Certified that we have evaluated this answer book according to the correct set of question paper and strictly as per the marking scheme.
**SECTION D**

**THE LAC OPERON: (E. Coli)**

(1) **IN ABSENCE OF INDUCER:**

- In the absence of inducer, the repressor protein synthesized by the inhibitory (i-gene) from a repressor mRNA binds to the operator region of the lac operon.
- Hence, the RNA polymerase enzyme fails to perform the transcription of the structural gene.
- This is the negative regulation of transcription by the inhibitory repressor protein (in the process of lactose hydrolysis to glucose and galactose in E. Coli).
In the presence of inducer:

- **I** - **p** - **o** - **z** - **y** - **a** → **switched** (on position)

  - Transcription begins with RNA polymerase enzyme
  - Translation on loc mRNA
  - Inducer (lactose or allolactose) → repressor protein
  - Repressor protein binds inducer → transcription is inhibited

- If an inducer (here lactose or allolactose) is present, it will bind to the repressor protein, which is inactivating the protein and it won't be able to bind to the operator region.

- Hence, the RNA polymerase can perform transcription of the structural gene creating the lac mRNA, and enzymes β-galactosidase, permease, and transacylase from the (α-lactase, lactose hydrolyzing) create fermentability of cell to θ-palactolactase.
29. a. Fertilization occurs in the ampullary-isthmus junction of the fallopian tube of females in humans.

* Events:

1. The sperm ejaculated by male into female reproductive tract during coitus reach the ampullary-isthmic junction of fallopian tube simultaneously as the ovum released after ovulation from Graafian follicle.

2. The ovum will be surrounded by sperm but only one sperm enters it — during this step, the entry of sperm induces structural changes in the zona pellucida layer on contact that makes it impermeable to further entry of sperm.

3. The sperm enters the cytoplasm of ovum by disorganization of membranes including plasma membrane of ovum with the hydrolytic enzymes from acrosome and in the process, loses all parts except the haploid elongated nucleus.
(v) The secondary oocyte completes the 2nd meiotic division leading to formation of a small second polar body (degenerate) and the haploid (2n) which fuse with haploid sperm nucleus to form diploid zygote.

b. 1) ICSI - Intra Cytoplasmic Sperm Injection
   In this method, the egg (ovum) and sperm (gamete) are collected from the female and male partner and the sperm is directly injected into the ovum under laboratory condition.
   The so formed zygote is then to allowed to develop further within the mother body after transferring it by ZIFT (Zygote Intra Fallopian Transfer).

2) SEWAGE TREATMENT (in STP's - Sewage Treatment Plants)
   (i) PRIMARY TREATMENT
      - Physical matter like debris and soil, sand, silt etc. removed by (ii) Sequential Filtration
(ii) Sedimentation

* The substance that settle down forms primary sludge and the effluent is primary effluent.

(ii) Secondary Treatment:

* Biological treatment in which primary effluent is passed to large aeration tanks and is constantly agitated and supplied with air / O₂.

* This causes creation of flocc or association of useful aerobic bacteria and fungal filaments into a mush-like structure.

* In this process, the microbe use up organic matter in the polluted water and hence reduce the BOD - Biochemical Oxygen Demand (amount of oxygen required to oxidize all the organic matter in a litre polluted water by microbe).

* Once the BOD is sufficiently reduced, it is allowed to pass to a settling tank where flocs are allowed to settle down - activated
Sludge

* A little sludge is pumped back to the aeration tank to serve as inoculum, but most is passed to the anaerobic sludge digester where it is degraded by useful anaerobic bacteria (e.g., methanogens) releasing a mixture of gases like CH₄, CO₂, H₂, H₂S, etc. (biogas).

* The water coming out after this treatment is hence purified and can be discharged into water bodies.

This treatment is essential to:

1. Avoid pollution of the natural water bodies by excessive accumulation of harmful chemicals, organic matters, and nutrients which may lead to eutrophication.
2. Prevent the spread of infectious water borne diseases caused due to the deadly pathogens in polluted water.
27. a. *The constant internal environment (homeostasis)* is beneficial to organisms as it ensures the proper occurrence of all the metabolic reactions and biological functions of the body, despite the changing external environment.

*Hence, the organism can survive in unfavourable conditions and changing climates without it affecting their internal processes.*

b. Organisms can overcome stressful external conditions by:

1. **Migrate.**
   
   If the stressful period lasts for a short time, the organism can migrate or move to a region with favourable conditions and then return when the period is over (e.g., Siberian crane: cold North to warm Rajasthan area).

2. **Suspend.**

   Organisms can also temporarily halt their functions.
for the unfavourable period like dormancy (seeds),
diapause or a stage of suspended development (pratfall),
liberation/winter sleep (polar bears), aestiva
lion/summer sleep (snails).

26. **OUTBREEDING DEVICES** (encourage crosspollination in plants):

(i) **Different positions and different heights of the**
    **male (stamen) and female (pistil) reproductive**
    **structure to prevent selfpollination in bumble**
    **flour** (autogamy) - inability to meet.

(ii) **Production of unisexual** (male and female) **flowers**
    **and on different plants** (diacy) **would prevent**
    both autogamy and gynodioecy.

(iii) **Asynchrony in the times of maturation of androecium**
    **and gynoecium** (protandry / protogyny) **to**
    prevent meeting of pollen and egg and prevent
    autogamy.
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<tr>
<th>Question</th>
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<tr>
<td>a. <strong>Definite recombination:</strong> It is the process in which a species' genetic material is exchanged between different individuals. This can lead to new combinations of traits, potentially beneficial for survival and adaptation to changing environments.</td>
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<td>b. <strong>Better allocating resources:</strong> The new hybrid strain might be more efficient in utilizing resources, which could enhance its survival and reproduction.</td>
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<td>25. a. (2)</td>
<td>RT</td>
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<td>25. b. (3)</td>
<td>C7</td>
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<td>c. <strong>Genetic variation:</strong> Genetic diversity within a species can lead to more efficient resource allocation and improved adaptability to environmental changes.</td>
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| 26. a. **Definitely:** The offspring of two different species, even if they are closely related, may exhibit hybrid vigor, which can manifest as improved fitness traits.
| b. **Not definitely:** The outcome of hybridization depends on various factors, including the species involved and the degree of genetic compatibility. |

- **Additional note:** Different species might respond differently to hybridization, with some species showing improved traits while others may exhibit reduced fitness. Understanding these dynamics requires careful study of the specific species involved.
* Evolution of placental mammals and Australian marsupials (placental mammals evolved to represent Australian marsupials, all within the Australian continent)
* Convergent evolution
* It is named so because it does not necessarily indicate common ancestry of the species but rather shows similar adaptations due to similar habitats and functions.

23. a. (1) Partially open mouth with pursed tongue
(3) Broad palm with characteristic palm crease
b. Both
(0) Klinefelter's
(1) Male
2. (1) Rudimentary ovaries and sterility
(2) Short stature and lack of secondary sexual female character

3. Female

22. a) Such visits must be organised to ensure the proper standards of life for such people who are often shunned by society.
   b) They must be made to know of the methods by which they can prevent the deadly infectious diseases which often break out in slums due to lack of hygiene and also the importance of proper nutrition.

Steps:
1. Maintenance of a clean and tidy home and surrounding areas.
2. Proper waste and sewage disposal methods must be introduced.
(iii) Importance of regular personal hygiene and awareness of the disease which can hence be avoided.

(iv) Advocating methods for water treatment and purification - provision of uncontaminated food and water.

* Alexander von Humboldt

Observation: The species richness discovered was directly proportional to the area explored but only up to a certain limit.

b. (i) The general case - when a limited area is explored and species richness noted.

(ii) The case when large areas like entire continents are taken and the relation between area and species richness studied.

\( \beta \rightarrow \text{Regression coefficient (slope of line)} \)

c. The slope is steeper when the value of regression coefficient \( \beta \) is higher, that is, increased species diversity.
in a given area and other large geographical areas.
* Function of reservoir: To make up for the imbalance caused (deficit) due to loss of balance in the efflux and influx of minerals.

* Carbon Cycle:

* The Carbon Cycle is a gaseous cycle with its source and sink as the atmosphere and the ocean.

* The carbon is present in atmosphere as Carbon dioxide which is released by:

1. Respiration by plants, animals and other living beings.
2. Burning of fossil fuels.
The fixation of Carbon dioxide is carried out by plants (photosynthesis) as dejectation homfus cycle.
* Carbon is also present in marine as calcareous sediments, on oceans (fossil) and land (nutrients).

**SECTION B**

18. * Due to high concentrations of LH (Luteinizing hormone), it stimulates ovulation in the mature graffian follicle.
* The graffian follicle ruptures, the secondary oocyte (ovum) is released from ovary (after which the ruptured follicle becomes corpus lutum).

19a. The appearance of pink flowers are not 'blending' because here, the alleles do not blend, but they do segregate independently. The genotype is the same (RR) as usual, and the genotypic ratio also deviates away. The only difference is that the 'R' allele is not completely domin
15. Stability of Double Helical Structure of DNA:
(i) Complementarity of the two strands of DNA due to complementary nitrogenous base pairs which form strong hydrogen bonds with each other - Adenine forms 2 hydrogen bonds with thymine and cytosine 2 with guanine.
(ii) The base pairs are stacked with their planes one over the other in the double helical structure which provides extra stability.

Also, DNA is less reactive due to absence of reactive -OH group at 2' carbon, evolution of a process of repair which prevents their degradation and presence of thymine instead of uracil as nitrogenous base.
feed for its young once and they will cease out
once the seeds start further development.

The phenomenon seen here is Mutualism (two organisms
existing symbiotically as in mutual cooperation and
survival to each other), and Co-evolution (the evolution
of fig tree and wasp in accordance with the change in
each other), and also Co-extinction (hence).

11. Age Pyramid of Expanding Population:

    (shows
    both
    males and
    females)

    → Post-reproductive age

    → Reproductive age

    → Pre-reproductive age

12. The viruses 'Baculoviruses' belonging to genus Nucleo-
    polyhedrovirus are effective attackers of insect pests
    and certain arthropods.
* They are suitable for use in an ecologically sensitive area as they are species-specific, narrow-spectrum limited-to-control agents that attack only the pests and do not affect any other organisms.

10. Symptoms of ascariasis:
   (i) Internal bleeding
   (ii) Fever
   (iii) Anemia
   (iv) Blockage of the intestinal (small) passage.
   A healthy person acquires it through contaminated food and water (eggs of the round worm Ascaris may be present).

9. Drosophila melanogaster
   Morgan preferred to work with fruit flies due to:
   (i) Short life cycle of about two weeks; hence many generations can be studied easily.
   (ii) Can be cultured in a simple synthetic medium in the laboratory.
A single mating between male and female produces a large number of offspring with easily studyable characteristics (heredity).

SECTION A:

8. The C-peptide is a polypeptide chain that connects the A and B polypeptide chains in the pro-insulin and is not present (after processing) in the mature human insulin.

7. Bacterial cells - lysozyme
   Fungal cells - chitinase

6. Gause's Competitive Exclusion Principle:
   Two species which compete for similar resources cannot exist indefinitely by the sharing of resources, that is, there will be the inevitable elimination of the less efficient species.
1. Hyphaethia (symbiotic association).

2. Lathyrus (pea grass).

3. Spirulina (single cell protein).

4. Anaphase - I (Meiosis I).

Because it will not become part of the genomic DNA of the chromosome without being in a certain region called the origin of replication, which allows the replication of the chromosome. Otherwise, the foreign DNA will be rejected.