Class XII Session 2023-24
Subject - Biology
Sample Question Paper – 2

Maximum Marks: 70 **Time: 3 Hours**

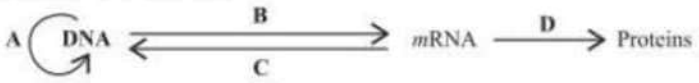
General Instructions:

(i) All questions are compulsory.
(ii) The question paper has five sections and 33 questions. All questions are compulsory.
(iii) Section-A has 16 questions of 1 mark each; Section-B has 5 questions of 2 marks each; Section- C has 7 questions of 3 marks each; Section- D has 2 case-based questions of 4 marks each; and Section-E has 3 questions of 5 marks each.
(iv) There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
(v) Wherever necessary, neat and properly labeled diagrams should be drawn.

SECTION – A

1. The three codons which result in the termination of polypeptide chain synthesis are
(a) UAA, UAG, GUA
(c) UAA, UGA, UUA
(b) UAA, UAG, UGA
(d) UGU, UAG, UGA.

2. The given flow chart represents the flow of genetic information between biomolecules. Identify the processes A, B, C and D and select the correct option.



	A	B	C	D
(a)	Translation	Transcription	Replication	Reverse Transcription
(b)	Replication	Transcription	Translation	Reverse Transcription
(c)	Replication	Transcription	Reverse Transcription	Translation
(d)	Replication	Reverse Transcription	Transcription	Translation

3. Which of the following appeared during ice age between 75,000 - 10,000 years ago?
(a) Cro-Magnon man
(b) Neanderthal man

(c) Modern Homo sapiens
(d) Heidelberg man

4. Which of the following equations correctly represents Verhulst-Pearl logistic growth?

(a) $dN/dt=rN\left(\frac{K-N}{K}\right)$

(b) $dN/dt=\frac{rN}{K}$

(c) $dN/dt=\left(\frac{N(K-N)}{K}\right)$

(d) $dN/dt=\left(\frac{r(K-N)}{K}\right)$

5. Introduction of Nile Perch in lake Victoria of East Africa resulted in
(a) excessive growth of water weeds
(b) elimination of water weeds
(c) elimination of many species of cichlid fish
(d) excessive growth of cichlid fish.

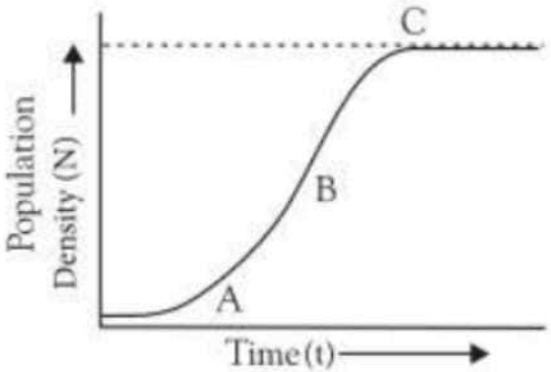
6. During isolation of genetic material, the chemical used to precipitate out the purified DNA is
(a) bromophenol blue
(b) chilled ethanol
(c) ethidium bromide
(d) both (b) and (c).

7. Match column I (enzyme) with column II (characteristic/activity) and select the correct answer from the given codes.

	Column I		**Column II**
A.	*Taq* DNA polymerase	(i)	Cleaves the ends of linear DNA
B.	Exonuclease	(ii)	Breakdown of fungal cell wall
C.	Protease	(iii)	Stable above 90°C
D.	Chitinase	(iv)	Made only by eukaryotic cells
		(v)	Degradation of proteins

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

8. For a population, the population density (N) was plotted against time (t) and growth curve obtained is shown in figure marked by A, B and C. Find the correct information about marked phases.



(a) A-initial log phase of growth
(b) C-final growth phase with rapid increase
(c) B-middle log phase with exponential growth
(d) A-initial exponential growth phase

9. Everytime, when the dosage of a drug has to be increased to achieve the same 'kick' that initially occurred in response to a smaller dose, this condition is known as
(a) rebound effect
(c) withdrawal symptoms
(b) tolerance
(d) addiction.

10. Which of the following is widely used as a successful biofertiliser in Indian rice field?
(a) Rhizobium
(c) Acalypha indica
(b) Acacia arabica
(d) Azolla pinnata

11. Match List I with List II and select the correct option from the given codes.

	List I		**List II**
A.	Parthenocarpy	(i)	Seed formation without fertilisation
B.	Polyembryony	(ii)	More than one embryo in same seed
C.	Apomixis	(iii)	Seedless fruits without fertilsation
D.	False fruit	(iv)	Thalamus contributes to fruit formation

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

12. Pollination in water hyacinth and water lily is brought about by the agency of
(a) water
(b) insects or wind
(c) birds
(d) bats.

Question No. 13 to 16 consist of two statements - Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

13. Assertion: Net primary productivity is equal to gross primary productivity minus respiration.
Reason: Secondary productivity is produced by heterotrophs.

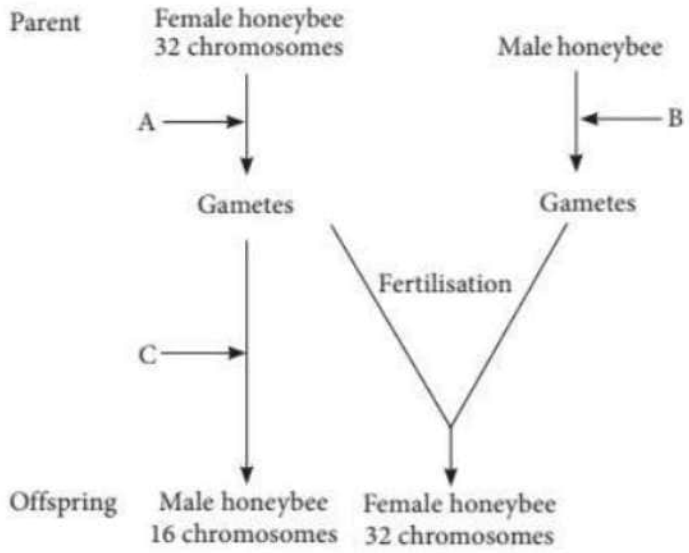
14. Assertion: Plasmodium is an endoparasite.
Reason: Plasmodium lives over the surface of their host.

15. Assertion: A network of food chains existing together in an ecosystem is known as a food web.
Reason: An animal like kite cannot be a part of a food chain.

16. Assertion: Water constitutes a major mode of pollination in most of the aquatic angiospermous plants.
Reason: Vallisneria and Zostera are examples of water pollinated plants.

SECTION – B

17. The cytological observations made in a number of insects led to the development of the concept of genetic/ chromosomal basis of sex determination mechanism. Honeybee is an interesting example to study the mechanism of sex-determination. Study the schematic cross between the male and the female honeybees given below and answer the questions that follow:



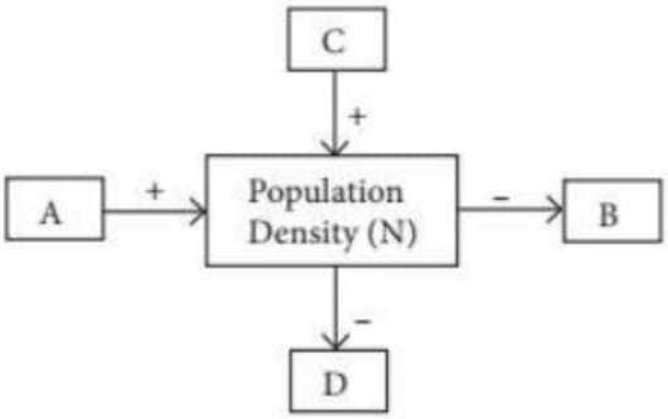
(a) Identify the cell divisions 'A' and 'B' that lead to gamete formation in female and male honeybees respectively.
(b) Name the process 'C' that leads to the development of male honeybee (drone).

18. Explain the processes of emasculation and bagging of flowers. State their importance in breeding experiments.

19. Suggest a technique to a researcher who needs to separate fragments of DNA.

20. Ringworm is one of the most common infectious fungal disease in humans. Name any two genera of fungi which cause ringworm and state any of its two symptoms.

21.



Study the schematic representation given above and answer the following questions.
(a) Identify A in it.

(b) When population density at time t is N as shown above, write the population density at time t + 1 in the form of an equation using appropriate symbols.

OR

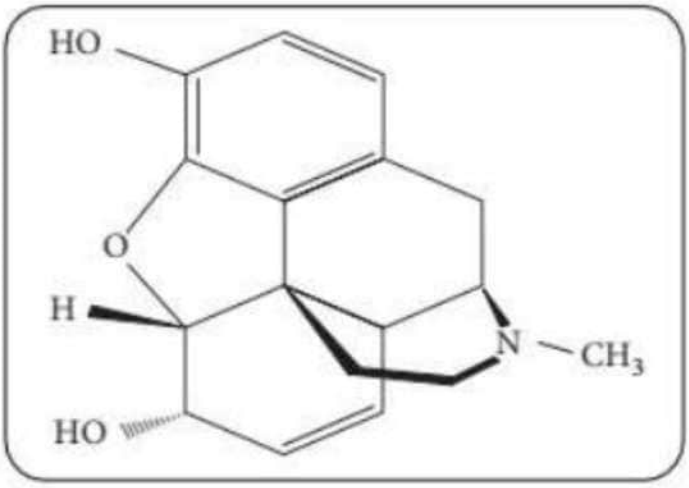
If 8 individuals in a population of 80 butterflies die in a week, calculate the death rate of population of butterflies during that period.

SECTION – C

22. Why is the possibility of a human female suffering from haemophilia rare? Explain.

23. How would lac operon operate in E. coli growing in a culture medium where lactose is present as source of sugar?

24. Identify the chemical structure of compound shown below. State any three of its physical properties.



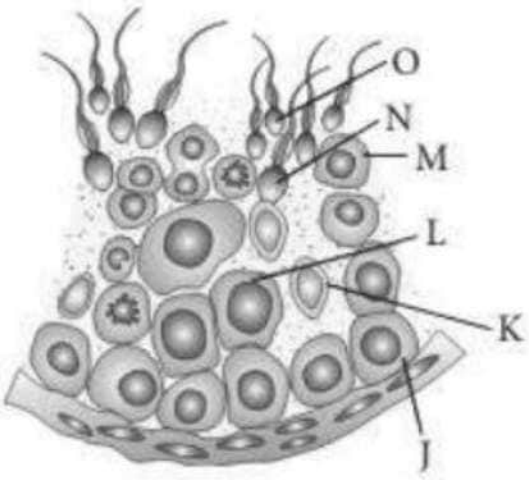
25. Explain the roles of the following with the help of an example each, in recombinant DNA technology:
(a) Restriction endonucleases
(b) Plasmids

26. Many plant and animal species are on the verge of their extinction because of loss of forest land by indiscriminate use by the humans. As a biology student what method would you suggest along with its advantages that can protect such threatened species from getting extinct?

OR

Compare narrowly utilitarian and broadly utilitarian approaches to conserve biodiversity, with the help of suitable examples.

27. Study the transverse section of part of seminiferous tubule and answer the following questions.



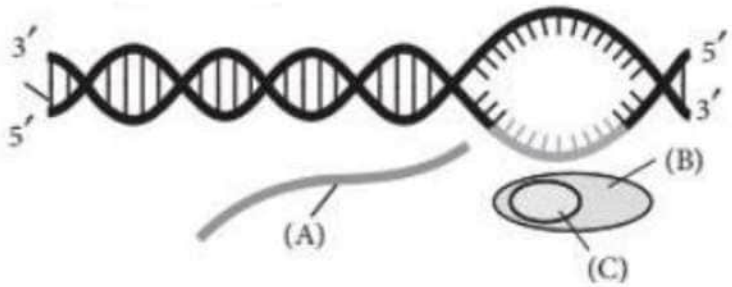
(a) Identify the cell that undergo reduction division to form secondary spermatocyte.
(b) How many among the labelled parts have 46 chromosomes?
(c) State the role of 'K' in this figure.

28. Explain the events in a normal woman during her menstrual cycle on the following days:
(a) Pituitary hormone levels from 8 to 12 days.
(b) Uterine events from 13 to 15 days.
(c) Ovarian events from 16 to 23 days.

SECTION-D

Q. No. 29 and 30 are case based questions. Each question has 3 subparts with internal choice in one subpart.

29. The process of copying genetic information from template strand of DNA into RNA is called transcription. It is mediated by RNA polymerase. Transcription takes place in the nucleus of eukaryotic cells. In transcription, only a segment of DNA and only one of the strands is copied into RNA. Transcription mainly consists of three steps. One of the steps of transcription is given below.

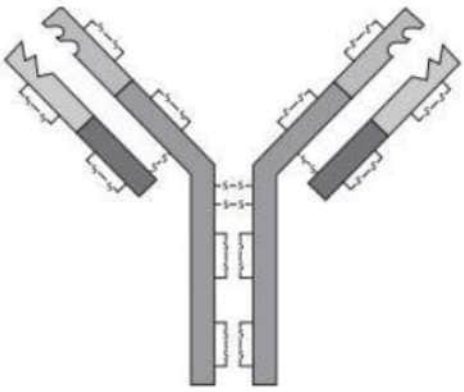


(a) Identify the given step and name the labels B and C.

OR

What will happen if C is not available in the above process?
(b) What changes will take place in A after the completion of above process in eukaryotes?
(c) Briefly explain the previous step or given figure taking place in prokaryotes.

30. Acquired immunity is pathogen specific and characterised by memory. Whenever our body encounters a pathogen for the first time, it produces a response. Subsequent encounter with the same pathogen elicts a highly intensified secondary response.
(a) Name the two lymphocytes which are responsible for acquired immunity.
(b) Identify the structure shown in the figure.



(c) It is generally observed that the children who had suffered from chicken-pox in their childhood may not contract the same disease in their adulthood. Explain giving reasons the basis of such an immunity in an individual. Name this kind of immunity.

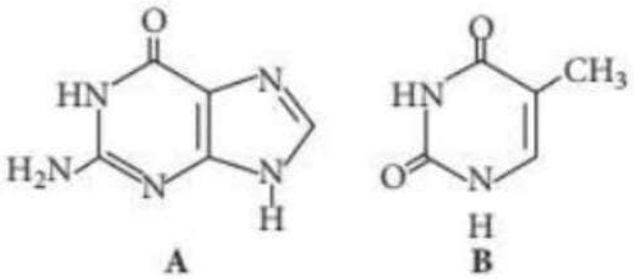
OR

Differentiate between the two lymphocytes responsible for acquired immunity.

SECTION – E

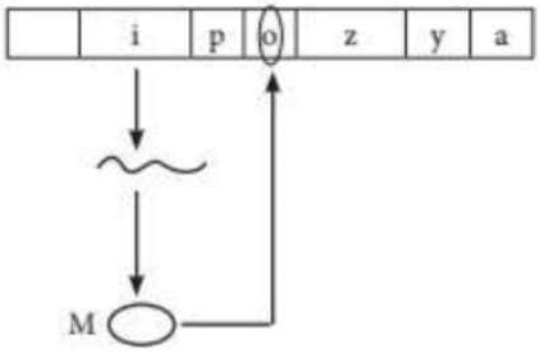
31. Explain the different stages of oogenesis in humans starting from fetal life till its completion. When and where in body is oogenesis completed?
(a) Trace the development of embryo after syngamy in a dicot plant with diagrams.
(b) Endosperm development precedes embryo development. Give reason.

32. Observe the given figures and answer the following questions.
(a) Identify the nitrogenous bases A and B.
(b) Where are these molecules found?
(c) What are the type and number of bonds they form with other nitrogenous bases?



OR

Refer to given figure showing regulation of gene expression in
E.coli and answer the following questions.
(a) Name the molecule 'M' that binds with the operator.
(b) Mention the result of such binding.
(c) What will prevent the binding of the molecule 'M' with the operator gene? Mention the event that follows.



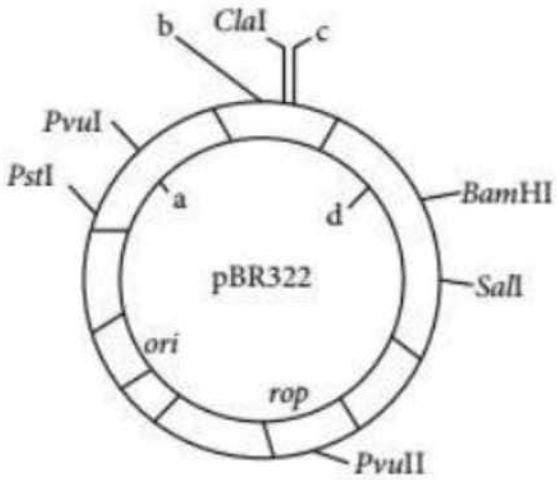
33. (a) A and B are the two different cloning vectors in two different bacterial colonies cultured in chromogenic substrate. Bacterial colonies with cloning vector A were colourless whereas those with B were blue coloured. Explain giving reasons the cause of the difference in colour that appeared.

(b) What are cloning vectors? Give examples.

(c) How do ori' and 'cloning sites' facilitate cloning into a vector?

OR

(a) Identify the selectable markers in the diagram of E. coli vector shown below.



(b) How is the coding sequence of B-galactosidase considered a better marker than the ones identified by you in the diagram? Explain.

SOLUTIONS

1. (b)

2. (c) DNA replication (A) refers to the process of formation of two similar copies of DNA using parental DNA as template. The expression of the genetic material occurs normally through the production of proteins. This involves two consecutive steps. These are transcription (B) and translation (D). The DNA codes for the production of messenger RNA (mRNA) during transcription. mRNA carries coded information to ribosomes. The ribosomes read this information and use it for protein synthesis. This process is called translation. Crick described this unidirectional flow of information in 1958 as the central dogma of molecular biology. Many tumour viruses contain RNA as genetic material and replicate by first synthesising a complementary DNA. This process is called reverse transcription (teminism) (C). It is carried out by an RNA-dependent DNA polymerase called reverse transcriptase.

3. (c)

4. (a)

5. (c)

6. (b) The purified DNA after treatment with various enzymes, precipitates out after addition of chilled ethanol. This is viewed as a collection of fine threads in the suspension and is easily collected. The process is known as DNA spooling.

7. (d)

8. (c): The middle phase is exponential log phase where population grows rapidly/exponentially. A is initial lag phase and C is phase of senescence.

9. (b) Tolerance is the reduction or loss of the normal response to a drug or other substance that usually provokes a reaction in the body. Drug tolerance may develop after taking a particular drug over a long period of time. In such cases increased doses are necessary to produce the desired effect. Some drugs that cause tolerance also cause dependence.

10. (d)

11. (b)

12. (b) In aquatic plants with emergent flowers, e.g., water lily and water hyacinth, pollination takes place by wind or insects.

13. (b) Net primary productivity is the rate of organic matter built up or stored by producers in their bodies in a unit area/volume per unit time. Net productivity is equal to gross primary productivity minus loss due to respiration and other reasons. Rate of assimilation of the food energy as organic matter or biomass by heterotrophs or consumers per unit time and area is known as secondary productivity.

14. (c) Plasmodium is a malarial parasite which lives intracellularly inside the body of host. The parasites that live inside the host is called endoparasites.

15. (c): The process of transfer of energy from producers through a series of organisms i.e., from primary consumers to secondary consumers to tertiary consumers by process of eating and being eaten constitute a food chain, e.g., grassland ecosystem. Food chains can never occur independently in ecosystem but various food chains are inter-connected with each other forming an interlocked system known as food web. In grassland ecosystem food chains may be-
(i) Grass → Rabbit → Hawk/Kite
(ii) Grass → Mouse → Snake → Kite/Hawk
(iii) Grass Grasshopper→ Lizard → Kite/Hawk
So, the food chain will always include kite.

16. (d) Hydrophily is the mode of pollination (transfer of pollen grains from the mature anther of a flower to the stigma of another flower) which is
accomplished through the agency of water. Pollination by water is quite rare in flowering plants and is limited to only about 30 genera, mostly monocotyledons, e.g., Vallisneria, Zostera, Ceratophyllum, etc. In many aquatic plants with emergent flowers, pollination occurs by wind or insects, e.g., lotus, water lily, water hyacinth, etc.

17. (a) Female honeybee produces eggs through meiosis (A) and male honeybee produces sperms through mitosis(B).
(b) Male honeybee (drone) develops through
parthenogenesis (C) i.e., direct development of the haploid egg without fertilisation.

18. Emasculation is the removal of the anthers of a bisexual flower in order to prevent self-pollination. Bagging involves covering of emasculated flowers by butter paper or polythene in order to protect them from contamination by foreign or undesirable pollen. Emasculation and bagging are important steps of artificial hybridisation technique used in crop improvement programmes.

19. Separation of DNA fragments can be done by a technique called agarose gel electrophoresis. In this technique, the DNA molecules are separated according to their size, under the influence of an electric field (DNA being negatively charged moves from cathode to anode).

20. The two genera of fungi which causes ringworm are - Microsporum and Trichophyton. Two symptoms of ringworm are:
(i) Appearance of dry, scaly lesions on various parts of the body such as skin, nails and scalp.
(ii) These lesions are accompanied by intense itching.

21. (a) In the given figure, A can be natality or immigration.
(b) If N is the population density of time t, then its density at time t + 1 will be:
$N_{t+1}=N+[(B+I) - (D+E)]$ Where, B = Natality, I = Immigration, D = Mortality and E = Emigration.

OR

Death rate is defined as the ratio of deaths to the population of a particular area or during a particular period of time usually calculated as number of deaths per 1000 individuals of a population. Since, total number of butterflies = 80, Number of butterflies that died = 8

$$\text{Death rate} = \frac{8}{80} = 0.1 \text{ butterflies per week}$$

22. Haemophilia is genetic disorder caused due to the presence of a recessive sex linked gene 'h', carried by X chromosome. It is generally observed in males as a single gene for the defect is able to express itself as the Y chromosome is devoid of any corresponding allele (XY). Women will only suffer from this disorder when a carrier woman (XX) marries with haemophilic man (XY). 50% girl babies will be carriers (XX) while the remaining 50% will be haemophilic (Xhxh).

23. When lactose is present in the culture medium, then the lac operon in E. coli is switched on. It is because the inducer (lactose) binds to the repressor protein thereby inactivating it. It prevents binding of repressor to the operator. Consequently, RNA polymerase gets access to the promoter and transcription of structural genes proceeds.

24. The given structure represents morphine. Following are the three physical properties of morphine.
(i) It is white in colour.
(ii) It is odourless compound.
(iii) It is crystalline in nature.

25. (a) Restriction endonucleases: Restriction endonucleases serve as a tool for cutting DNA molecules at predetermined sites, which is the basic requirement for gene cloning or recombinant DNA technology. For example, restriction endonuclease EcoRI found in the colon bacteria Escherichia coli, recognises the base sequence GAATTC in DNA duplex and cuts its strands between G and A as shown:

(b) Plasmids Plasmids are essential in biotechno- logical experiment as they help in transferring a segment of foreign DNA (gene of interest) into suitable host. Ti plasmid is widely used vector for cloning genes in plants. Plasmids have been modified to serve as vectors in the laboratory. The most widely used, versatile, easily manipulated vector, pBR322 is an ideal plasmid vector. It was the first artificially cloned vector and is used widely in gene cloning experiments.

26. Conservation of biodiversity is protection, uplift and scientific management of biodiversity so as to maintain it at its optimum level and derive sustainable benefits for the present as well as future generations. There are two types of conservation strategies - in situ (on site) and ex situ (offsite). In situ conservation is conservation and protection of the whole ecosystem and its biodiversity at all levels in their natural habitat in order to protect the threatened species. It involves hotspots and protected areas. Hotspots are areas of high endemism and high level of species richness. Protected areas are ecological/ biogeographical areas where biological diversity along with natural and cultural resources is protected, maintained and managed through legal or other effective measures. Protected areas include National parks, sanctuaries and biosphere reserves. Ex-situ conservation is conservation of threatened plants and animals in places outside their natural homes under full protection and supervision. It includes offsite collections and gene banks.

OR

There are a number of reasons to conserve biodiversity
which can be grouped as: Narrow utilitarian: Human derive a major part of their requirement from organisms. Their direct benefits are countless. For example:
(i) Food cereals: Pulses, fruits and vegetables are derived from plants and milk, egg and meat are derived from animals
(ii) Fats and oils are obtained from plants and animals.
(iii) Firewood as a source of energy for cooking and heating.

(iv) Fibres, e.g., cotton, flax silk, wool.
(v) Industrial products like tannins, lubricant, dyes, resins, and perfumes.
(vi) Drugs: Nearly 25% of drugs being used by us are directly coming from plants. Broadly utilitarian: Biodiversity is fundamental to ecosystem services of nature. For example,
(i) Oxygen: Through their photosynthetic activity plants are replenishing oxygen of the atmosphere. Amazon rainforest is estimated to contribute 20%
of it.
(ii) Pollination: Bees, bumble bees, butterflies, moths, beetles, birds and bats are engaged in pollination of plants which is essential for formation
of fruits and seeds.
(iii) Climate regulation: Forest and oceanic systems regulate global climate. (iv) Aquifers: Plant cover is essential for retention of rain water, its percolation and storage in aquifers and reservoirs.
(v) Flood and erosion control: Plant cover protects the soil from wind and water erosion. Run off of rain water is reduced so that flood water is rarely formed.
(vi) Nutrient cycling: It is essential for continued availability of nutrients to plants without which there would be no photosynthetic activity.

27. (a) L represents primary spermatocyte, that undergo meiosis, which forms two equal haploid cells called secondary spermatocytes.
(b) Spermatogonium (J) and primary spermatocytes
(L) are diploid (2N), i.e., have 46 chromosomes.
(c) The cells that nourish the germ cells in the testes are called Sertoli cells (K). Sertoli cells are located in the germinal epithelium of the seminiferous tubules.

28. (a) From 8-12 days (follicular phase), the level of gonadotropins (LH and FSH) increase gradually and stimulate follicular development as well as secretion of estrogens by growing follicles.
(b) From 13 to 15 days, the endometrium becomes thicker by rapid cell multiplication and there is increase in uterine glands and blood vessels.
(c) From 16 to 23 days, the remaining cells of the ovarian follicles are stimulated by the LH to develop corpus luteum. The corpus luteum secretes progesterone which is required for the maintenance of endometrium. In the absence of fertilisation, corpus luteum degenerates causing disintegration of endometrium leading to menstruation that takes place for 3-5 days.

29. (a) The given figure represents the termination process during transcription in bacteria. A is mRNA transcript, B is RNA polymerase and C is Rho factor.

OR

When RNA polymerase reaches to termination region, rho factor finds it and alters its specificity. As a result, the process of transcription terminates if Rho factor is absent, termination will not occur.
(b) After the completion of transcription, in eukaryotes, the newly formed RNA undergoes three processes, namely, splicing, capping and tailing.
(c) With the help of RNA polymerase the adjacent ribonucleotides held over DNA template to form RNA chain. As the RNA chain formation initiates, the sigma (o) factor of the RNA polymerase separates. RNA polymerase (core enzyme) moves along the DNA template causing elongation of RNA chain at the rate of some 30 nucleotides per second. RNA synthesis stops as soon as polymerase reaches the terminator region.

30. (a) B lymphocytes and T lymphocytes are responsible for acquired immunity.
(b) The structure shown in the figure is of antibody molecule.
(c) Children who had suffered from chicken-pox may not contract the same disease in their adulthood because of development of memory cells. These type of cells develop during first encounter with the pathogen. Memory cells are highly specific and may remain in body for decades. Subsequent encounter with the same pathogen elicits a highly intensified secondary or anamnestic response. This type of immunity is known as acquired natural active immunity.

OR

Differences between B-Lymphocytes (B-cells) and T-Lymphocytes (T-cells) are:

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

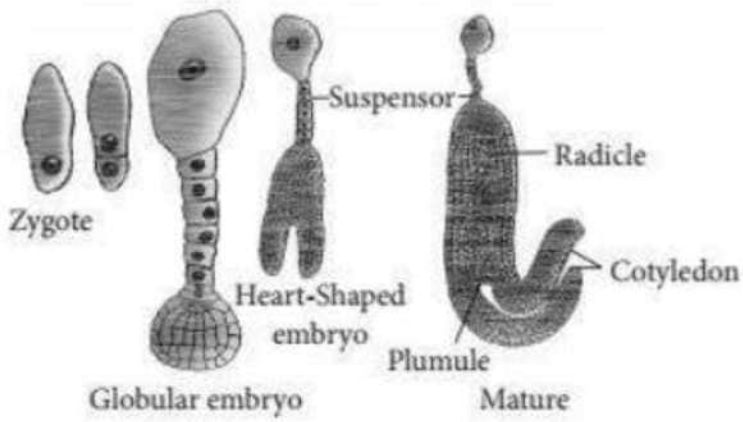
31. The process of formation of a mature female gamete (ovum) is called oogenesis. It occurs in the ovaries. It consists of three phases: multiplication, growth and maturation.
(i) Multiplication phase: In the fetal development, certain cells in the germinal epithelium of

the ovary of the fetus are larger than others. These cells divide by mitosis, producing a couple of million egg mother cells or oogonia in each ovary of the fetus. The oogonia multiply by mitotic divisions forming the primary oocytes.

(ii) Growth phase: This phase of the primary oocyte is very long. The oogonium grows into a large primary oocyte by taking food from the surrounding follicle cells.

(iii) Maturation phase: Each primary oocyte undergoes two maturation divisions, first meiotic and the second meiotic. In the first, meiotic division, the primary oocyte divides into two very unequal haploid daughter cells - a large secondary oocyte and a very small first polar body. In the second maturation division, the first polar body may divide to form two second polar bodies. The secondary oocyte again divides into unequal daughter cells, a large ootid and a very small second polar body. The ootid grows into a functional haploid ovum. Thus from one oogonium, one ovum and three polar bodies are formed. The polar bodies take no part in reproduction and, hence, soon degenerate. In humans, ovum is released from the ovary in the secondary oocyte stage, this process is called ovulation. Oogenesis gets completed in fallopian tube during fertilisation events.

(a) Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo. Though the seeds differ greatly, the early stages of embryo development (embryogeny) are similar in both monocotyledons and dicotyledons. The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo. A typical dicotyledonous embryo, consists of an embryonal axis and two cotyledons. The portion of embryonal axis above the level of cotyledons is the epicotyl, which terminates with the plumule or stem tip. The cylindrical portion below the level of cotyledons is hypocotyl that terminates at its lower end in the radicle or root tip. The root tip is covered with a root cap (calyptra). The stages in embryo development in a dicot is shown below.



(b) Endosperm provides nourishment to the developing embryo. So, endosperm development precedes embryo development.

32. (a) The given figure represents two molecules A-Guanine, B-Thymine. Guanine is a kind of purine (a two ringed, heterocyclic nitrogenous compound) and thymine is a kind of pyrimidine (single ringed nitrogenous compound).
(b) Purines (adenine and guanine) and pyrimidines (thymine, cytosine and uracil) are involved in making nucleic acids- DNA and RNA. Purines and pyrimidines are an important ingredient of the DNA along with the phosphate and the pentose sugar. They form the backbone of nucleic acid as nucleotides. Thymine is found in DNA only.
(c) In DNA, guanine pairs with cytosine with three hydrogen bonds and thymine pairs with adenine with two hydrogen bonds.

OR

(a) M is repressor protein.
(b) Binding of repressor (M) with operator (O) switches off the lac operon. (c) Presence of inducer i.e., lactose will prevent the binding of the molecule M with the operator gene. Inducer will bind to the repressor, change the latter into non-DNA binding state so as to free the operator gene and switch on the lac operon.

33. (a) Presence of the insert within a gene results in insertional inactivation of the enzyme b-galactosidase, hence bacterial colonies do not produce any colour. Therefore, bacterial colonies with cloning vector A are colourless as they are recombinants with the insert and bacterial colonies with cloning vector B are blue coloured as they are non-recombinants.
(b) Cloning vectors are DNA molecules that can carry foreign DNA segment and replicate inside a host cell. It may be plasmids, a phagemid, cosmids, yeast artificial chromosomes(YACs), Bacterial artificial chromosomes (BACs) and viruses.
(c) Ori sites are the origin of replication sites which control replication of the DNA in which they are present. Cloning of a vector containing rDNA requires its multiplication to produce large number of copies and ori is essential for it. Cloning sites are the specific sites in vector that possess recognition sequences for a particular enzyme. It enables insertion of foreign DNA segment into that particular site.

OR

(a) Selectable marker in given cloning vector pBR322 are ampicillin resistance gene(a), and tetracycline resistance gene(d). They help in selecting transformant from nontransformant ones.
(b) Selection of recombinants due to inactivation of antibiotics is a cumbersome procedure because it requires simultaneous plating on two plates having different antibiotics. Therefore,

alternative selectable markers have been developed which differentiate recombinants from non-recombinants on the basis of their ability to produce colour in the presence of a chromogenic substrate. In this, a recombinant DNA is inserted within the coding sequence of an enzyme, b-galactosidase. This results into inactivation of the enzyme, which is referred to as insertional inactivation. The presence of a chromogenic substrate gives blue coloured colonies if the plasmid in the bacteria does not have an insert. Presence of insert results into insertional inactivation of the b-galactosidase and the colonies do not produce any colour, these are identified as recombinant colonies.