

Section A

1. (a) $\text{gm}^{-2}\text{yr}^{-1}$

Explanation:

Primary productivity expressed as $\text{gm}^{-2}\text{yr}^{-1}$

- 2.

- (b) Turner's syndrome

Explanation:

Turner's syndrome is a random genetic disorder that affects females. The main characteristics include short stature and infertility. Usually, a female has two X chromosomes. However, in females with Turner's syndrome, one of these chromosomes is missing or abnormal.

3. (a) Zoological garden

Explanation:

Zoological garden

4. (a) Chikungunya Virus

Explanation:

Chikungunya Virus

5. (a) Biopatent

Explanation:

The right granted to the company or organization of which others cannot use it is called biopatent.

A biological parent is a patent on an invention in the field of biology that by law allows the patent holder to exclude others from making, using, selling, or importing the protected invention for a limited period of time.

This right is given as an intellectual right to the company.

- 6.

- (d) Pair (C) is not correct.

Explanation:

Monascus purpureus - Citric Acid

Citric acid is produced by the species of *Aspergillus*, *Aspergillus niger*

- 7.

- (c) 22

Explanation:

22

- 8.

- (c) Some amino acids as glycine and alanine

Explanation:

In Urey and Miller's experiment, the product formed after the continuous sparking in the mixture of gases at high temperature were some amino acids like glycine and alanine. Sugar and nitrogenous base were also obtained from the same set up by some other scientist.

- 9.

- (c) Biomass of fishes exceeds that of phytoplankton.

Explanation:

The pyramid of biomass in sea is also generally inverted because the biomass of fishes far exceeds that of phytoplankton.

10.

(d) XX - XO type of sex determination

Explanation:

The chart given below represents XX-XO type of sex determination in which XX forms the female and XO develops as a male. It is common in birds.

11.

(b) Increasing its resistance to insects

Explanation:

The fungal symbiont in mycorrhiza absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits also, such as resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.

12.

(d) A - Denaturation, B - Annealing, C - Primer Extension

Explanation:

A - Denaturation, B - Annealing, C - Primer Extension

13. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Natality is generally expressed as the number of birth per 1,000 individuals of a population per year. It increases the population size and population density.

14. **(a)** Assertion and reason both are correct statements and reason is correct explanation for assertion.

Explanation:

Assertion and reason both are correct statements and reason is the correct explanation for assertion.

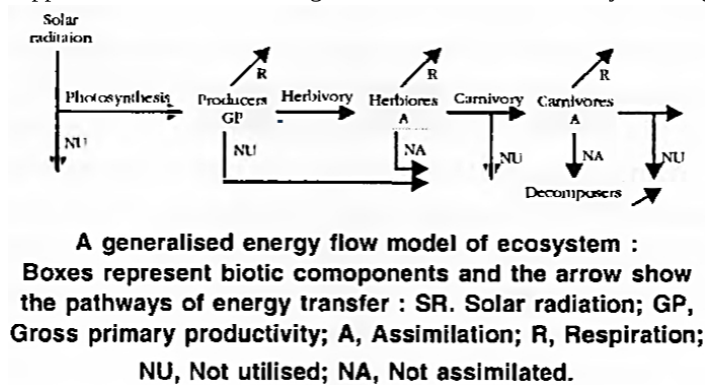
15.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

Energy flow is the key function in the ecosystem. Two aspects with respect to energy flow in ecosystem need careful consideration. First, the energy flows one way i.e., Producers → Herbivores → Carnivores, it can not be transferred in the reverse direction. Second, the amount of energy flow decreases with successive trophic levels. Producers capture only a small fraction of solar energy (1-5 percent of total solar radiation), and the bulk of unutilised energy is dissipated mostly as heat. Part of the energy captured in gross production of producers is used for maintenance of their standing crop (respiration) and for providing food to the herbivores. The unutilised net primary production is ultimately converted into detritus, which serves as energy source to decomposers. Thus energy actually used by the herbivore trophic level is only a small fraction of the energy captured at the producer level. On an average, in different ecosystems, the herbivore assimilation or productivity approximates ten percent of gross productivity of producers. The energy assimilated by the herbivores is used in respiration and a fraction of unassimilated energy is transferred to decomposers (e.g., faecal matter). The remaining herbivore level energy is either utilised by the carnivores, or gets transferred to decomposers after the death of herbivores. Again, only a small fraction (about ten percent) of herbivore productivity is used to support carnivore productivity. Similarly, the energy available at carnivore trophic level is again partitioned, leaving a very small fraction to support the next trophic level (top carnivore). The respiration cost also increases sharply along successive higher trophic levels. On an average, respiration of producer consumes about 20 percent of its gross productivity. Herbivores consume about 30 percent of assimilated energy in respiration. The proportion of assimilated energy consumed in respiration rises to about 60 percent in carnivores. Because of this tremendous loss of energy at successive higher trophic levels, the residual energy is decreased to such an extent that no further trophic level can be

supported. Therefore, the length of food chains in an ecosystem is generally limited to 3-4 trophic levels.



16.

(c) A is true but R is false.

Explanation:

A is true but R is false.

Section B

17. ADA or adenosine deaminase deficiency is the deficiency for which the first clinical gene therapy was given.

It is caused due to deletion of the gene for adenosine deaminase.

The first clinical gene therapy was performed for treating adenosine deaminase deficiency, in which the defective gene of the patient's blood cells was replaced by the functional variant.

18. The RNA strand transcribed from the given transcription unit along with its polarity is as follows:

3'- U-A-C-G-U-A-C-G-U-A-U-G- 5'

19. A. represents the multi carpellary and syncarpous pistil of *Papaver*.

B. represents the multi carpellary and apocarpous gynoecium of *Michelia*.

20. 1. A-Spermatogonia,

B-Interstitial cells

C-Spermatozoa.

2. A-Spermatogonia produces a spermatogonium (plural: spermatogonia) is an undifferentiated male germ cell. Spermatogonia undergo spermatogenesis to form mature spermatozoa in the seminiferous tubules of the testes.

D-Sertoli cells provide nutrition to sperms.

21. By the use of biofertilizers and biological pest control method, the use of chemical fertilizers and pesticides can be reduced. The fertility of the soil depends not only on its chemical composition but also on the presence of useful microbes in it, which enrich the nutrient quality of the soil. The main source of biofertilizers are bacteria, fungi and cyanobacteria.

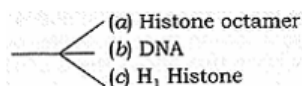
OR

Bottled fruit juices are clearer as compared to those made at home because, in these juices pectinase enzyme is added, which digests the pectin and other fibres present in juices.

Section C

22. i. Nucleosome

ii.



iii. In prokaryotes, the DNA is held with some positively charged proteins to form a nucleoid. The DNA is then organized as large loops held by the proteins.

23. When plants of the F1 generation are allowed to reproduce without the cross, the alleles segregate and one allele goes to one parent while another allele goes to another parent. This is in accordance with the transfer of halved number of the chromosome during meiosis. This segregation is a random process and there is a 50% chance of a particular allele going to either the male gamete or the female gamete. Due to this, the genotype produced in F2 generation is the same as the phenotype produces in that generation. So, the percentage of plants with pure genotype and those with mixed genotype will be same, i.e. 50%.

24. i. Three ways of measuring population density of a habitat.

A- Per cent cover for trees with larger canopy

- B- Number of fishes caught per trap
- C- Pug marks or faecal pellets for tiger census.

- ii. The population density tells us about the status of a species, i.e., the outcome of competition, impact of predation or effect of pesticides, etc.
25. a. i. Anode = S
 ii. Smallest/lightest DNA Strand = R
 iii. Agarose gel = T
- b. The DNA fragments purified in this way are used in constructing recombinant DNA by joining them with cloning vectors.
26. Friends should be explained how water hyacinth can damage the ecosystem of the lake and harm the environment. Excessive growth of such aquatic weeds cause ageing of a lake by mineral enrichment of water (eutrophication) which is harmful to aquatic life.

Values

- Problem solving
- Critical thinking
- Responsibility
- Concern for others

OR

In situ conservation	Ex situ conservation
1. It means conservation on site. An endangered species is protected in its natural habitat by maintaining the habitat itself and defending the species from predators and poachers.	1. It means off site conservation. An endangered species is protected by removing it from the threatened habitat and placing it under the care of humans.
2. This approach emphasizes on the protection of total ecosystem.	2. This approach restricts to the protection of genetic resources at population and species level.
3. This approach includes methods of protection like establishing hot spots, national parks, wildlife sanctuaries and biosphere reserves.	3. It is done through live collections of animals and plants in zoos, botanical gardens, seed banks, etc.

27. **Gene flow** occurs due to gene migration either emigration or immigration in a population multiple times and it can result in changing the frequency of alleles of a gene within the gene pool of that population. Such population with active gene flow will not obey the Hardy-Weinberg principle.

Genetic Drift is a sudden and by chance change in the frequency of genes and their alleles within a gene pool of a population over a very short duration of time. This type of population will also not obey the Hardy-Weinberg principle.

28. a. Contact inhibition is the avoidance behavior exhibited by fibroblast-like cells when in contact with one another. Contact inhibition is neither hormone nor enzyme. It is a regulatory mechanism to control the cell growth. When two cells collide they attempt to move in a different direction to avoid future collisions. As replication increases the number of cells, and the number of directions those cells can move without touching one another is decreased. As the two cells come into contact, their locomotive process is paralyzed.
- Cancerous cells typically lose this property and thus grow in an uncontrolled manner even when in contact with neighboring cells. They aren't motivated to change direction upon contact, so they pile up and grow over each other.
- b. Interferon alpha helps stimulate the body's immune system to fight some types of cancer by strengthening the immune system, reducing the ability of the cancer cells to defend themselves from the immune system and by slowing down or stopping the cancer cells from dividing and helping in destroying the tumor.

Section D

29. i. Menstrual phase
 ii. 10-12 days after menstruation
 iii. The endometrium (uterine lining) gets ready to support pregnancy. The cells of the lining make and release many types of chemicals. Progesterone level rises. This causes the uterine lining to thicken and prepare for implantation if an egg gets fertilized.

OR

- i. Secondary oocyte- It enters fallopian tube for fertilization after second meiotic division if male gamete enters otherwise it disintegrates.

ii. Polar body- it remains inside ovary and disintegrates.

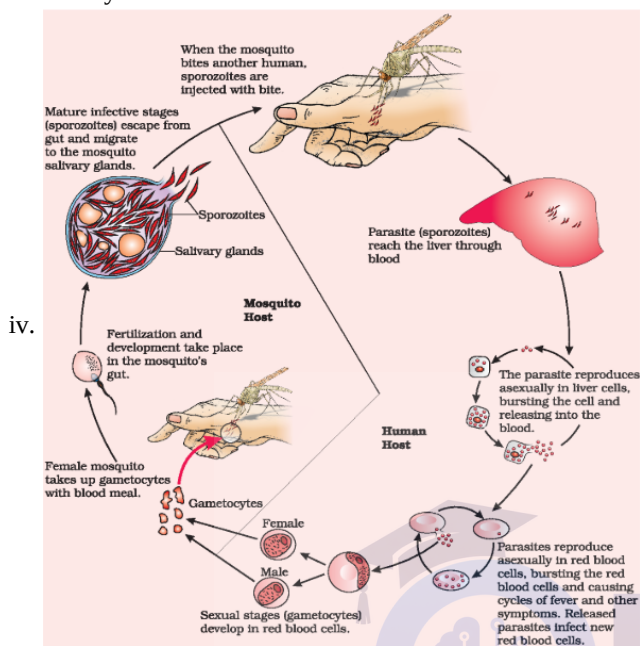
30. i. Malaria

ii. Different species of Plasmodium viz P. vivax, P. Malariae and P. falciparum.

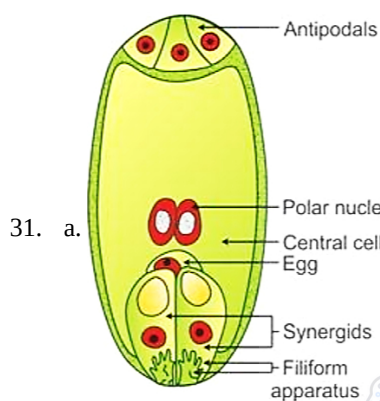
iii. Malaria is caused by the toxins (haemozoin) produced in the human body by the malarial parasite. This toxin is released by the rupturing of RBCs.

OR

Life cycle of Plasmodium



Section E



Mature Embryo Sac

b. The development of an endosperm precedes that of the embryo in angiosperm because the cells get packed with reserve food supplies, used for providing the nutrition to the developing embryo.

c. Cells with 16 chromosomes are called zygote and cells with 24 chromosomes are called endosperm.

OR

Condition in which seeds are produced without fertilization is called apomixis. Apomixis is a kind of asexual reproduction but it mimics sexual reproduction. There are several mechanisms for apomixis. One of them is seen in citrus and mango fruits. In this case, the nucellus begins to divide and intrude into the embryo sac. It eventually develops into a seed. Since nucellus is composed of diploid cells, embryo sac in such cases has diploid cells.

It is also important to recall that fertilization cannot happen in those cells which were not formed after meiosis. Moreover, haploid cells are never involved in apomixis rather it is the diploid cells that bring apomixis. Hence, embryo sacs of apomictic species appear normal but contain diploid cells.

32. i. Aminoacylation is the process by which amino acids become activated by binding with its aminoacyl tRNA synthetase in the presence of ATP. If two charged tRNAs come close during translation process the formation of peptide bond between them is energetically favourable.

When two charged tRNA are in close contact they form peptide bond.

ii. During translation: For initiation the small subunit of ribosome binds to mRNA at start codon (AUG), recognised only by the initiator tRNA.

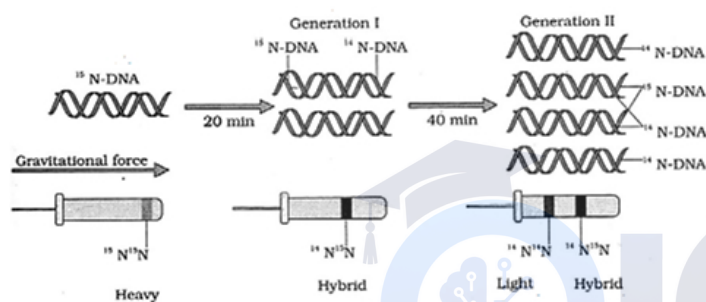
iii. mRNA is located at 5' end before the start codon (AUG) and 3' end after the stop codon (UAA/UAG/UGA).

They are required for efficient translation process.

OR

Matthew Meselson and Franklin Stahl performed the following experiment in 1958:

1. They grew *E. coli* in a medium containing $^{15}\text{NH}_4\text{Cl}$ (^{15}N is the heavy isotope of nitrogen) as the only nitrogen source for many generations. The result was that N was incorporated into newly synthesised DNA (as well as other nitrogen containing compounds). This heavy DNA molecule could be distinguished from the normal DNA by centrifugation in a cesium chloride (CsCl) density gradient.
2. Then they transferred the cells into a medium with normal $^{14}\text{NH}_4\text{Cl}$ and took samples at various definite time intervals as the cells multiplied, and extracted the DNA that remained as double-stranded helices. The various samples were separated independently on CsCl gradients to measure the densities of DNA.
3. Thus, the DNA that was extracted from the culture one generation after the transfer from ^{15}N to ^{14}N medium [that is after 20 minutes; *E. coli* divides in 20 minutes] had a hybrid or intermediate density. DNA extracted from the culture after another generation [that is after 40 minutes, II generation] was composed of equal amounts of this hybrid DNA and of 'light' DNA. They concluded that DNA replicates semi conservatively. Thus DNA is semi-conservative in nature was proved by them.



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33. i. *Escherichia coli* / *E. coli*

ii. ori.

iii. amp^R is the marker gene that helps in identification and elimination of the non-transformant growing in ampicillin medium and selectively permitting the growth of the transformant resistant to ampicillin. tet^R is the marker gene that helps in identification and elimination of the non-transformant growing in tetracycline medium and selectively permitting the growth of the transformant resistant to tetracycline.

OR

An antibiotic resistance gene in a cloning vector, such as plasmid pBR322, serves as a selectable marker to distinguish recombinant DNA containing the desired insert from non-recombinant DNA.

The plasmid pBR322 contains two antibiotic resistance genes: ampicillin resistance (amp^R) and tetracycline resistance (tet^R). The presence of these genes allows bacteria carrying the plasmid to survive in the presence of corresponding antibiotics.

During the cloning process, the target DNA is inserted into the pBR322 plasmid. Recombinant plasmids carry the desired insert, disrupting one of the antibiotic resistance genes.

After introducing the recombinant plasmids into bacteria, the next step involves plating the transformed bacteria on agar plates containing antibiotics. Only bacteria carrying the recombinant plasmids will be unable to grow in the presence of the specific antibiotic, while non-recombinant bacteria will survive due to their intact antibiotic resistance gene.

By observing the growth or lack thereof on the selective medium, researchers can identify and select the recombinant colonies while eliminating non-recombinant colonies. This antibiotic resistance gene-based selection allows for efficient isolation and identification of the desired recombinant DNA. Hence, an antibiotic resistance gene in a cloning vector (plasmid pBR 322) help in selecting the recombinants from the non-recombinants.