

CBSE Board
Class XII Biology
Board Paper 2014 – Outside Delhi (Set 3)

Time: 3 hour

Total Marks: 70

General Instructions:

1. All questions are compulsory.
 2. This question paper consists of four Sections A, B, C and D. Section A contains 8 questions of one mark each, Section B is of 10 questions of two marks each, Section C is of 9 questions of three marks each and Section D is of 3 questions of five marks each.
 3. There is no overall choice. However, an internal choice has been provided in one question of 2 marks, one question of 3 marks and all the three questions of 5 marks weightage. A student has to attempt only one of the alternatives in such questions.
 4. Wherever necessary, the diagrams drawn should be neat and properly labelled.
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SECTION – A

1. Why is it not possible for an alien DNA to become part of a chromosome anywhere along its length and replicate normally? [1]
2. Name the stage of cell division where segregation of an independent pair of chromosomes occurs. [1]
3. Write an alternate source of protein for animal and human nutrition. [1]
4. Give an example of a plant which came into India as a contaminant and is a cause of pollen allergy. [1]
5. Name the type of association that the genus *Glomus* exhibits with higher plants. [1]
6. State Gause's Competitive Exclusion Principle. [1]
7. Name the enzymes that are used for the isolation of DNA from bacterial and fungal cells for recombinant DNA technology. [1]
8. State the role of C peptide in human insulin. [1]

SECTION – B

9. Write the scientific name of the fruit-fly. Why did Morgan prefer to work with fruit-flies for his experiments? State any three reasons. [2]

OR

Linkage and crossing-over of genes are alternatives of each other. Justify with the help of an example.

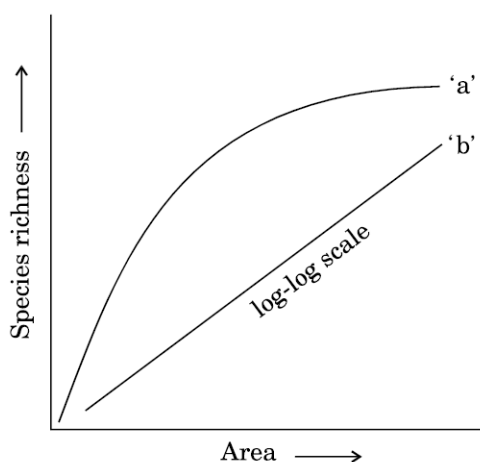
10. List the symptoms of Ascariasis. How does a healthy person acquire this Infection? [2]
11. Explain the significant role of the genus Nucleopolyhedrovirus in an ecological sensitive area. [2]
12. Construct an age pyramid which reflects an expanding growth status of human population. [2]
13. Describe the mutual relationship between fig tree and wasp and comment on the phenomenon that operates in their relationship. [2]
14. How have transgenic animals proved to be beneficial in : [2]
(a) Production of biological products
(b) Chemical safety testing
15. How does a restriction nuclease function? Explain. [2]
16. Explain the two factors responsible for conferring stability to double helix structure of DNA. [2]
17. In Snapdragon, a cross between true-breeding red flowered (RR) plants and true-breeding white flowered (rr) plants showed a progeny of plants with all pink flowers. [2]
(a) The appearance of pink flowers is not known as blending. Why?
(b) What is this phenomenon known as?
18. Write the effect of the high concentration of L.H. on a mature Graafian follicle. [2]

SECTION – C

19. State the function of a reservoir in a nutrient cycle. Explain the simplified model of carbon cycle in nature. [3]

20. Name and describe the technique that helps in separating the DNA fragments formed by the use of restriction endonuclease. [3]

21. The following graph shows the species – area relationship. Answer the following questions as directed. [3]



- (a) Name the naturalist who studied the kind of relationship shown in the graph. Write the observations made by him.
- (b) Write the situations as discovered by the ecologists when the value of 'Z' (slope of the line) lies between
 - (i) 0.1 and 0.2
 - (ii) 0.6 and 1.2What does 'Z' stand for?
- (c) When would the slope of the line 'b' become steeper?

22. Community Service department of your school plans a visit to a slum area near the school with an objective to educate the slum dwellers with respect to health and hygiene. [3]

- (a) Why is there a need to organise such visits?
- (b) Write the steps you will highlight, as a member of this department, in your interaction with them to enable them to lead a healthy life.

23. Identify 'a', 'b', 'c', 'd', 'e' and 'f' in the table given below: [3]

No.	Syndrome	Cause	Characteristics of affected individuals	Sex Male/Female/Both
1.	Down's	Trisomy of 21	'a' (i) (ii)	'b'
2.	'c'	XXY	Overall masculine development	'd'
3.	Turner's	45 with XO	'e' (i) (ii)	'f'

24. [3]

- (a) Explain adaptive radiation with the help of a suitable example.
- (b) Cite an example where more than one adaptive radiations have occurred in an isolated geographical area. Name the type of evolution your example depicts and state why it is so named.

25. [3]

- (a) Name any two copper releasing IUDs.
- (b) Explain how they act as effective contraceptives in human females.

26. Make a list of any three outbreeding devices that flowering plants have developed and explain how they help to encourage cross-pollination. [3]

OR

Why angiosperm anthers are called dithecous? Describe the structure of its microsporangium.

27. [3]

- (a) State how the constant internal environment is beneficial to organisms.
- (b) Explain any two alternatives by which organisms can overcome stressful external conditions.

SECTION - D

28. Explain the process of sewage water treatment before it can be discharged into natural water bodies. Why is this treatment essential? [5]

OR

Explain the process of replication of a retrovirus after it gains entry into the human body.

29. [5]

(a) Where does fertilization occur in humans? Explain the events that occur during this process.

(b) A couple where both husband and wife are producing functional gametes, but the wife is still unable to conceive, is seeking medical aid. Describe any one method that you can suggest to this couple to become happy parents.

OR

(a) Explain the different ways apomictic seeds can develop. Give an example of each.

(b) Mention one advantage of apomictic seeds to farmers.

(c) Draw a labelled mature stage of a dicotyledonous embryo.

30. [5]

(a) Describe the various steps of Griffith's experiment that led to the conclusion of the 'Transforming Principle'.

(b) How did the chemical nature of the 'Transforming Principle' get established?

OR

Describe how the lac operon operates, both in the presence and absence of an inducer in E.coli.

CBSE
Class XII Biology (Theory)
Board Question Paper 2014 – Outside Delhi (Set 3)
SOLUTION

Time: 3 hrs

Total Marks: 70

SECTION A

1. **Ans.** It is not possible for an alien DNA to become part of a chromosome anywhere along its length and replicate normally because the replication process begins at a particular spot called the origin of replication. Also, replication in eukaryotes occurs in the nucleus during the S phase of the cell cycle when the chromosomes are in their extended form.
2. **Ans.** Segregation of an independent pair of chromosomes occurs during the M phase (mitotic phase) of cell division. Homologous chromosomes line up independently on the metaphase plate.
3. **Ans.** SCP (single cell protein) is a microbial biomass rich in high-quality protein. It is used as an alternate source of protein and is a valuable supplement in human diet. Cells from a variety of microorganisms such as bacteria, yeasts, filamentous fungi and algae are treated in various ways and used as food to supplement proteins.
4. **Ans.** Pollen grains of many species, allergic diseases and bronchial afflictions in some people. The pollen grains of *Parthenium* or carrot grass which came to India as contaminant with imported wheat cause pollen allergy.
5. **Ans.** *Glomus* exhibits symbiotic association with higher plants called mycorrhiza. The root of the plant provides food and shelter to the fungus, and in return, the fungus helps the plant in solubilisation and absorption of minerals, water uptake and protection against pathogenic fungi.
6. **Ans.** Gause's competitive exclusion principle states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior will be eliminated eventually.
7. **Ans.** Lysozyme is used for the isolation of DNA from bacterial cells and chitinase is used for the isolation of DNA from fungal cells.
8. **Ans.** Mammalian insulin is synthesised as a prohormone which undergoes processing to become fully mature and functional insulin molecule. The prohormone

contains an extra chain called C peptide which is removed during the conversion of prohormone to the mature hormone, insulin.

SECTION B

9. **Ans.** The scientific name of fruit fly is *Drosophila melanogaster*. Morgan preferred to work with fruit fly for his experiments because
- (i) It is simple and convenient to breed under laboratory conditions throughout the year.
 - (ii) Its generation time is only 10–12 days.
 - (iii) It breeds quickly and prolifically and so produces large progeny after each mating.
 - (iv) Its contrasting features are easily observable.

OR

Linkage and crossing over of genes are alternatives of each other. Linkage is the tendency of the genes present in the same chromosome to stay together during hereditary transmission, while crossing over is the mutual exchange of segments of non-sister chromatids of homologous chromosomes during the process of meiosis.

An example of linkage: A double dominant female *Drosophila* homozygous for red eyes and normal wings is crossed with a double recessive male *Drosophila* homozygous for purple eyes and vestigial wings. The F₁ flies are heterozygous red-eyed and normal winged. It is then test crossed with a double recessive male having purple eyes and vestigial wings. The F₂ generation comprises two types of flies—red-eyed, normal winged and purple eyed, vestigial winged in the ratio of 1:1. No recombinant types are formed because linkage is complete and no crossing over occurs.

An example of crossing over: A double dominant sweet pea plant homozygous for blue flowers and long pollen grains is crossed with a double recessive plant homozygous for red flowers and round pollen grains. The F₁ flies are heterozygous blue flowered and long pollen grains. It is then crossed with a double recessive plant having red flowers and round pollen grains. The F₂ generation of plants have new combination of traits—blue flowers and round pollen grains and red flowers and long pollen grains. This is due to crossing over, i.e. separation of genes for flower colour and form of pollen grains during gamete formation.

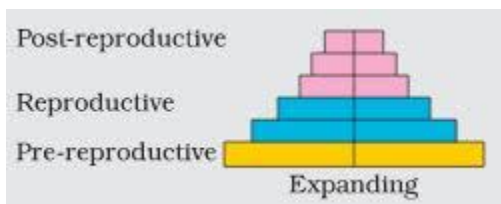
10. **Ans.** Symptoms of Ascariasis:

- (i) Abdominal discomfort
- (ii) Colic pain
- (iii) Fever
- (iv) Indigestion
- (v) Diarrhoea
- (vi) Vomiting

A healthy human being may acquire this infection directly and orally. It can occur through contaminated water, vegetables and fruits.

11. Ans. Nucleopolyhedroviruses are biocontrol agents and useful in controlling many insects and arthropods. They are species-specific narrow spectrum bioinsecticides and have no negative impacts on plants and other organisms or even non-target insects.

12. Ans.

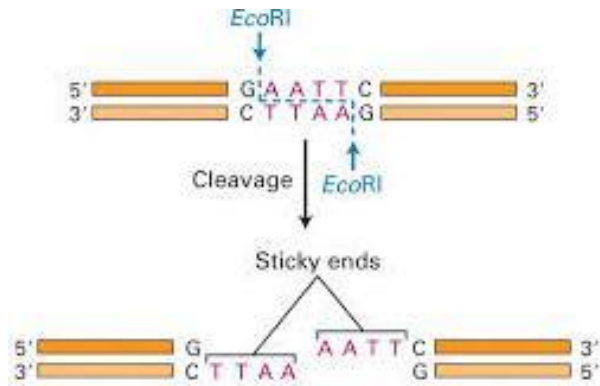


13. Ans. Mutualism exists between fig tree and its pollinator species, wasp, where both individuals are benefited. A fig species can be pollinated only by its partner wasp species and no other species. The female wasp uses the fruit as the egg-laying site and the developing seeds within the fruit for nourishing its larvae. The wasp pollinates the fig inflorescence while finding egg-laying sites, and in turn, fig offers the wasp developing seeds as food for the developing larvae.

14. Ans.

- a. Biological products: Many human diseases are controlled by biological products. The transgenic animals which produce these products are introduced with DNA which codes for a particular product such as human protein (α -I-antitrypsin) for treating emphysema. In 1997, the first transgenic cow (Rosie) was produced, capable of secreting human protein-enriched milk. The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than cow milk.
- b. Chemical safety testing: The transgenic animals are tested to study the sensitivity of toxic substances. Toxicity testing in such animals helps obtain results in less time.

15. Ans. Restriction endonuclease functions by recognising its specific sequence. It binds to the DNA and cuts each to the two strands of the double helix at specific points in their sugar phosphate backbones. These enzymes cut the strand of DNA between the same two bases on the opposite strands leaving a single-stranded portion at their ends. These overhanging stretches are called sticky ends on each strand. The enzyme DNA ligase functions depending on the stickiness of these ends. For example, restriction endonuclease EcoRI found in the colon bacteria *E. coli* recognises the base sequence GAATTC in the DNA duplex and cuts its strands between G and A.



16. Ans. Factors responsible for conferring stability to the double helix structure of DNA are

- The two strands of DNA separated by heating come together when appropriate conditions are provided.
- The presence of thymine at the place of uracil confirms additional stability to DNA.

17. Ans.

- When the red and white flowers varieties of snapdragon are crossed, the F_1 progeny exhibits pink colour flowers. It is not known as blending inheritance because in blending inheritance, the characters are mixed in the offspring and do not segregate.
- This phenomenon is known as incomplete dominance.

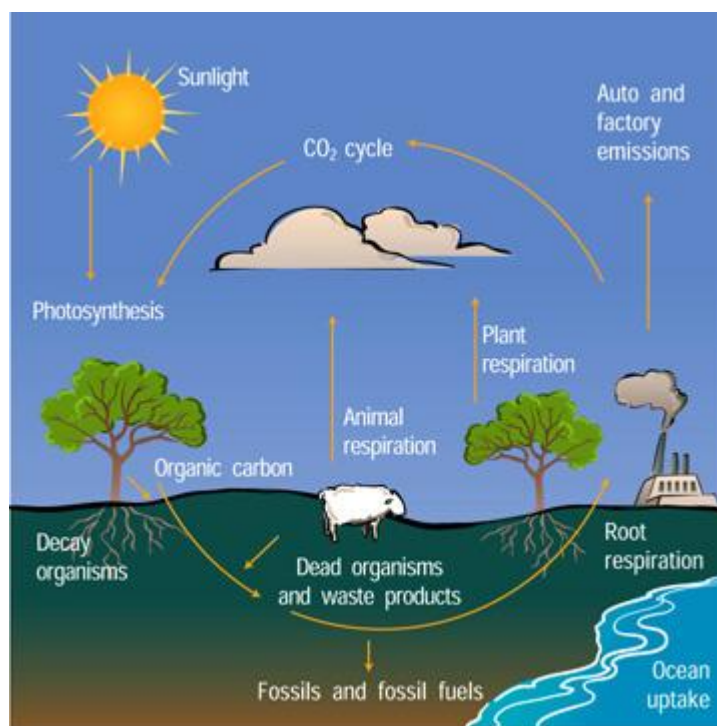
18. Ans. The high concentration of LH surge induces the mature Graafian follicle to burst and eject its egg into the fallopian tube. This is called ovulation.

SECTION C

19.Ans. The function of the reservoir is to meet the deficit which occurs because of an imbalance in the rate of influx and efflux.

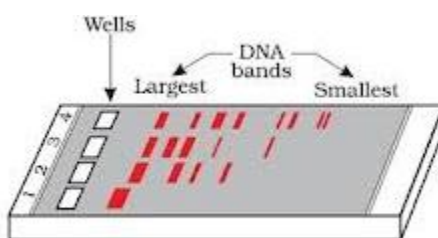
Carbon cycle in nature:

- (i) The main source of carbon in this Universe is CO_2 which is dissolved in water and present in air (0.03–0.04%).
- (ii) Plants take up carbon dioxide from the atmosphere and form organic compounds during photosynthesis. These organic compounds are transferred to animals as their food.
- (iii) The carbon dioxide is returned to the atmosphere during respiration, decay and combustion of plants and animals.
- (iv) The organic compounds of plants and animals are buried in the deep soil where they are acted by decomposers to change them in petroleum, coal, oil and carbonate rocks. These substances on their combustion release carbon dioxide in the atmosphere.
- (v) Some carbon dioxide is found in the dissolved state in water. This gets converted to calcium carbonate in limestone. The weathering and combustion of carbonate-containing rocks or treatment of their minerals give CO_2 .
- (vi) The hot springs and volcanic eruptions also give out CO_2 in the atmosphere.



20. Ans. Gel electrophoresis is a technique of separating DNA fragments formed by the action of restriction endonucleases.

The fragments of DNA are placed in a typical agarose gel under an electric field. The DNA fragments move towards the anode as these fragments are negatively charged molecules. The DNA fragments separate according to their size through the sieving effect provided by the agarose gel. The smaller the fragment size, the farther it moves. The separated DNA fragments are stained with ethidium bromide followed by exposure to ultraviolet radiation. The DNA fragments are seen as orange-coloured and are cut out from agarose gel and extracted from the gel piece. This step is called elution.



21. Ans.

(a) The German naturalist and geographer Alexander von Humboldt studied the species-area relationship.

He found that within a region, the species richness increased with increasing area but up to a certain limit. The relationship between species richness and area turned out to be a rectangular hyperbola for a wide variety of taxa.

(b)

(i) If the value of Z lies in the range of 0.1–0.2, then it is regardless of the taxonomic group or region.

(ii) If the value of Z lies in the range of 0.6–1.2, then the slope of the line will be much steeper.

Z stands for slope of the line or regression coefficient.

(c) If the species-area relationship is for very large areas such as the entire continent, the slope of the line will be much steeper.

22. Ans.

(a) There is a need to organise such visits to make people aware of personal and public hygiene. Maintenance of personal and public hygiene is essential for prevention and control of many infectious diseases.

(b) Steps to be highlighted which enables them to lead a healthy life are

- (i) Intake of hygienic and balanced diet
- (ii) Consumption of clean drinking water
- (iii) Personal and community hygiene
- (iv) Regular physical exercise
- (v) Knowledge about diseases and their effects on the body
- (vi) Immunisation against infectious diseases
- (vii) Proper disposal of wastes and excreta
- (viii) Control of vectors

- (ix) Close contact with the infected persons or their belongings should be avoided in case of air-borne diseases

23. Ans.

N o.	Syndrome	Cause	Characteristics of affected individuals	Sex/Male/Female/Both
1.	Down's	Trisomy of 21	(i) Broad forehead (ii) Permanently open mouth, protruding and furrowed tongue and projecting lower lip	Both
2.	Klinefelter's	XXY	Overall masculine development	Male
3.	Turner's	45 with XO	(i) Short stature females with webbed neck (ii) Body hair absent	Female

24. Ans.

- (a) Development of different functional structures from a common ancestral form is called adaptive radiation.

Examples: Darwin's finches of the Galapagos Islands, Australian marsupials and locomotion in mammals

- (b) Darwin's finches of the Galapagos Islands is an example where more than one adaptive radiations has occurred in an isolated geographical area. They had common ancestors but now have different types of modified beaks according to their food habits. He differentiated thirteen species of finches and grouped them into main types—large ground finches, cactus ground finches feeding on cacti, vegetarian tree finches, insectivorous tree finches, warbler finches and tool using or woodpecker finches.

This type of evolution is called divergent evolution as in this process the new species produced is diverged from a single ancestral form and is adapted to new invaded habitats.

25. Ans.

- (a) The copper-releasing IUDs are Multiload 375 and CuT.
- (b) IUDs increase the phagocytosis of sperms in the uterus and the copper ions released decrease sperm motility and prevent fertilisation.

26. Ans. The outbreeding devices in flowering plants which encourage cross-pollination are

- (i) Dicliny: Flowers are unisexual so that self-pollination is not possible. The plants may be monoecious (bearing both male and female flowers such as maize) or dioecious (bearing male and female flowers on individual plants such as mulberry and papaya).
- (ii) Prepotency: Pollen grains of another flower germinate more rapidly over the stigma than the pollen grains of the same flower. Examples: Apple, grape
- (iii) Self-sterility: Pollen grains of a flower do not germinate on the stigma of the same flower because of the presence of similar self-sterile gene. Examples: Tobacco, potato, crucifers

OR

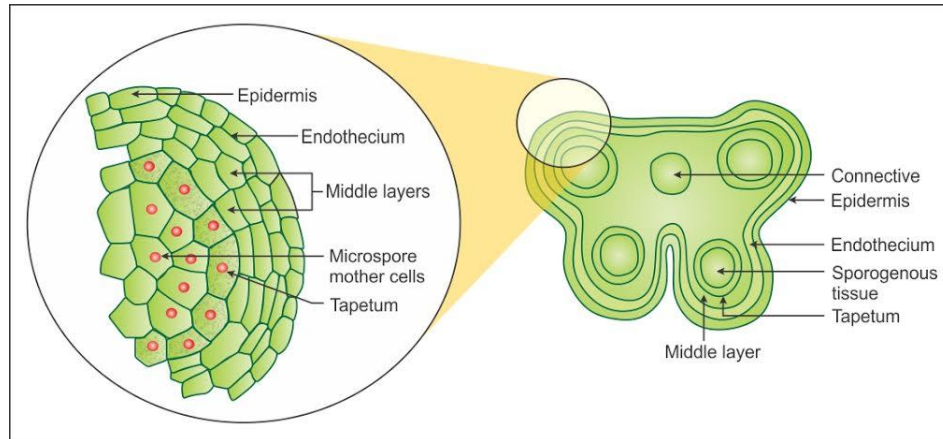
A typical angiosperm anther is broad, terminal and bilobed. Each lobe of the anther has two pollen sacs which, at maturity, fuse to form a single chamber called the thecus, so it is called dithecal.

A microsporangium is a cylindrical sac which appears circular in the transverse section. It contains the following parts:

- (i) Outer wall
- (ii) Central homogeneous sporogenous tissue
- (iii) Epidermis
- (iv) Endothecium
- (v) 1–3 middle layers and tapetum

The outer three layers perform the function of protection in the younger anther and the mechanism of dehiscence in the ripe anther.

The endothelial cells develop fibrous thickening of α -cellulose on the inner and radial walls and die. The innermost layer is called tapetum. It nourishes the developing pollen grains.



27. Ans.

- (a) Homeostasis is the property of a system in which variables are regulated so that internal conditions remain stable and relatively constant. Example of homeostasis includes the regulation of temperature and the balance between acidity and alkalinity. It is the process which maintains the stability of the human body's internal environment in response to changes in external conditions.
- (b) The alternatives by which organisms can overcome stressful external conditions are
- (i) Migrate: Some organisms migrate temporarily from an unfavourable habitat to a more favourable habitat and return when the favourable period is over. Example: Migratory birds move from very cold northern regions to warmer places.
 - (ii) Suspend: Some organisms avoid the unfavourable environment by escaping from it. Example: Polar bears hibernate during winter to escape extreme cold. Some snails and fish undergo aestivation to avoid summer-related problems such as heat and desiccation.

SECTION D

28. Ans. The sewage in sewage treatment plants is carried out in two ways:

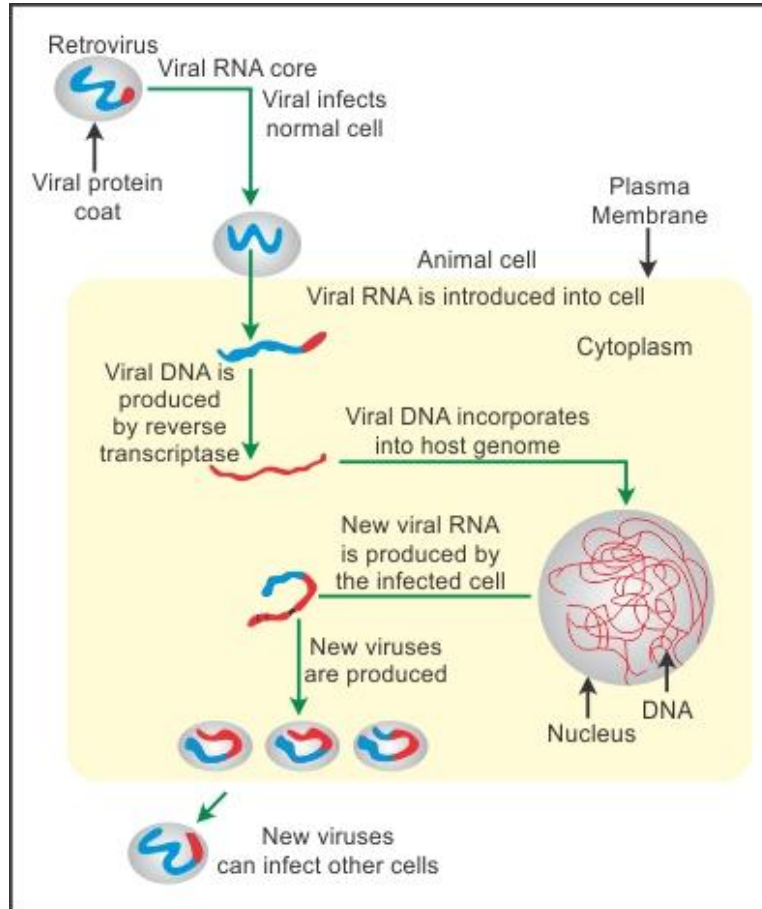
(a) Primary treatment: It involves the physical removal of particles from sewage through filtration and sedimentation. Floating debris is removed by filtration and grit is removed by sedimentation. Thus, all solids which settle form the primary sludge and the supernatant forms the effluent.

(b) Secondary treatment: The effluent from primary treatment is passed to aeration tanks where air is pumped into it. This allows the growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments) and microbes consume the major part of the organic matter in the effluent. This reduces the BOD (biological oxygen demand) of the effluent.

The effluent is then passed into the settling tank where bacterial flocs are allowed to sediment. This sediment is called activated sludge. The small portion of this activated sludge is again passed to the aeration tank to serve as inocula. The remaining major part of this sludge is pumped into large anaerobic sludge digesters. Here, anaerobic bacteria digest bacteria and fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, H_2S and CO_2 . This treatment is essential as the sewage or municipal waste discharged into rivers, streams and other water bodies contains human excreta, organic wastes and several pathogenic microbes.

OR

HIV is a retrovirus which has RNA genomes and it replicates via DNA copies. On infection, the virus enters the macrophages where viral RNA genome is converted to viral DNA copy with the help of an enzyme reverse transcriptase. This viral DNA copy of HIV is inserted into human chromosomes and replicates with the cell DNA.



29.Ans.

(a) Fertilisation in humans occurs in the fallopian tube of the female reproductive system.

It is the process of fusion of a haploid sperm and a haploid ovum to form a diploid zygote. The process of fertilisation is completed under the following major steps:

- (i) **Attraction:** During copulation (intercourse of coitus), millions of sperms are inserted into the vagina of the female through the penis. The sperms swim in the fluid mucous lining of the female genital tract at the rate of 1.5–3.0 mm per minute to reach the ovum in the upper part of the fallopian tube where fertilisation occurs. The ova are formed in the ovaries and are released into the abdominal cavity through ovulation. One mature egg is released from the ovary on the 14–15 day of the menstrual cycle and that is picked off by the fimbriae of the ampulla of the fallopian tube. The ovum enters the fallopian tube and moves in it by the muscular contractions and ciliary action of the epithelium of the fallopian tube. The ovum secretes a chemical substance called fertilizin glycoprotein or mucopolysaccharide to attract the sperms. The sperms produce a chemical substance antifertilizin (protein). Each species produces a specific type of fertilizin and antifertilizin, and the reactions between them bring about the process of fertilisation.
- (ii) **Penetration of sperm into ovum:** The human ovum is a rounded and non-motile structure surrounded by the vitelline membrane, zona pellucida and corona radiata. The radially arranged follicle cells of the corona radiata are attached by a complex organic substance called hyaluronic acid (a

mucopolysaccharide) which acts as a barrier for the entry of sperms. The human sperm undergoes several changes so that it may be able to fertilise the ovum. This is called capacitation of sperm. The sperm attaches to the surface of the ovum near the animal pole and starts penetrating the various membranes of the egg. The acrosome of the sperm bursts and secretes sperm lysins containing an enzyme hyaluronidase to dissolve the adhesive substance and to disperse the cells of the corona radiata. Ultimately, with the help of sperm lysin, one sperm penetrates the layers of the corona radiata and zona pellucida in about 30 minutes.

- (iii) Activation of the ovum: After the penetration of sperm, a series of changes are brought about in the egg cortex. The dark cortical granules appear below the cell membrane in the cortex which migrates through the plasma membrane. These granules get attached along the inner surface of the vitelline membrane and make it thick. This thickened vitelline membrane is called the fertilisation membrane which prevents polyspermy by inhibiting the entry of other sperms.
- (iv) Fusion of sperm and ovum nuclei: The sperm entry stimulates the ovum to undergo a second meiotic division for the removal of the last polar body. Usually the sperm head and middle piece enter the ovum through a definite path called the copulation path. The sperm nucleus acts as the male gamete and the egg nucleus as the female gamete. The centrioles of the middle piece of sperm form the spindle and the nuclear membranes of the sperm and ovum break down. This process of mixing up of the haploid sperm nucleus with the haploid egg nucleus is called amphimixis. The fusion product of sperm and egg pronuclei results in the formation of a diploid zygote which initiates pregnancy in females.

- (b) *In vitro* fertilisation: In this method, fertilisation occurs outside the body and is followed by embryo transfer (ET). This technique is applied when the fallopian tube of the mother is blocked and she is unable to conceive. In this technique, the egg of a wife/donor is removed and fertilised (*in vitro*) by the husband/donor sperm outside her body under sterile conditions. When the fertilised egg reaches the 8-celled stage, it is transferred into the fallopian tube and embryos with more than 8 blastomeres into the uterus to complete its further development.

OR

- (a) Apomixis is the formation of new individuals through asexual reproduction without involving the formation and fusion of gametes.

The two common types of apomixis are recurrent agamospermy and adventive embryony.

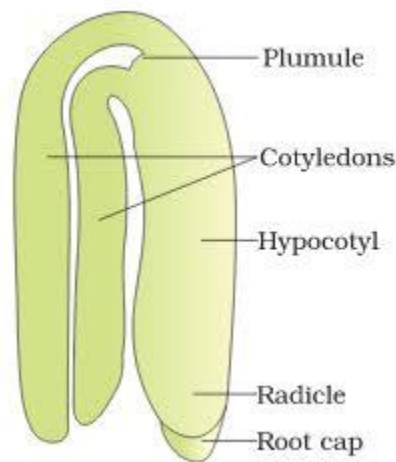
- (i) Recurrent agamospermy: Agamospermy is the formation of seed and has an embryo formed without meiosis and syngamy. It is of two types—noncurrent and recurrent. In noncurrent agamospermy, the embryo is haploid. Therefore, the seed having it is nonviable. In recurrent agamospermy, all the cells of the embryo sac are diploid as they are formed directly either from a nucellar cell (apospory) or diploid megaspore mother cell (diplospory). The diploid egg and other diploid cells of the embryo sac can grow into normal embryos. The formation of the embryo directly from the diploid egg without fertilisation is called diploid parthenogenesis. Example: Rubus, apple, poa

(ii) Adventive embryony (sporophytic budding): The formation of an embryo directly from the diploid sporophytic cells such as nucellus and the integument of the ovule is called adventive embryony. Examples: Citrus, *Opuntia*. During embryogenesis, an embryo develops from the zygote inside the embryo sac and the embryo sac becomes an endosperm. Apomictic embryo, if developed, increases the number of embryos inside the seed, called polyembryony.

In gymnosperms, polyembryony can also occur because of the cleavage of the growing embryo. It is called cleavage polyembryony. Occurrence of polyembryony because of fertilisation of more than one egg is called simple polyembryony. Formation of extra embryos through sporophytic budding is called adventive polyembryony. Polyembryony is quite common in onion, groundnut, mango, lemon and orange.

(b) Embryos formed through apomixes are generally free from infection.

(c)



30.Ans.

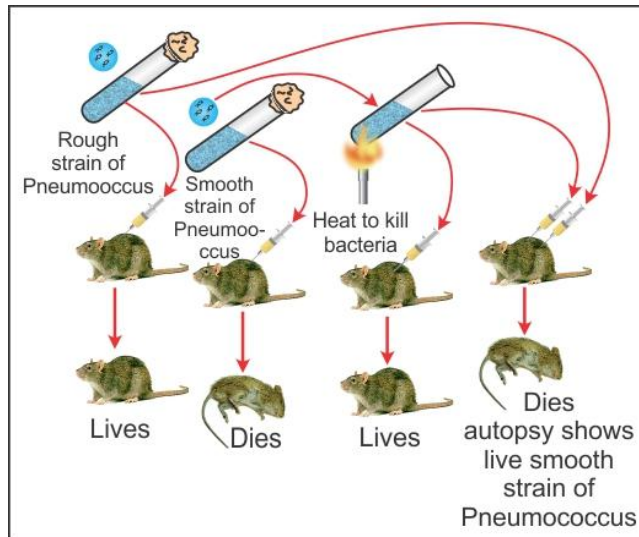
(a) S. F. Griffith demonstrated bacterial transformation experimentally by performing experiments on *Diplococcus pneumonia*. It has two distinct forms—one form secretes a polysaccharide capsule which gives the colonies a smooth appearance and another form is non-capsulated which gives the colonies a rough appearance. The capsule of the smooth form (S) is virulent and gives an infected animal the disease pneumonia, while the rough form (R) is not virulent.

The main steps are as follows:

- (i) Griffith conducted his experiments on *Diplococcus pneumonia* which causes pneumonia in mice. He injected the 'S' type living bacteria into mice and they died because of pneumonia.
- (ii) He then injected live non-virulent bacteria (R) into mice and they did not suffer from pneumonia.
- (iii) He then injected heat-killed virulent 'S' type bacteria into mice and they survived equally well.
- (iv) Finally, he injected a mixture of heat-killed 'S' and live 'R' simultaneously, the

mice died with symptoms of pneumonia. Living 'S' type bacteria were recovered from their bodies.

The occurrence of the living 'S' type virulent bacteria is possible only by their formation from the 'R' type non virulent bacteria which pick up the trait of virulence from dead bacteria. This phenomenon is called the Griffith effect or transformation. Thus, transformation is the transferring of characters from one strain to another using the DNA extract of the former.



- (b) Oswald Avery, Colin MacLeod and Maclyn McCarty concluded that DNA is the hereditary material. They discovered that the protein-digesting enzymes (proteases) and RNA-digesting enzymes (RNases) did not affect transformation. So, the transforming substance was not a protein or RNA. However, digestion with DNase inhibits transformation; therefore, they concluded that DNA is the hereditary material.

OR

Lac operon consists of regulator gene, promoter gene, operatoral gene and structural gene.

The *E. coli* bacterium carries numerous genes and these genes turn on and off according to requirement. When these genes are turned on, they undergo enzymes which metabolise the new substrate. This phenomenon is known as induction and the small molecules eliciting this induction are called inducers. In this lac operon, the presence of lactose acts as an inducer.

The lac operon contains a promoter, an operator and three closely related structural genes, *z*, *y*, *a* coding for enzymes β -galactosidase, β -galactoside permease and β -galactoside transacetylase, respectively. β -galactoside permease pumps lactose into the cells, whereas β -galactosidase catalyses the conversion of lactose into glucose and galactose. These genes are not expressed in the absence of lactose. The promoter (P) for the operon is the site at which RNA polymerase binds to initiate transcription of the structural genes. The operator (O) is the site at which the protein repressor—the product of regulator gene binds. In the presence of a regulator protein, the RNA-polymerase is prevented from attaching

to the promoter.

A regulator gene is a DNA segment independent of an operon and it synthesises a repressor protein. This protein combines with the operator and makes it inactive. This prevents RNA polymerase from binding to the adjoining promoter (P) and from initiating transcription of the structural gene. Therefore, RNA polymerase is required to negotiate the operator before transcription can occur. The repressor binds to the operator in the absence of a metabolite (effector molecule – lactose). When an inducer or effector molecule-lactose is added to the system, it binds to the repressor to form a complex which is unable to bind the operator. The RNA polymerase enzyme now becomes free to bind to the promoter (P) and so the operator is switched on. This initiates the transcription of structural genes, producing the three polypeptides. These enzymes bring about the metabolism of lactose into glucose and galactose.

