Section A

1. **(b)** Ecosystem services
Explanation:
The products of ecosystem processes are called as ecosystem services. Ecosystem services includes purification of air and water by forests and soil formation as well as nutrient cycles.

2. **(a)** A normal distribution
Explanation:
A normal distribution

3. **(a)** Critically endangered, endangered, vulnerable.
Explanation:
The International Union for Conservation of Nature (IUCN) is the foremost authority on threatened species, and treats threatened species not as a single category, but as a group of three categories, depending on the degree to which they are threatened:
   - Vulnerable species
   - Endangered species
   - Critically endangered species

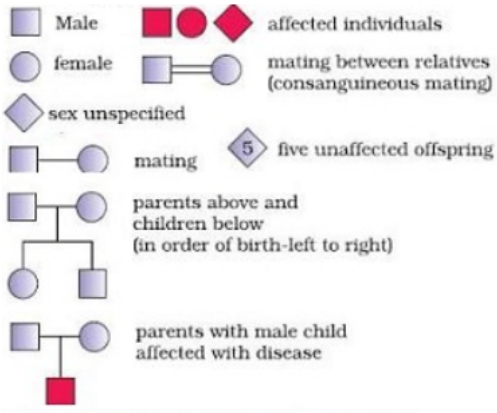
4. **(d)** S-shaped growth curve
Explanation:
S-shaped growth curve

5. **(b)** Recombinant DNA technique
Explanation:
Recombinant DNA technique

6. **(b)** A - Fleming; B - Staphylococci
Explanation:
A - Fleming; B - Staphylococci

7. **(c)** Affected individuals
Explanation:

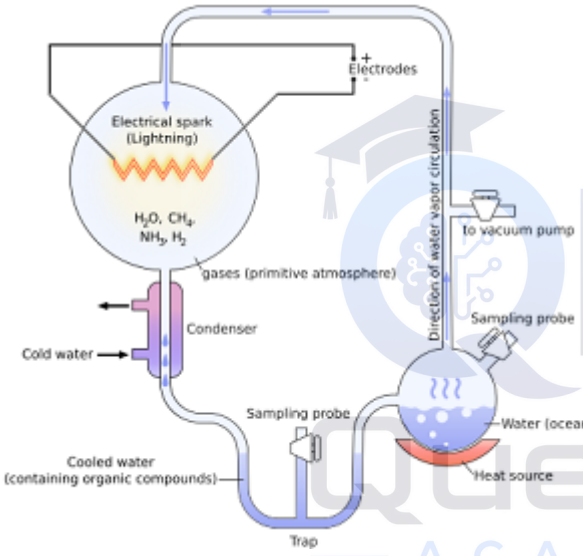
In pedigree analysis, the symbol shown above represents affected individuals.



8. **(a)** A – electrodes, B – (NH_3 + H_2 + H_2O + CH_4), C – cold water, D – Vacuum, E – U Trap.

Explanation:

In Urey and Miller experiment the set up labelled as A – electrodes, B – (NH_3 + H_2 + H_2O + CH_4), C – cold water, D – Vacuum, E – U Trap.



9. **(c)** Fish

Explanation:

Fish

10. **(c)** Male

Explanation:

Male birds bear ZZ sex chromosome as sex determination is ZO type, in which ZZ is male and ZO is female.

11. **(b)** Rhizobium

Explanation:

Rhizobium is heterotrophic soil bacteria with diverse lifestyles.

12. **(c)** DNA fingerprinting

Explanation:

DNA fingerprinting

13.

(c) A is true but R is false.

Explanation:

A is true but R is false.

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

Explanation:

Both A and R are true and R is the correct explanation of A.

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

Explanation:

The pyramid of biomass can be inverted because the biomass of fishes far exceeds that of phytoplankton on which fishes feed.

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

Explanation:

Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Section B

17. The following microorganisms are used as biofertilizers:

i. **Rhizobium:** They form root nodules in leguminous plants and fix the atmospheric nitrogen into an organic form. Rhizobium also has no negative effect on soil quality and improves the quality, nutrient content, and growth of the plant.

ii. **Azotobacter:** These are free-living nitrogen fixers found in all types of upland crops. These not only fix nitrogen but also provide certain antibiotics and growth substances to the plant.

18. i. A - Replication of DNA
B - Transcription
C - Translation

ii. Central dogma states that the genetic information flows from DNA to RNA and then to proteins. In some viruses the flow of information is reversed in direction, i.e. from RNA to DNA.
It is called reverse transcription.

19. Advantage. These flowers produce assured seed set even in the absence of pollinators.
Disadvantage: Not advantageous to the plant since it does not result in genetic variation.

20. A-Spermatogonium
B-Primary spermatocyte
C-Secondary spermatocyte
D-Spermatid
E-Spermatozoa
F-Sertoli cell

21. During treatment (after adding small amount of inoculum) primary effluent is constantly agitated mechanically in (large) aeration tanks and air is pumped into it, this allows the vigorous growth of useful microbes into flocs, the microbes consume the major part of the organic matter in the effluent, it reduces the BOD of the effluent, the effluent is then passed into settling tank where the bacterial flocs are allowed to sediment, major part of the activated sludge is pumped into aerobic sludge digester.

OR

Enzyme produced by Streptococcus bacterium is streptokinase.
It is used as a 'clot buster' for removing clots from the blood vessels of patients who have undregone myocardial infraction leading to heart attack.

Section C

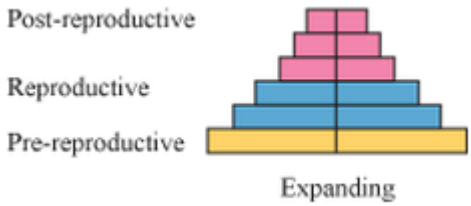
22. i. Pentose sugar or deoxyribose sugar.
ii. Two nucleotides are linked through 3'-5' phosphodiester linkage to form a dinucleotide.
iii. The ribose sugar has a free 3'-OH group which is referred to as 3' end of the polynucleotide chain.

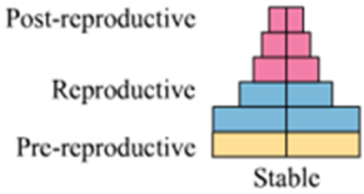
23. The genes that produce photopigments are present on X-chromosomes. If some of the genes are missing or damaged, it can result in colour blindness. Since males have only one X-chromosome, the chances of colour blindness are very high in males. In the case of females, to be colourblind must have the allele for it in both her X-chromosomes. In case, if female possesses the allele for colourblind in only one X-chromosome, then she will act as a carrier and won't be affected by it.

24.

Expanding age pyramid	Stable age pyramid

The population of pre-reproductive age is greater than population of reproductive age	The population of pre-reproductive age equals to population of reproductive age





25.
- **Name of biochemical/molecular diagnostic tests for viruses:**
  - **ELISA** - Enzyme-Linked Immunosorbent Assay
  - **PCR** – Polymerase Chain Reaction
- **Principle of ELISA -** It is based on antigen-antibody interaction. Infection by a pathogen can be detected by the presence of antigens or by detecting the antibodies synthesized against the pathogen.

26. The broadly utilitarian argument described as biodiversity plays a major role in many ecosystem services that nature provides.

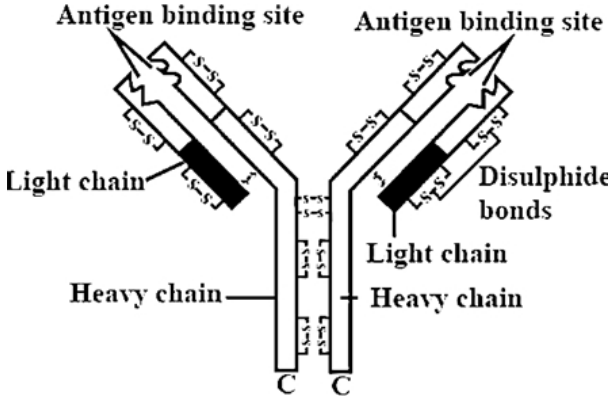
i. Broadly utilitarian mainly explains the broad and general use of biodiversities like **oxygen,**
ii. **pollination, and**
iii. **aesthetic value** which is not limited to particular species.

OR

i. Endemism: These are the species which are confined to a particular geographical region and they are not found anywhere else. Such species are called endemic species.
ii. Four regions in and around our country that are considered hot-spots are
   a. Western Ghats
   b. Himalaya
   c. Indo-Burma
   d. Sri Lank

27.
- The term evolution is considered to be used by Charles Lyell initially. But the theory of evolution was proposed by Charles Darwin.
- Evolution signifies “Descent with modification” which means the process of inheritable changes in any species over several generations.
- There are many pieces of evidence which support the evolution. Few are:
  - Homologous and analogous structures
  - Molecular biology related evidence where shared ancestry of life has been reflected by DNA and genetic code in different species.
  - Biogeography related evidence showing speciation due to geographical isolation.
  - Fossils records from different geological timelines.

28. a. lg A, lg I are the two produced antibodies.
b. There are schematic representation of an antibody molecule as follows:



Section D

29. i. When the zygote moves through the isthmus of the oviduct, the mitotic division is initiated and is called the cleavage towards the uterus to form 2,4,8,16 daughter cells called blastomeres. It is an embryo containing 8 to 16 blastomeres from the morula. It continues to transform and divide into blastocysts as it further approaches the uterus.

ii. The endocrine function of corpus luteum is to secrete progesterone which is essential for the maintenance of endometrium layer of uterus. Thickened endometrium is necessary for the implantation of fertilised ovum and other events of pregnancy.

iii. Fertilization may take place but the zygote may develop in the tube instead of the uterus.

OR

The trophoblast layer of the human blastocyst gets attached to the endometrium and the inner cell mass gets differentiated into an embryo. After attachment, the uterine cells divide rapidly and cover the blastocyst.

30. i. The patient is suffering from AIDS (Acquired Immuno Deficiency Syndrome).

ii. HIV (Human Immunodeficiency Virus) identified by the ELISA.

iii. Helper T-cells, macrophages, B-lymphocytes are attacked by the pathogen.

OR

Preventive measures:

a. People should be educated about AIDS transmission.

b. Disposable needles and syringes should be used.

c. Sexual habits should be changed immediately.

d. High-risk groups should be discouraged from donating blood.

e. Routine screening may be done.

Section E

31. a. Hypocotyl - The portion of embryonic axis between the radical and cotyledon
Epicotyl - The portion of embryonic axis between the plumule and cotyledon

b. Coleoptile - It is a conical protective sheath over the plumule in monocot seeds.
Coleorrhiza - It is a protective sheath over the radical and root tip.

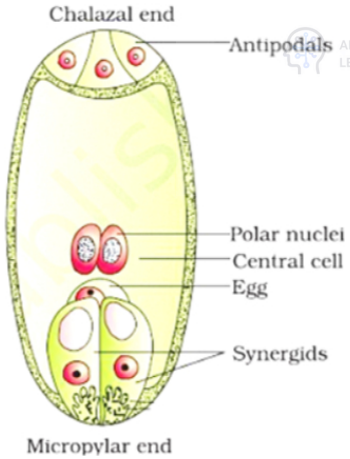
c. Integument is the covering of ovule, while testa is the outer seed coat developed from the outer integuments.

d. Perisperm is the residual persistent nucellus, while the pericarp is the fruit wall derived from the ovary wall.

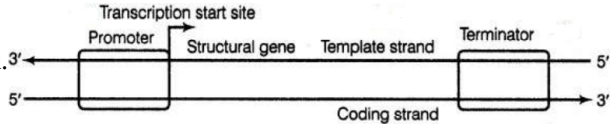
OR

i. The first cell of the female gametophyte is represented by the functional megaspore that grows along the micropylar known as the chalazal axis. The functioning megaspore's nucleus divides during phase to produce two cells that migrate to the opposing poles to form the 2-nucleate embryo sac. The 4-nucleate and eventually the 8-nucleate stages of the embryo sac are created by two more consecutive mitotic nuclear divisions. One nucleus from each group at a pole migrates to the cell's core, becoming known as a polar nucleus. The three remaining cells form antipodals and are encircled by a wall towards the end of the chalazal. The egg apparatus is made up of three cells at the micropylar end, one of which is an egg or female gamete and the other two are synergids. The mature embryo sac contains two polar cells, three antipodals cell at chalazal end, one egg, and two synergids at micropylar end.

ii.



32. a. Structure of transcription unit is - The promoter , and terminator flank/present on either side of structural gene, promoter located towards 5'end / upstream, (it is the presence of a promoter that defines the template and coding strands) terminator is located towards 3'end / downstream of the coding strand.



b. Since two DNA strands have opposite polarity, and DNA dependent RNA-polymerase catalyses the polymerisation, in only one direction 5'→3', the strand with polarity 3'→5' act as a template strand, the other strand with polarity 5'→3' is (does not

code for anything) during transcription, and is referred to as coding strand.

OR

Matthew Meselson and Franklin Stahl conducted an experiment in 1958 to prove that DNA replication is semiconservative. They labeled the DNA of Escherichia coli bacteria with heavy nitrogen isotope N-15. Then, they transferred the bacteria to a medium with a lighter nitrogen isotope N-14. After allowing the bacteria to replicate their DNA, they extracted DNA samples at different time points and subjected them to density gradient centrifugation. The results showed a hybrid band in the first generation, indicating semiconservative replication. In subsequent generations, two distinct bands appeared, representing fully heavy and fully light DNA.The heavier strand represents the parents stand and the lighter is the new one synthesized from the culture indicating the semiconservative mode of DNA replication. This confirmed the semiconservative nature of DNA replication.

33. The bacterium *Thermus aquaticus* is employed and used for amplification of the gene of interest using PCR technique.
Usually Taq (*Thermus aquaticus*) DNA polymerase, a thermostable enzyme is isolated from a thermophilic bacterium. The enzyme extends the two primers towards each other in order to copy the DNA segment (act as a template) lying between the two primers.

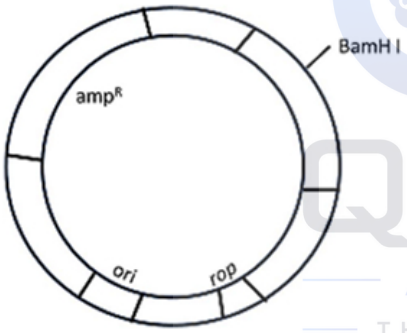
The step requires the presence of deoxynucleoside triphosphates and Mg^{2+} and occurs at 72°C.
If these cycles are repeated many times, the DNA segment can be amplified to approximately a billion times the DNA segment are made.

i. These are restriction endonucleases enzymes which cut the DNA molecule at the specific base sequences into fragments with sticky ends.
e.g., Eco RI, Hind II

ii. The enzyme restriction endonuclease cleaves DNA at a specific site resulting in the formation of fragments with single strand portions at the ends called sticky-ends. In practice, the digestion by the restriction enzyme keeping all other conditions at the optimum level and checked by using agarose gel electrophoresis technique.

OR

i.



ii. The **rop gene** (repressor of primer) regulates the copy number of the plasmid. It helps maintain a balance in the number of plasmid copies in the host cell by encoding a protein that interacts with the origin of replication, thereby controlling the replication rate of the plasmid.

iii. Without a selectable marker, such as antibiotic resistance, it becomes challenging to identify and isolate cells that have successfully taken up the cloning vector. In the absence of a selectable marker, distinguishing between transformed and non-transformed cells is difficult, which significantly hampers the efficiency of cloning and selection processes.

iv. **Insertional inactivation** is preferred over solely using selectable markers because it provides a more specific method for identifying successful cloning. Insertional inactivation involves inserting a gene or sequence into the vector that disrupts the function of a reporter gene. This allows for easy identification of successful clones by checking for loss of function of the reporter gene.