.
- Apical meristems are of two types: root apical meristem present on root apex and shoot apical meristem present on shoot apex.
- Root apical meristem (RAM) and shoot apical meristem (SAM) contribute cells for elongation of plant parallel to its axis. It is primary growth. Another meristem contributing to primary growth is intercalary meristem located above the nodes in grasses and related plants. It increases length of the plant organs.

**PRIMARY GROWTH**

- Primary growth is the first form of growth to occur. A whole plant can be built up by primary growth, and in most monocotyledonous plants and herbaceous dicotyledons it is the only type of growth. It is a result of the activity of the apical, and sometimes intercalary meristems.
- The seedling undergoes primary growth to form the herbaceous (non-woody) green plant. Primary growth is initiated by divisions of meristematic cells at the apex of stem and root, the apical meristems.

**Primary growth in shoots**

- The primary growth of the shoot is concentrated at the shoot tip. All tissues of the stem and leaves arise from terminal meristem. The shoot apical meristem (SAM) is conical or dome shaped in outline in seed plants. Leaf primordia originate on the lateral flanks of the shoot apical meristem.
- Shoot apical meristem and the young primordia are commonly termed the bud. The leaf primordia subsequently grow and differentiate into leaves and lateral buds. The point of attachment of the leaf and lateral bud on the stem is the node. The part of stem between the nodes is referred to as the internode.
- Growth of the stem axis is by cell enlargement in the internodal region caused by intercalary meristem. There is a progressive increase in the distance between the young nodes and therefore, the apex of the shoot is pushed upward. Branch primordia develop in the axils of old leaves.
- According to tunica-corpus theory of Schmidt (1924), the shoot apex has two parts, outer mantle like tunica and inner cellular mass known as corpus. Cells of tunica undergo anticlinal divisions and form protoderm (gives rise to epidermis). Cells of corpus divide in different planes to form procambium and ground meristem. Procambium gives rise to primary vascular tissues (xylem and phloem) and interfascicular cambium. Ground meristem gives rise to...
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pith in the centre and pericycle, endodermis, cortex and hypodermis respectively towards the outer side.

- The shoot apical meristem forms three histogens: dermatogen, periblem and plerome (Hanstein’s histogen theory, 1870). Dermatogen forms epidermis, periblem forms cortex and plerome forms stele (the part inner to endodermis). Central part of plerome which forms vascular tissues is called procambium.
During the formation of vascular tissue, the innermost cells of the procambial strands of the stem form the protoxylem. Cells at the outer side of the procambial strands form the protophloem. Metaxylem and metaphloem tissues are formed subsequently.

Cells of the procambial strand may also differentiate into fibres, a form of sclerenchyma.

The formation and enlargement of more robust metaxylem and metaphloem tends to crush the first-formed vascular tissue, particularly the protophloem.

**Primary growth in roots**

- The apical meristem of the root is a mass of irregularly arranged cells, which divide and cut off new cells in all directions. The cells which cut off ahead of this meristem form the root cap. In monocots and many other plants, calyptrogen forms root cap.
- Dermatogen, periblem and plerome form the root tissues in a fashion similar to stem development.
- The bulk of the cells cut off by the root apical meristem give rise to the central procambial strand, and to the tissues of the cortex. Protoxylem and protophloem develop from the procambial strand cells followed by metaxylem and metaphloem.
- The central vascular tissue is referred to as the stele. The stele is surrounded by a single layer of cells, the endodermis, and immediately within this layer is a layer of cells, the pericycle.

**Development of cambium in dicot plants**

- After primary growth is completed and the mature primary tissues of stem and root are formed, some procambial strand cells remain in the vascular bundles of the stem and in the stele of the root. These meristem cells lie between the metaxylem and metaphloem, and are known as cambium. Cambium cells are capable of further growth, leading to secondary growth of roots and stems.

- The developmental phase in plant life when rapid primary growth occurs is called juvenile phase. This phase begins with young seedling and continues until the plant begins reproductive development. In some plants, juvenile phase extends for a long period, sometimes indefinite, e.g., English ivy. Juvenile phase is followed by maturity. At maturity plant shows reduced vegetative growth and active reproductive growth.

**Intext Practice Questions**

1. Name the tissue that gives rise to root cap in monocots. What kind of tissue is it?
2. What is the significance of quiescent centre to the roots of a plant?

**SECONDARY GROWTH**

- In dicots of angiosperms and gymnosperms, the primary body forms the fundamental structure and increase in girth and diameter takes place by the formation of secondary tissue. This formation of secondary tissue is called secondary growth.
- Secondary growth is the growth in thickness due to the formation of secondary tissues by lateral meristems. With the exception of some annuals, most of the dicots and gymnosperms show secondary growth in their roots.
- It takes place by the production of two types of secondary tissues: secondary vascular tissues and periderm. These tissues are formed by meristems, vascular cambium and cork cambium respectively.
- Secondary growth results in the formation of a large amount of secondary xylem called wood and an external layer known as bark.

**Secondary growth in dicot roots**

- Secondary growth in dicotyledonous roots occurs by the initiation and activity of two secondary meristems—
(i) vascular cambium and (ii) cork cambium (or phellogen).

**Stelar growth by vascular cambium**
- The process of stelar secondary growth in dicotyledonous roots begins with the initiation of vascular cambium strips which develop from the parenchymatous cells present along the inner edges of primary phloem. The number of cambial strips depends on the number of phloem or xylem strands.

- The cells of cambium strips (vascular cambium) divide repeatedly to produce new cells both towards inner as well as outer side. The cells produced towards inner side (centripetally) differentiate into secondary xylem elements and those produced towards outer side (centrifugally) differentiate into secondary phloem.

- Subsequently, the cells of pericycle lying towards outer side of protoxylem divide by tangential division. The inner derivatives of these cells become meristematic and function as cambium. These join with cambia derived from phloem strands to form a complete ring of cambium. Thus, a continuous wavy ring is produced which is present below the phloem but above the xylem and is secondary in origin. Soon, the cambium becomes circular by its divisions and secondary tissue formation.

- Some cambial cells may function as ray initials and produce secondary medullary rays. Secondary vascular tissue assumes the shape of continuous cylinder interrupted at places where wide vascular rays connect primary xylem to cortex through pericycle and endodermis.

- The primary xylem remains in its original position but the primary phloem is pushed towards outer side and crushed.

**Extrastelar growth by cork cambium**
- Addition of more and more tissues of secondary xylem and secondary phloem in the central part of root exerts pressure towards periphery. The tissues outside this zone of active growth get crushed and are sloughed off. To avoid injury to secondary phloem, the roots develop a new cambium ring in the pericycle, called cork cambium (phellogen).

- The cells of cork cambium (phellogen) divide to form cells of cork (phellem) towards outer side and secondary cortex (phelloderm) towards inner side. It results in the formation of outer protective covering consisting of multilayered cork, cork cambium and multilayered secondary cortex. These three layers collectively constitute the periderm.

**Secondary growth in dicot stems**
- The dicotyledonous stems are characterised by presence of fascicular (intrafascicular) cambium (primary meristem) derived from procambium of shoot apical meristem between xylem and phloem.

- Interfascicular cambium (secondary meristem) arises from the cells of medullary rays which occur at the level of intrafascicular strips.

- The cambium ring formed by joining of fascicular and interfascicular cambium, is called vascular cambium. It is composed of two types of cells— the fusiform initials and the ray initials.

- The cells of cambium mostly divide by periclinal divisions. Out of the two cells produced from single cell of cambium, one differentiates into secondary tissue and the other remains cambial cell. In this way the cambial cells, by repeated divisions, add new cells either towards centre or towards periphery and the cambium still remains single layered.

**Formation of secondary xylem and secondary phloem**
- The fusiform initials of cambium ring divide by tangential divisions and add new cells. The new cells produced toward inner side (i.e., towards primary xylem) may remain meristematic for sometime and differentiate into elements of secondary xylem. On the other hand, the new cells produced towards outer side (i.e., towards primary phloem) remain meristematic for a limited period and differentiate into secondary phloem. The primary phloem gets crushed.

**Formation of secondary medullary rays**
- Ray initials of cambium ring divide by tangential divisions and add new cells.
which form secondary medullary rays. They are usually one to few layers in thickness and one to several layers in height. The medullary rays form the radial system responsible for radial conduction of solutes. They maintain connection between pith and cortex.

Formation of periderm
- In order to provide an increase in girth and prevent harm to outer ground tissues, dicot stems produce a cork cambium (or phellogen) in the outer cortical cells. Phellogen cuts derivatives on the outer side to form cork (or phellem) and on the inner side to form secondary cortex or phelloderm. Cork, phellogen and phelloderm are collectively referred to as periderm.
- At places, phellogen produces aerating pores instead of cork. These pores are called lenticels. Each lenticel is a mass of loosely arranged suberised cells called complementary cells.
- Bark is a non-technical term that refers to all the tissues outside the vascular cambium viz. secondary phloem and periderm, in a woody stem in which secondary growth has taken place. Bark formed in early growing season is early or soft bark whereas bark formed towards end of growing season is late or hard bark.

Annual rings
Annual ring (growth ring) is the wood formed in a single year. It consists of two types of wood, spring wood and autumn wood. The spring or early wood is much wider than the autumn or late wood. It is lighter in colour and of lower density. Spring wood consists of larger and wider xylem elements. The autumn or late wood is dark coloured and of higher density. The transition from spring to autumn wood in an annual ring is gradual but the transition from autumn wood to the spring wood of the next year is sudden. Therefore, each year’s growth is quite distinct. The number of annual rings corresponds to the age of the plant, the annual rings also give some clue about the climatic conditions of the past through which the plant has passed. Dendrochronology is the science of determining age of trees by counting and analysing annual growth rings of trees.

Sapwood and heartwood
- The wood of the older stems (Dalbergia, Acacia) formed by secondary growth gets differentiated into two zones, the outer light coloured and functional sapwood or alburnum and the inner darker and non-functional heartwood or duramen.

<table>
<thead>
<tr>
<th>Differences between sapwood or alburnum and heartwood or duramen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sapwood (Alburnum)</strong></td>
</tr>
<tr>
<td>(i) It is outer wood of an old stem.</td>
</tr>
<tr>
<td>(ii) It is light coloured.</td>
</tr>
<tr>
<td>(iii) Living cells are present.</td>
</tr>
<tr>
<td>(iv) Sapwood is the functional part of the secondary xylem or wood.</td>
</tr>
<tr>
<td>(v) The tracheary elements are not plugged by tyloses.</td>
</tr>
<tr>
<td>(vi) Tracheary elements do not possess any deposition in their lumen.</td>
</tr>
<tr>
<td>(vii) Sapwood is lighter.</td>
</tr>
<tr>
<td>(viii) It is less durable because it is susceptible to attack by pathogens and insects.</td>
</tr>
</tbody>
</table>
In dicot roots cork cambium originates in
(a) pith  (b) hypodermis
(c) pericycle  (d) endodermis.

2. Differential divisions in various parts of RAM give rise to
(a) protoderm  (b) procambium
(c) calyptragen  (d) all of these.

3. Which of the following is a primary lateral meristem?
(a) Interfascicular cambium
(b) Intrafascicular cambium
(c) Cork cambium
(d) Phellogen

4. During secondary growth in dicot root phellogen forms
_____ towards outer side.
(a) periderm
(b) secondary vascular tissue
(c) cork cambium
(d) phellem

5. Spring wood is _____ than autumn wood, _____ in colour
and _____ in density.
(a) wider, lighter, lower
(b) narrower, lighter, lower
(c) wider, darker, higher
(d) narrower, darker, higher

6. Growth refers to
(a) reversible increase in size
(b) irreversible increase in shape
(c) irreversible increase in size
(d) none of these.

7. Sapwood is
(a) outer functional wood of an old stem
(b) central non-functional wood of an old stem
(c) heavier and durable than heartwood
(d) comprised of dead cells only.

8. Cork cambium and vascular cambium are the examples of
(a) apical meristem  (b) lateral meristem
(c) wound tissue  (d) intercalary meristem.

9. Procambium, situated just behind apical meristem, gives
rise to
(a) vascular cambium  (b) primary vascular bundle
(c) cork cambium  (d) pith and endodermis.

10. Which of the following is not a characteristic of meristematic tissue?
(a) Presence of prominent nucleus
(b) Presence of intercellular spaces
(c) Absence of vacuole
(d) Presence of proplastids

Anomalous secondary growth

The term anomalous secondary growth is used to indicate the forms of cambial activity that deviate from that commonly found
in conifers and in woody dicotyledons of the temperate regions. It occurs in some arborescent monocots (e.g., Dracaena, Yucca, Agave) and storage roots (e.g., beet, sweet potato). In arborescent monocot stems, a secondary cambium grows in hypodermal region. The latter forms conjunctive tissue and patches of meristematic cells. The meristematic patches grow into secondary vascular bundles. Anomalous vascular bundles also occur in cortex (cortical bundles, e.g., Nyctanthes) and pith (e.g., Boerhaavia). In storage roots (e.g., beet), accessory cambial rings appear in the outside of endodermis. They produce less secondary xylem but more secondary phloem. The secondary phloem contains abundant storage parenchyma.

3. What is the fate of primary phloem after secondary growth has occurred in a dicot stem?
4. How does periderm formation take place in a dicot stem?
5. What is the significance of periderm to a woody dicotyledonous plant?
PMT/PET के Entrance Exam में हिंदी माध्यम छात्रों के लिए Triple धमाका

NCERT Textbook पर Based भौतिकी, रसायन और जीव विज्ञान की Objective पुस्तकें

NCERT पाठ्यक्रम पर आधारित और हमारे Subject Experts द्वारा निर्मित 10,000 से अधिक Objective Type प्रश्नों का अभ्यास कर इन तीनों विषयों पर अपनी महत्ता हासिल कर परीक्षाओं में अवकलता प्राप्त करे और विजयी बने।

ये तीनों पुस्तकें ही क्यों पढ़नी जरूरी हैं?

- प्रश्नों को शीघ्रता और सरलता से हल करने के लिए CHAPTERWISE SYNOPSIS (मुख्य विषय)
- प्रश्नों की प्रगति जोखिम के लिए TOPICWISE Objective प्रश्न
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- सभी राष्ट्रीय एवं राज्य सत्ताओं के प्रश्नों की तैयारी के लिए, अलग-अलग उत्तरों, सरल एवं महत्वपूर्ण पुस्तकें
- AIIMS|JEE की पौर्णिमा हेतु अभ्यासकृत एवं तर्क प्राप्त प्रश्न
- समालोचनक हेतु पौधा अभ्यास प्रश्न पत्र

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ये पुस्तकें देश के सभी श्रेणी प्रतियोगिताओं के पास उपलब्ध हैं।
अधिक जानकारी हेतु कृपया संपर्क करें:
0124-6601200 or e-mail:info@mtg.in
11. Growth in numbers is maximum in the zone of
(a) cell maturation (b) cell division
(c) cell elongation (d) all of these.

12. Vascular tissues in flowering plants develop from
(a) periblem (b) dermatogen
(c) phellogen (d) plerome.

13. Anatomically fairly old dicotyledonous root is distinguished from the dicotyledonous stem by
(a) absence of secondary phloem
(b) presence of cortex
(c) position of protoxylem
(d) absence of secondary xylem.

14. Youngest layer of secondary xylem in wood of dicot plants is located between
(a) pith and primary xylem
(b) just outside vascular cambium
(c) just inside vascular cambium
(d) just inside cork cambium.

15. Between the bark and the wood in a woody stem, there is a layer of meristem called
(a) cork cambium
(b) apical meristem
(c) vascular cambium
(d) the zone of cell division.

16. Intercalary meristem occurs at the
(a) bases of internodes of monocot plants
(b) buds of the axillary leaves
(c) apex of dicot stem
(d) between the phloem and xylem.

17. Which one of the following is not correct?
(a) Early wood is characterised by large number of xyllary elements.
(b) Early wood is characterised by vessels with wider cavities.
(c) Late wood is characterised by large number of xyllary elements.
(d) Late wood is characterised by vessels with narrower cavities.

18. Refer to the given figure showing primary meristems and select the incorrect option for L, M and N.

(a) Derivatives of the meristem 'L' produce the primary plant body.
(b) Meristem ‘M’ is usually present at the bases of leaves and above or below the nodes.
(c) Meristem 'L' contributes towards primary growth and meristem 'N' contributes towards secondary growth.
(d) Intrascissular cambium is an example of 'L' type of meristem.

19. Which of the following is correct with regard to histogen theory of Hanstein?
(a) Dermatogen forms epidermis
(b) Periblem forms vascular tissues
(c) Plerome forms cortex
(d) Calyptrogen forms endodermis

20. During secondary growth in dicot stems generally the periderm produces
(a) phelloderm towards the periphery and cork towards the centre
(b) phellem towards the periphery and phelloderm towards the centre
(c) xylem towards the periphery and phloem towards the centre
(d) none of these.

**ANSWER KEY**

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

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**MEMORY CAPSULE**

To easily remember ten enzymes involved stepwise in glycolysis, the mnemonic “High Profile People Act Too Glamourous, Picture Posing Every Place” can be used as follows:

- H: Hexokinase
- P: Phosphohexose isomerase
- P: Phosphofructo kinase
- A: Aldolase
- T: Triose phosphate
- G: Glyceraldehyde phosphate dehydrogenase
- P: Phosphoglycerate kinase
- P: Phosphoglycerate mutase
- E: Enolase
- P: Pyruvate kinase
1. Which satellite was launched by PSLV-C31 on 20th January, 2016?
   (a) IRNSS - 1B  (b) IRNSS - 1C
   (c) IRNSS - 1D  (d) IRNSS - 1E

2. What is the name of the programme sponsored by the European Union for developing methods of using nuclear weapons to deflect asteroids and comets from colliding with the earth?
   (a) COMET Shield  (b) NEO Shield
   (c) ASTCOMET Shield  (d) NEOWISE Shield

3. Which country recently agreed to transfer its bio-farming technologies to India?
   (a) Sey Chelles  (b) Israel
   (c) Mauritius  (d) Sri Lanka

4. AIDS epidemic in which country, crossed the tipping point after the number of HIV+ve people passed 1 million mark?
   (a) Turkey  (b) South Africa
   (c) Nigeria  (d) Russia

5. The Union government has recently formed a technical expert group to deal with which type of virus?
   (a) Zika  (b) Ebola
   (c) Chikungunya  (d) Dengue

6. Who has been recently appointed as the Chairperson of the Energy and Resources Institute (TERI)?
   (a) R.K. Pachauri  (b) B.V. Sreekantan
   (c) Ashok Chawla  (d) Ajay Mathur

7. A new genus, named Frankixalus, was discovered by a group of scientist in jungles of north-eastern India. The genus relates to which species?
   (a) Sparrow  (b) Frog
   (c) Snake  (d) Turtle

8. Who took charge as the Executive Director of Greenpeace India on 20th January, 2016?
   (a) Samit Ach  (b) Divya Raghunandan
   (c) Ravi Chellam  (d) Sangeeta Ravi

9. Name the person of Indian-origin who won film Academy’s Scientific and Technical Award 2016.
   (a) Rahul Thakkar  (b) A.R. Rehman
   (c) Bhanu Athaiya  (d) Satyajit Ray

10. A new bird species named Himalayan Forest Thrush was discovered in north-eastern India. Which famous ornithologist gave scientific name to the bird?
    (a) Salim Ali  (b) Humayun Abdulali
    (c) Biswamoy Biswas  (d) Bikram Grewal

11. The 19th National Conference on e-Governance was held in Nagpur with the title
    (a) Transforming India  (b) Digital India
    (c) Empowering India  (d) Inclusive India.
12. Where did Indian Railways inaugurate India’s first high speed public wi-fi service?
(a) Chennai Central Station  
(b) Bangalore Central Station  
(c) Mumbai Central Station  
(d) Chhatrapati Shivaji Terminus, Mumbai

13. From which date Schedule Caste and Schedule Tribe (Prevention Atrocities) Amendment Act, 2015 came into force?
(a) 26th January, 2016  
(b) 1st February, 2016  
(c) 31st January, 2016  
(d) 16th January, 2016

14. In which country, ISRO will build a satellite tracking and imaging centre that will give the concerned country access to picture from Indian earth observation satellites over the region?
(a) Malaysia  
(b) Brunei  
(c) Vietnam  
(d) Indonesia

15. A team of Indo-German geologist and palaeontologist have found fossils of a 135-million-year old herbivorous dinosaur, which possibly is the oldest fossil found in this century. The fossil were found in
(a) Jaisalmer, Rajasthan  
(b) Kutch, Gujarat  
(c) Narmada Valley Basin, Gujarat  
(d) Rajsamand, Rajasthan.

16. Hybrid Annuity Model of implementing highway project was in news. Main advantage of the model is
(a) Adoption of rational approach in allocation of risk  
(b) Optimum return on investment  
(c) Ensure transparency in bidding of projects  
(d) Maximises revenue for all the partners involved.

17. Which state launched special weekly free clinics for women on 26th January, 2016?
(a) Maharashtra  
(b) Madhya Pradesh  
(c) Punjab  
(d) Uttar Pradesh

18. What is the strike range of indigenously-developed surface-to-air Akash Missile which successfully test fired on January 28, 2016 from ITR, Chandipur?
(a) 50 Km  
(b) 25 Km  
(c) 60 Km  
(d) 30 Km

19. What is the name of largest solar system that was discovered by astronomers in January 2016?
(a) 2MASS J2126-8140  
(b) 3MASS J262-4186  
(c) SS4 J2126-8140  
(d) S2MASS J226-4180

20. On which day anti leprosy day was observed?
(a) 30th January, 2016  
(b) 29th January, 2016  
(c) 28th January, 2016  
(d) 27th January, 2016

Contributed by: Sonam Jha, Ranchi

SOLUTIONS TO JANUARY 2016 CROSSWORD

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

The Humble Guar

Guar seed is much sought after by oil companies. Guar gum, extracted from guar seed, is used by drilling companies to thicken water that is mixed with sand and pumped through shale rock cracks to extract gas. It is also used as a thickening agent in products like ice cream, bread, pasta and pastries. In the 2015 kharif season, India produced 17 lakh tonnes of guar seed, making it the largest producer with about 80% of world production.
Direction: In the following questions, a statement of Assertion is followed by a statement of Reason. Mark the correct choice as:
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

6. **Assertion**: Lymph transports nutrients, oxygen, hormones etc. from the blood to the body cells and brings CO₂ and other wastes from the body cells to blood.
   **Reason**: Lymph has a low glucose concentration and it does not play any role in maintaining the volume of blood.

7. **Assertion**: Crop is a small part of alimentary canal of cockroach which mainly functions to grind the food.
   **Reason**: Gizzard is a part of alimentary canal of cockroach which is directly connected to mouth at one end and rectum at other end.

8. **Assertion**: Malpighian tubules in cockroach reabsorb a large amount of water and bicarbonates of sodium and potassium and then transfer them to the haemolymph.
   **Reason**: Malpighian tubules are long, fine and unbranched blind tubules which are attached at the junction of mid-gut and hind-gut.

9. **Assertion**: Each ovary of a cockroach consists of eight ovarioles which function to produce ova.
   **Reason**: All the eight ovarioles of each ovary unite to form oviduct, which transfer the ova to the common oviduct.

10. **Assertion**: A fasciculum consists of a bundle of nerve fibres and is surrounded by a connective tissue called endoneurium.
    **Reason**: A dense layer of connective tissue that surrounds the entire nerve is called as perineurium.

11. **Assertion**: The conduction of nerve impulse is faster in medullated nerve fibres than in non-medullated nerve fibres.
    **Reason**: When an impulse travels along a non-medullated nerve fibre, it does not proceed uniformly along the length of axis cylinder rather it jumps from one nodes of Ranvier to the next.

12. **Assertion**: The epithelium present in mucous membrane of intestine is highly absorptive.
    **Reason**: This epithelium possesses microvilli which increase the absorptive surface area of the epithelium.

13. **Assertion**: Areolar tissue acts as a supporting framework for epithelium.
14. **Assertion**: Mature mammalian RBCs lack nuclei and other cell organelles.  
**Reason**: Absence of cell organelles helps in better accommodation of haemoglobin in RBCs so as to carry out oxygen transport more efficiently.

15. **Assertion**: Leucocyte extravasation refers to the movement of leucocytes out of the circulatory system and towards the site of injury.  
**Reason**: Lymphocytes and monocytes are granulocytes which produce antibodies to destroy the antigens.

16. **Assertion**: Hardy-Weinberg Principle states that in the absence of disturbing influences, gene frequencies of large populations of sexually reproducing organisms do not change, provided that matings occur at random.  
**Reason**: The disturbing influences include mutation, gene flow, genetic drift, genetic recombination and natural selection pressure.

17. **Assertion**: Herbaceous lycopods and arborescent lycopods evolved from *Zosterophyllum* of palaeozoic era.  
**Reason**: *Zosterophyllum* is a primitive gymnosperm with vascular tissues.

18. **Assertion**: In sympatric speciation, a new species arises from an existing species that is living in the same area.  
**Reason**: Temporal and behavioural isolations produce significant changes in the genetic make-up within a species so that a new species is formed.

19. **Assertion**: The flippers of seal, patagia of bat, front legs of horse and arms of man look very different, perform different functions, but exhibit the same structural plan in bone pattern.  
**Reason**: These organs are an example of convergent evolution which involves the tendency of unrelated organisms to acquire similar structures.

20. **Assertion**: Australia has many species of egg-laying mammals and pouched mammals that occur only in Australia.  
**Reason**: Australia separated from the mainland during mesozoic era, before placental mammals evolved.

21. **Assertion**: Directional selection arises from a changing environment, it results in reduced variance and a shift in the mean value of population for the selected character.  
**Reason**: Directional selection results in the organism being adapted to changed environment.

22. **Assertion**: *Seymouria* has been considered as a missing link between amphibians and reptiles.  
**Reason**: *Seymouria* was a lizard-like animal with relatively small pointed head with dorsally placed nostril and a short tail.

23. **Assertion**: Palaeontological evidences indicated that evolution has taken place from simple to complex forms in a gradual manner.  
**Reason**: Rocks of palaeozoic era show fossils of great reptiles, primitive birds and mammals whereas those of palaeozoic era show fossils of first primates and placental mammals.

24. **Assertion**: Darwin’s finches cites an example of adaptive radiation.  
**Reason**: Darwin’s finches had common ancestors but then they evolved different types of modified beaks according to their food habits.

25. **Assertion**: Vestigial organs are believed to be the remnants of organs which were complete and functional in the ancestors.  
**Reason**: Wings of flightless birds, splint bones in feet of horse, wisdom teeth in human etc. are the examples of vestigial organs.

26. **Assertion**: Reproductive isolation is the prevention of interbreeding between the populations of the two different species.  
**Reason**: Natural selection is the process by which those organisms which are physically, physiologically and behaviourally better adapted to the environment, survive and reproduce while those not so well adapted fail to reproduce or die.
Do you have a question that you just can’t get answered? Use the vast expertise of our MTG team to get to the bottom of the question. From the serious to the silly, the controversial to the trivial, the team will tackle the questions, easy and tough. Few questions and their solutions are printed in this column. For more queries and their answers, please visit www.mtg.in.

Readers can send their queries at editor@mtg.in or post to us.

Q.1. How should one prepare for National Standard Examination in Biology (NSEB) and subsequently for Indian National Biology Olympiad (INBO)?

Ans. A proper planning will help to clear both NSEB and NBO exams. NSEB is the first stage of selection of students in biology olympiad programme organised by IAPT. The syllabus for NSEB is broadly equivalent to the senior secondary level (Class XI and XII) of CBSE Biology. However, only basic guideline for the course is mentioned and no detailed syllabus is given for NSEB. The syllabus of INBO is broadly similar to NSEB. However, the questions asked in olympiads are non-conventional and of high difficulty level.

So, to prepare for both the exams, it is important to master NCERT. Read and understand every concept mentioned in the NCERT book and then practice as many questions as possible and also keep an eye on how you score. High scores will boost your confidence but do not let low scores demotivate you, revise the chapter and practice again. ‘MTG NCERT @ Your Fingertips’ may come handy for this. It is also important to practice application based questions for certain topics like cladogram, Hardy-Weinberg equilibrium, etc. For that, various problems based on these topics can be studied from online available study material or through olympiad preparatory books.

To get an idea of the questions asked in the exam, solve previous years’ papers of the exam. Every exam has a specific pattern of questions asked and solving previous years’ papers gives an insight into this and helps you prepare better. Adopt chapterwise approach initially and solve questions of a chapter just after reading it.

MTG Fingertips HOTS questions, NSO workbooks, OSDS, Model Test Papers and articles from Biology Today like HOTS question from NCERT Xtract can prove useful. When exams are close, then start solving practice papers from entire syllabus in exam simulating environment and within that time slot. By this time, you should have covered your entire syllabus and started revision. In case, any chapter is left then finish it at earliest and then start revision and practice.

Hope this helps you. MTG team is here with all the support possible and wishes you great success in the exam.

Q.2. Why hair on body grows faster when shaved?

Ans. Hair growth is controlled by hair follicles found underneath the skin. These follicles are not affected by shaving. Shaving does not increase overall hair growth so it’s a myth that shaving makes hair grow back faster and thicker. Shaving slices off the tips of the hair, leaving the ends blunt and more noticeable once regrowth occurs. It does not remove the hair from the root but keep the hair at bay for a few days.

In addition, shaving removes the dead portion of hair, not the living section lying below the skin’s surface. So, it is unlikely to affect the rate or type of growth. On the other hand waxing and plucking remove the hair from the follicle at the base. Therefore, it will take a bit longer time to regenerate and will come out with a tapered end rather than a blunt one.

Q.3. Why twelve molecules of water are used as a substrate in photosynthesis equation “6CO₂ + 12H₂O → C₆H₁₂O₆ + 6H₂O + 6O₂” when only seven molecules of water can result the same “6CO₂ + 7H₂O → C₆H₁₂O₆ + H₂O + 6O₂”?

Ans. Photosynthesis equation is an overall result of light and dark reaction. To form one molecule of glucose, six turns of Calvin cycle are required as six molecules of carbon dioxide one molecule of glucose. Formation of glucose takes place during dark reaction. The products of light reactions required in dark reaction to form one molecule of glucose are 12 molecules of NADPH and 18 molecules of ATP.

During photolysis of water, two molecules of water split to form one molecule of oxygen and the respective number of electrons and hydrogen ions as follows:

\[ 2H₂O → 4H^+ + 4e^- + O₂ \]

Two molecules of water are required which satisfies the demand of 4 electrons and 2 protons to form two molecules of NADPH from NADP⁺. It can be stated as follows:

\[ 2H₂O + 2NADP⁺ → 2NADPH + 2H^+ + O₂ \]

So, from the above equations it is stated that one molecule of water is required to form one molecule of NADPH. Therefore, for producing 12 molecules of NADPH, total 12 molecules of water are required. Hence, twelve molecules of water are used as substrate in the equation.
Tardigrades (also known as water bears or moss piglets) are water-dwelling, eight-legged, segmented microscopic (body size from 0.05 to 1.2mm) invertebrates. They were first discovered by the German pastor Johann August Ephraim Goeze in 1773. Italian biologist Lazzaro Spallanzani named them *Tardigrada* meaning slow stepper. They can be found throughout the world, from the Himalayas above 6,000 m (20,000 ft), to deep sea (below 4,000 m (13,000 ft)) and from the polar regions to the equator.

Tardigrades are notable for being perhaps the most durable of known organisms. They are able to survive extreme temperature ranges from 1K (–458°F; –272°C) to about 420K (269°F; 147°C), pressures about six times greater than those found in the deepest ocean trenches, ionising radiations at doses hundreds of times higher than the lethal dose for a human, and the vacuum of outer space. They can go without food or water for more than 30 years, drying out to the point where they are 3% or less water. They are not considered as true extremophiles because they are not adapted to exploit these conditions. This means that their chances of dying increase, the longer they are exposed to the extreme environments.

During desiccation, tardigrades can dry out completely, replacing almost all the water in their bodies with a sugar called trehalose. As a result, they're able to survive environments that would otherwise kill them. Scientists have discovered that to survive extreme desiccation, tardigrades produce a special type of ‘bioglass’ to hold essential proteins and molecules together until they’re rehydrated back to life.

Researchers from the University of Chicago discovered a new type of glass produced internally by the tardigrades during desiccation. They concluded that the glass is produced as a protective mechanism to ensure that tardigrades can survive losing pretty much all of the water in their cells.

During desiccation, they very quickly coat themselves in large amounts of glassy molecules. According to another group of researchers, Boothby and his colleagues, tardigrade—specific genes code for specialised proteins called intrinsically disordered proteins (IDPs), which are responsible for the production of tardigrade glass. Intrinsically disordered proteins are shapeless and highly flexible under normal conditions, but when extreme drying occurs, the production of these proteins is kicked up, and they rearrange themselves into solid biological glasses. These newly formed IDP glass structures target specific proteins, molecules and other essential cell parts when the tardigrades start losing water, and enclose them in stiff, protective envelopes so they don’t fall apart during the desiccation process. When the tardigrade is exposed to water once more, the glass melts and the IDPs return to their floppy, random state.

Boothby and his colleagues also found that at lower levels of IDPs these tardigrades were less able to withstand desiccation but remained unaffected by other stresses such as extreme cold. So, they suggest that the creatures have different mechanisms to survive different types of extreme stresses.

According to researchers, foreign DNA has allowed the water bear to survive in such extreme conditions. Scientists on sequencing the whole genome of the tardigrades, suggest that tardigrades have most foreign genes of any animal studied so far.

Foreign DNA have presumably come from another organism via a process known as horizontal gene transfer, as opposed to being passed down through traditional reproduction. The foreign DNA comes primarily from bacteria, but also from plants, fungi and Archaea. During desiccation tardigrades’ DNA breaks down into tiny pieces. When their cells rehydrate, there is a point in time when the cell nucleus is leaky, allowing DNA and other molecules to pass through. That means that while the tardigrade is quickly patching up its own genome, it may accidentally be stitching in another organism’s genes.

This drying or freezing out of water bears during extreme conditions is a peculiar form of existence known as cryptobiosis or anabiosis. Their cryptobiotic properties helped scientists to develop so called ‘dry vaccines’. In such vaccines water is replaced with trehalose. Dry vaccines don’t require refrigeration and thus can be delivered and stored at room temperature in the most remote developing countries in the world.
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**ACROSS**

2. A dried latex of unripe capsular fruits of poppy plant. (5)

7. A sweeten nutrient medium prior to alcoholic fermentation. (4)

10. Regeneration of whole body of an organism from a small fragment. (12)

14. The part of a plant stem from which one or more leaves arise. (4)

16. Another name for pig. (3)

20. An institute which has developed an oral contraceptive Saheli for females. (4)

22. A modern horse which arose from *Pliohippus* in Pleistocene epoch. (5)

23. An insecticide obtained from red variety of sea onion. (6)

24. A homogentisic acid, which occurs in urine as a result of incomplete oxidation of tyrosine and phenylalanine. (8)

26. A protein hormone which is secreted by Sertoli cells and suppresses FSH synthesis. (7)

27. A soil water which is available to plants. (8)

28. A plasma expander used in blood transfusions. (7)

29. A psychotropic drugs group which induces sleep. (8)

30. A type of pollination which is carried out by snails. (11)

**DOWN**

1. A menstrual disorder marked by absence of menstruation. (10)

3. An amino acid which is useful in maintaining osmotic and water potential in plants. (7)

4. A tree that grow in saline coastal area. (8)

5. A group of morphologically and genetically similar organisms. (5)

6. A drug used to cure impotency. (6)

8. First transgenic cow. (5)

9. A lymphocyte present in thymus. (9)

11. The geological period in which conifers originated. (7)

12. Substances which are incapable of inducing antibody formation by themselves. (7)

13. A wall or covering of pollen grain. (9)

15. A recombinant protein used for prevention of blood clots. (6)

17. Folding of leaves in response to darkness. (10)

18. A hinder free part of the soft palate freely hangs down as a small flap. (5)

19. A green cattle food stored in a silo. (6)

21. A bone which lies just above the larynx and does not articulate with any other bone. (5)

25. Oldest cereal crop. (6)
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