

Solution

SECTION A

1. In organisms exhibiting haploidic life cycle, meiosis occurs at the zygote stage. Meiosis results in production of haploid gametes, which repeat the life cycle. (1)
2. No. of chromosomes of workers = 32 (1/2)
No. of chromosome of drones = 16 (1/2)
3. Flocs are masses of bacteria associated with fungal filaments to form mesh like structures. They significantly reduce the BOD. (1)

OR

Methanogens can be found in:

- Anaerobic sludge during sewage treatment (1/2)
 - In rumen of cattle (1/2)
4. Stratosphere is associated with 'good ozone'. (1)

OR

Commensalism is the term used to describe a population interaction between an orchid growing on a forest tree. (1)

5. Punnett square is a graphical representation to calculate the probability of all possible genotypes of offspring in a genetic cross. (1)

Section B

6. Apomixis is a type of asexual reproduction only because apomixis is a special mechanism to produce seeds without fertilization. In some species, diploid egg cell is formed without reduction division and develops into a embryo. Because no fertilization is involved, hence apomixis is a type of asexual reproduction that mimics sexual reproduction. (1 + 1)
7. Four significant services that a healthy ecosystem provides are as follows:
 - Purify air and water (1/2)
 - Mitigate droughts and floods (1/2)
 - Cycle nutrients (1/2)
 - Provide storage site for carbon (1/2)

OR

In an ecosystem, Mutualists:

1. Tend to co evolve. Example - The Mediterranean orchid *Ophrys* specifically; one petal of its flowers bears an uncanny resemblance to the female of the bee in size, color and markings to such an extent that male bee is attracted to what it perceives as female, thus resulting in pollination.
If the female bee's color patterns change even slightly during evolution, orchid flower co-evolves to maintain the resemblance of its petal to the female bee to ensure the pollination success. (1)
 2. Mutualists are one of the major causes of biodiversity loss. Example - in the above stated coevolved plant-pollinator mutualism, extinction of one invariably leads to the extinction of the other. (1)
8. Steps as carried in multiple ovulation embryo transfer technology:
 - A cow is administered hormones, with FSH-like activity, to induce follicular maturation and super-ovulation-instead of normal production of one egg, they produce 6-8 eggs. (1/2)
 - The animal is either mated with an elite bull or artificially inseminated.
 - The fertilized eggs at 8-32 cells stages, are recovered non-surgically and transferred to surrogate mothers. (1/2)
 - The genetic mother is available for another round of super ovulation. (1/2)

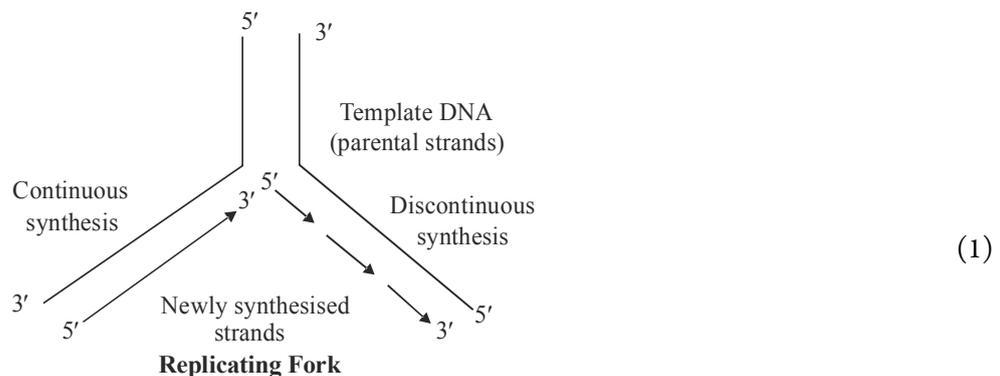
9. Origin of replication is a definite region or a particular sequence where the replication originates. (1)
Function - They provide the site of origin of replication as well as recognition site for restriction enzymes. (1)
10. MO'S have been useful for enhanced crop output in following ways: (1/2)
 • Made crops more tolerant to abiotic stresses (cold, drought, salt, heat) (1/2)
 • Helped to reduce post harvest losses (1/2)
 • Reduced reliance on chemical pesticides (1/2)
 • Increased efficiency of mineral usage by plants. (1/2)
11. A continuous culture system is maintained in bioreactors by following way: The used medium is drained out from one side while fresh medium is added from the other to maintain the cells in their physiologically most active log phase and this method also produces larger biomass, thus leading to higher yield of desired protein. (1 + 1)
12. If gene flow/genetic drift happen to take place, gene frequencies change in original as well as new population. New genes are added to new population and lost from old population. Sometimes, change in allele frequency is so different in new population that they become a different species (founder effect). (1+1)

SECTION - C

13. A bisexual flowering plant ensures cross pollination by following ways: (1)
 • In some species, pollen release and stigma receptivity are not synchronized. Either pollen is released before the stigma becomes receptive or stigma becomes receptive before the release of pollen. (1)
 • The anther and stigma are placed at different positions so that pollen cannot come in contact with stigma of the same flower. (1)
 • Self incompatibility - It inhibits pollen germination/pollen tube growth in the pistil. (1)
14. Different points to be kept in mind for successful bee keeping are as follows: (1)
 • Knowledge of the nature and habits of bees. (1)
 • Selection of suitable location for keeping the beehives (1)
 • Catching and hiving of swarms (1)
 • Management of beehives during different seasons (1)
 • Handling and collection of honey and of beeswax. (1)
- Scientific name of the most common Indian species used for the purpose is:
Apisindica (1)
15. Mechanism of DNA replication with the help of a replication fork: (1)
 • As the DNA cannot be separated in its entire length due to very high energy requirement, replication occurs within a small opening of the DNA helix, termed as replication fork. (1)
 • DNA - dependent DNA polymerases catalyse polymerization only in one direction, that is 5'-3'. (1)
 • Consequently, on one strand with polarity (3'-5'); the replication is continuous. (1)
 • On the other strand, with polarity 5'-3, replication is discontinuous. (1)

Role of DNA ligase:

The discontinuously synthesized fragments are later joined by the enzyme DNA ligase.



OR

Transcription unit - There appears to be some misprinting in this question as the question says RNA segment is being displayed; while RNA does not contain nitrogen base Thymine (T). It contains Uracil (U) in place of (T). This is not an RNA segment. Printed version of this question appears to be wrong.

16. a.

Homo habilis	Homo erectus
Brain capacities were between 650-800cc.	Had a large brain around 900cc.
They probably did not eat meat.	They probably ate meat.

 (1½)

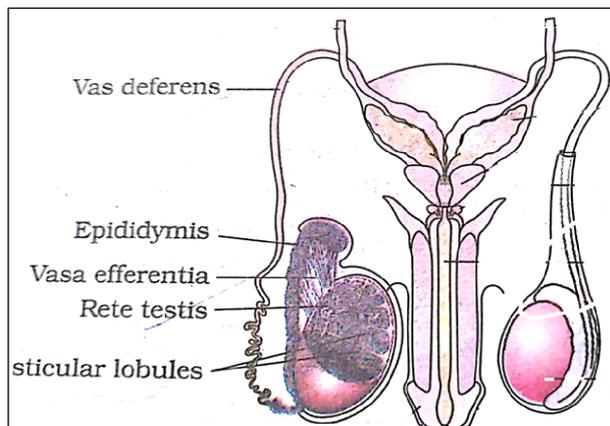
b. Early to late geologic periods:
 Silurian, Carboniferous, Jurassic (1½)

17. Six advantages of "ex-situ" approach to conservation of biodiversity:
- Threatened animals and plants are placed in special setting where they can be protected and given special care. (½)
 - There are many animals that have become extinct in the wild but continue to be maintained in zoological parks. (½)
 - Now gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques. (½)
 - Eggs can be fertilized in vitro (½)
 - Plants can be propagated using tissue culture methods (½)
 - Seeds of different genetic strains can be kept for long periods in seed banks. (½)

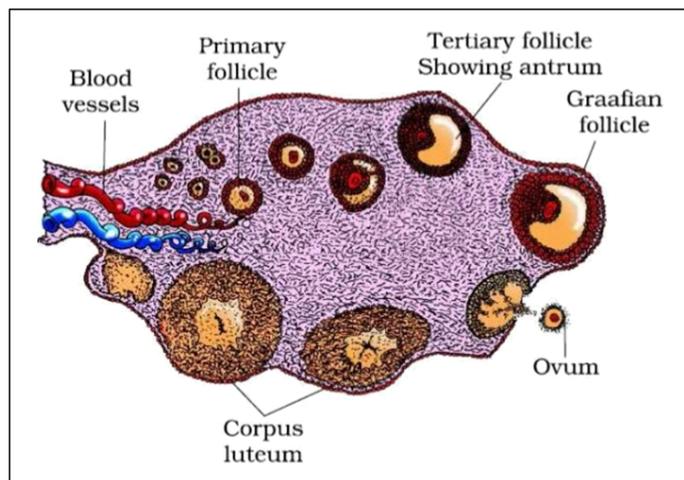
18. Effluent from the primary treatment of sewage is passed for secondary treatment. Process is as follows:
- Primary effluent is passed into large aeration tanks.
 - It is constantly agitated mechanically and air is pumped into it.
 - It allows vigorous growth of useful aerobic microbes into flocs. (1)
 - These microbes consume the major part of the organic matter of the organic matter in the effluent.
 - This significantly reduces BOD.
 - The effluent is then passed into a settling tank where bacterial flocs are allowed to sediment. (1)
 - Sediment, called activated sludge is pumped into large tanks called anaerobic sludge digesters, while small part of it is pumped back to serve as inoculum.
 - Here, bacteria and fungi digest the sludge; afterwards the effluent is released into natural water bodies. (1)

19. a. Two girls were suffering from adenosine deaminase (ADA) deficiency. (1)
 b. The treatment provided to girl A required repeated visits because only functional ADA was given to the patient by injection. (1)
 c. Girl B was cured permanently because of gene therapy. (1)

20. (3)



OR



(3)

21. Comparison of Chromosomal theory of inheritance as proposed by Sutton and Boveri and experimental results of Mendel:

Sutton and boveri theory	Mendel theory
They discovered structures in the nucleus that appeared to double and divide just before each cell division.	He conceptualized factors as stable and discrete units that controlled the expression of traits .
Chromosomes occur in pairs in the cell	Mendelian factors also occur in pairs
Independent pairs segregate independently of each other.	One pair segregates independently of another pair.

(1 + 1 + 1)

OR

- a. Morgan described LINKAGE as physical association of the two genes on the same chromosome. RECOMBINATION was used to describe the generation of non-parental gene combinations. Tightly linked genes show very low recombination while loosely linked show higher recombination. (2)
- b. Alfred Sturtevant used the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes and mapped their position on the chromosome. (1)
22. Formation of recombinant DNA by the action of EcoRI:
- The DNA with desirable gene is identified first. (½)
 - The cutting of DNA at specific locations, or specifically ori sites is achieved with the help of restriction enzyme EcoRI which recognize specific pallindromic sequence or recognition sequence. (½)
 - The same restriction enzyme is used to cut vector DNA or native DNA. (½)
 - The desired DNA of interest is purified using gel electrophoresis to be used in recombinant DNA. It is employed to check the progression of a restriction enzyme digestion. (½)
 - Amplification of gene of interest is thus achieved using PCR. (½)
 - The amplified fragment can now be used to ligate with a vector for further cloning. (½)

OR

Process of amplification of "gene of interest" using PCR technique:

- **Denaturation** - The desired DNA to be amplified or the gene of interest is first denatured at a very high temperature which results into separation of both the strands. (1)

- **Annealing** - Two sets of primers (small chemically synthesized oligonucleotides complementary to the regions of DNA) attach to both the ends of the DNA. (1)
 - **Extension** - The enzymes DNA polymerase (Taq polymerase) extends the primers using the nucleotides provided in the reaction and genomic DNA as template.
 - If the process of replication is repeated many times, the segment of DNA can be amplified to approximately billion times. (1)
23. a. Match:
- | | | |
|-------------------------------------|--------------------|-----|
| (H) <i>Penicillium notatum</i> | (iii) antibiotic | (½) |
| (I) <i>Trichoderma polysporum</i> | (iv) cyclosporin A | (½) |
| (J) <i>Monascus purpureus</i> | (i) statin | (½) |
| (K) <i>Saccharomyces cerevisiae</i> | (ii) ethanol | (½) |
- b. 'Swiss cheese' develop large holes due to production of a large amount of CO₂ by a bacterium named *Propionibacterium sharmanii*. (1)
24. Two most important levels of biological organization showing biodiversity:
- **Genetic diversity:** A single species might show high diversity at the genetic level over its distributional range.
Example - Genetic variation shown by medicinal plant *Rauwolfia vomitoria* might be in terms of the potency and concentration of the active chemical (reserpine) that the plant produces. (1½)
 - **Species diversity** - The diversity at the species level.
Example - The Western Ghats have greater amphibian species diversity than the Eastern Ghats. (1½)

SECTION - D

25. a) Differentiate:

		SPERMATOGENESIS	OOGENESIS
i.	Time of initiation of the process	At puberty	During embryonic development
ii.	Time of initiation of the process	Sertoli cells	Ovary
iii.	Nature of meiotic division undergone by gamete mother cells	Complete meiotic division	The cells start division and enter into prophase-I of meiotic division and get temporarily arrested. (2)

- b) Hormones and their role involved in controlling spermatogenesis in humans:
- Spermatogenesis is initiated at puberty due to secretion of GnRH. (1)
 - The increased levels of GnRH stimulated secretion of two gonadotropins - cells LH and FSH. (1)
 - LH acts at Leydig cells and stimulates synthesis and secretion of androgens. (1)
 - Androgens, in turn, stimulate the process of spermatogenesis. (1)
 - FSH acts on the sertolicells and help in secretion of some factors which help in process of spermiogenesis. (1)

OR

- a) Double fertilization in angiosperms:
- After entering one of the synergids, pollen tube releases the two male gametes into cytoplasm of the synergid. (½)
 - One of male gamete fuses with egg cell, thus completing the syngamy; hence resulting in formation of zygote. (½)

- The other male gamete move towards the polar nuclei located in central cell and fuses with them to produce a triploid PEN. (½)
 - Since two types of fusions, syngamy and triple fusion take place - take place; it is termed as double fertilization. (½)
- b) Development of endosperm precedes that of embryo :
Because cells of endosperm tissue are filled with reserve food materials and are used for the nutrition of the developing embryo. (1½)
- c) Parts of a typical dicot embryo:
- Plumule
 - Cotyledons
 - Hypocotyl
 - Radicle
 - Root cap (1½)
26. a) Population can be defined as a group of people that live in a well defined geographical area, share or compete for similar resources and potentially interbreed. (1)
- b) The size of a population for any species is not a static parameter. It keeps changing in time, depending on various factors including food availability, predation pressure and adverse weather. (1)
- Density of a population during a given period fluctuates due to changes in four basic processes:
- Natality - Number of births during a given period in the population that are added to the initial density. (1)
 - Mortality - Number of deaths in the population during a given period.
 - Immigration - Number of individuals of the same species that have come into habitat from elsewhere during time period under consideration. (1)
 - Emigration - Number of the individuals of the population who left the habitat and gone elsewhere during the time period under consideration. (1)

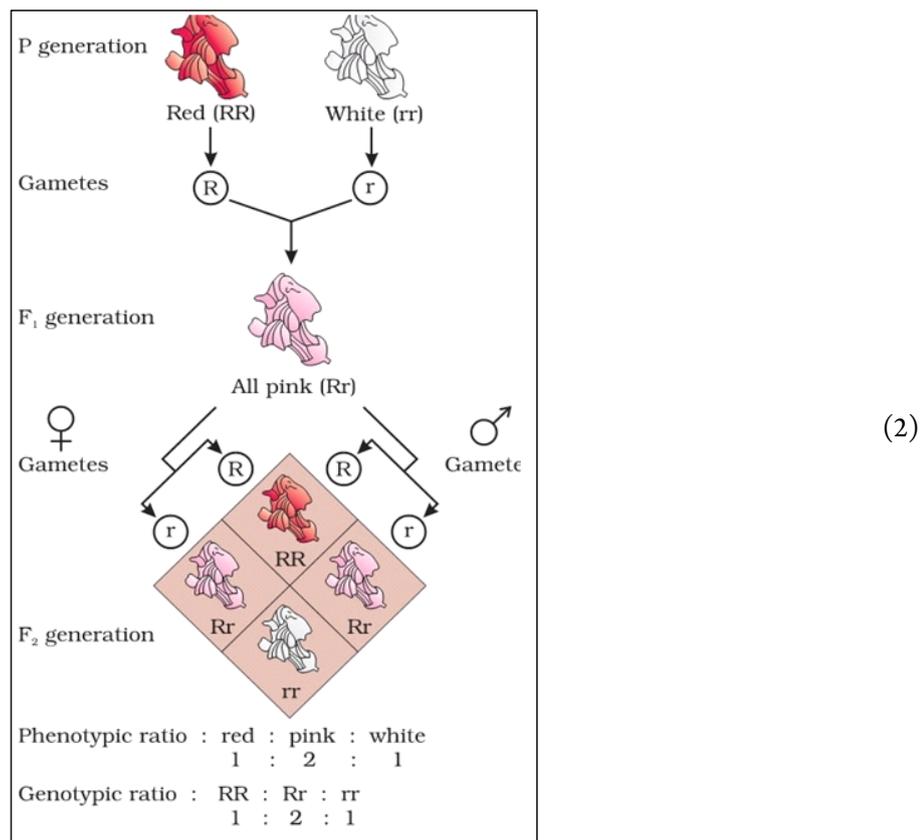
OR

- a. **Hydrarch succession:** Succession of plants in very wet areas, which leads from hydric to mesic condition, is termed as hydrarch succession. (1)

	HYDRARCH	XERARCH
PIONEER SPECIES	Small phytoplanktons	Lichens
CLIMAX COMMUNITY	Forest	Forest

- c. Factors upon which the type of invading pioneer species depend in secondary hydrarch succession:
- Condition of the soil
 - Availability of water
 - Environment
 - Seeds or other propagules present
- Rate of this succession is faster than that of primary succession because soil is already present there. (2)
27. Incomplete dominance:
It is defined as the condition when the F1 has phenotype does not resemble either of the two parents and is in between the two.
Example - inheritance of flower color in the dog flower; Antirrhinum

In a cross between true breeding red flowered (RR) and true breeding white flowered plants (rr); the F₁ (Rr) was pink. When the F₁ was self pollinated; F₂ resulted in following ratio 1 red: 2 pink: 1 white (1)



Co-dominance:

In the case of co-dominance, the F₁ generation resembles both parents.

Example - Different types of red blood cells that determine ABO blood grouping in human beings. (1)

ABO blood groups are controlled by the gene I. The alleles I^A and I^B produce a slightly different form of the sugar while i do not produce any sugar.

I^A and I^B are completely dominant over i. But when, I^A and I^B are present together, they both express their own types of sugars.

Since there are three different alleles, there are six different combinations of these three alleles that are possible, and a total of six genotypes of human ABO blood types. (1)

OR

a. Contribution:

- George Gamow -He argued that since there are only 4 bases and if they have to code for 20 amino acids, the code should constitute a combination of bases. He suggested the code should be made up of three nucleotides. (1)
- Har Gobind Khorana - He developed chemical method which was instrumental in synthesizing RNA molecules with defined combinations of bases (homo polymers and copolymers). (1)
- Marshall Nirenberg - His cell free system for protein synthesis finally helped the code to be deciphered. (1)
- Severo Ochoa - Severo Ochoa enzyme was helpful in polymerizing RNA with defined sequences in a template independent manner. (1)

b. Importance of genetic code in Protein biosynthesis:

Genetic code directs the sequence of amino acids during synthesis of proteins. (1)