CLASS : XII

SUBJECT – BIOLOGY

SOLUTIONS

1. (c) 1300
2. (d) P-ii, Q-iii, R-i, S-iv
3. (c) Point Q
4. (c) Promoter ; Sigma (σ) ; RNA polymerase
5. (d) P-iii, Q-i, R-ii, S-iv
6. (a) (iv) only
7. (d) Stabilising selection as giraffes with medium neck lengths are selected.
8. (b) XO type of sex chromosomes determines male sex in grasshoppers
9. (d) (iii) and (iv) only
10. (b) (ii) and (iii) only
11. (b) *Salmonella typhimurium*
12. (b) Point (ii)
13. (c) A is true but R is false.
14. (a) 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.
16. (a) Both A and R are true and R is the correct explanation of A.
17. (a) In Hibiscus, the pollen tube enters the ovule through the micropyle, which is a small opening at the apical end of the ovule.

The process occurs in this sequence:

1. Pollen germinates on the stigma of the flower.
2. A pollen tube grows down the style toward the ovary.
3. The tube reaches the ovule and penetrates it through the micropyle.
4. The pollen tube then delivers male gametes (sperm cells) directly into the embryo sac for fertilization.

(b) The pollen tube contains two male nuclei (sperm cells).

1. Syngamy - One male nucleus fuses with the egg cell to form the zygote (2n).
2. Triple fusion - The other male nucleus fuses with the secondary nucleus (central cell) of the embryo sac to form the primary endosperm nucleus (PEN), which is triploid (3n).

18. In eukaryotic cells, there are three main types of RNA polymerases:

(i) RNA Polymerase I

(ii) RNA Polymerase II

(iii) RNA Polymerase III

Polymerase that transcribes hnRNA is RNA Polymerase II

OR

The length of DNA in a eukaryotic cell is indeed much longer than the size of the nucleus. For example, the total DNA in a human cell is about 2 meters, while the nucleus is only about 5–10 μm in diameter. This is possible due to highly organized packaging of DNA.

DNA exists as a double-stranded helix (2 nm in diameter).

DNA wraps around histone proteins (H2A, H2B, H3, H4) forming nucleosomes.

Nucleosomes coil further to form a 30 nm chromatin fiber, giving higher-order packing.

30 nm fibers form looped domains attached to a nuclear scaffold/matrix, further compacting DNA.

During cell division, chromatin fibers condense into visible chromosomes.

This allows DNA to fit efficiently inside the nucleus.

19. (a) In a secondary treatment plant (biological treatment of sewage), the first step the primary effluent undergoes is usually aeration in the aeration tank.

Purpose: To biologically degrade organic matter and reduce pollution load.

(b) In a secondary treatment plant, the B.O.D. level indicates the extent of

organic pollution remaining in the effluent.

- High B.O.D.: More organic matter → sewage is heavily polluted.
- Low B.O.D.: Most organic matter has been removed → effluent is cleaner.

Significance: Measures treatment efficiency, protects aquatic ecosystems, and ensures safe discharge.

20. (a) (i) A – Plasmid, B - Bacteriophage

(ii) Significance -

Plasmids are essential tools in genetic engineering and molecular biology, enabling gene cloning, protein production, and study of gene function.

Bacteriophages are powerful tools in genetic engineering, molecular cloning, protein engineering, and bacterial research, enabling both fundamental studies and practical applications in biotechnology.

OR

(b) Making Bacteria Competent Using Divalent Cations and Temperature Treatment

1. DNA molecules are negatively charged. Ca^{2+} ions neutralize the charges on both DNA and the bacterial cell surface, reducing electrostatic repulsion, and facilitating DNA binding to the cell membrane.

2. The bacterial cells are first treated with cold $CaCl_2$ solution. Cold temperature stabilizes the cell membrane, making it more rigid and better able to interact with DNA without being damaged.

3. After the DNA binds to the cell surface, a brief heat shock (42°C for ~ 30 – 90 seconds) is applied. Heat shock creates a thermal imbalance across the cell membrane, temporarily increasing its permeability, allowing DNA to enter the cytoplasm.

4. Cells are then incubated in a nutrient-rich medium to recover and express the genes carried by the foreign DNA (e.g., antibiotic resistance genes).

21. (1) In situ conservation, biodiversity hotspot/biosphere reserve/national parks / sanctuaries / Ramsar sites/sacred groves (Any one)

(2) Ex situ conservation, Zoological parks/botanical garden/wild life safarı parks/cryopreservation techniques/Tissue culture/seed bank/pollen banks (Any one)

22. (a) (i) Developmental process of secondary spermatocyte from primary spermatocyte -

The primary spermatocyte undergoes the first meiotic division (Meiosis I).

Homologous chromosomes pair and undergo recombination (crossing over) during prophase I.

By the end of Meiosis I, the chromosome number is reduced by half forming two haploid (n) secondary spermatocytes.

(ii) Developmental process of spermatid from secondary spermatocyte -

The secondary spermatocyte undergoes Meiosis II.

Sister chromatids separate and move to opposite poles.

Each secondary spermatocyte produces two haploid spermatids.

(iii) Developmental process of spermatozoa from spermatid -

During spermiogenesis, spermatids undergo structural changes to become motile spermatozoa containing head, middle piece and tail.

Nucleus elongates and condenses.

Acrosome forms from Golgi apparatus, covering the anterior part of the nucleus.

Acrosome contains enzymes (e.g., hyaluronidase, acrosin) needed for egg penetration.

Centrioles reorganize to form the flagellum, which provides motility.

Mitochondria gather around the proximal part of the tail (midpiece) to provide energy (ATP) for motility.

(b) a- primary spermatocyte , b- secondary spermatocyte, c- Sertoli cells

23. (a) (i)

(1) ZIFT - Zygote Intrafallopian Transfer

(2) ICSI - Intracytoplasmic Sperm Injection,

(3) IUT - Intrauterine Transfer

(4) GIFT - Gamete Intrafallopian Transfer.

(ii) IUT and GIFT

Reason- In IUT - sperm is directly placed in the uterus; fertilization occurs inside the female body (in vivo), not in vitro.

In GIFT - eggs and sperm are transferred together into the fallopian tube; fertilization occurs inside the body, not in vitro.

OR

(b) (i) Difference between Perisperm and Pericarp

Feature	**Perisperm**	**Pericarp**
Definition	The remnant of the nucellus that persists in the seed.	The wall of the fruit, developed from the ovary wall after fertilization.
Origin	Derived from the nucellus (a part of the ovule).	Derived from the ovary wall (of the flower).
Location	Found inside the seed, surrounding the embryo (if present).	Forms the outer covering of the fruit.
Function	May provide nutrition to the developing embryo (in some seeds).	Protects the seed and may aid in fruit dispersal.
Presence	Found in some seeds like black pepper and beet.	Present in all fruits (as it forms the fruit wall).

(ii)

Feature	Syncarpous Pistil	Apocarpous Pistil
Definition	A pistil with fused carpels	A pistil with free (unfused) carpels
Structure	Carpels are joined together to form a single compound pistil	Each carpel is separate, forming multiple pistils
Number of Pistils	One pistil, made up of multiple fused carpels	More than one pistil, each from a separate carpel
Example Plants	Tomato, Mustard, China rose (*Hibiscus*)	Lotus, Rose, Buttercup (*Ranunculus*)
Ovary Chambers	Ovary may be multilocular (many chambers)	Each ovary is usually unilocular (single chamber)
Reproductive Advantage	Efficient fertilization and fruit formation	More diversity in fruit/seed development

(iii)

Feature	Plumule	Radicle
Definition	The part of the embryo that develops into the shoot system (stem and leaves).	The part of the embryo that develops into the root system.
Future Growth	Forms the stem, leaves, and upper parts of the plant.	Forms the primary root and root system.

24. (a) The trait given in the chart is recessive because unaffected parents have affected offspring, suggesting both are carriers

(b) It is autosomal because the trait affects males and females equally.

(c) Possible genotypes of children number ‘1’of the second generation: AA or Aa (cannot be aa).

1 spouse is affected (aa) but their child is unaffected — so second parent must contribute an A allele. That leaves either homozygous normal (AA) or carrier (Aa).

Possible genotypes of children number ‘1’of the second generation: Aa (definitely a carrier).

II–3 has an affected child (aa), so she must carry an allele; because she is phenotypically normal she must be Aa.

25. (a) The two primate genera that existed around 15 million years ago and are considered potential ancestors to humans are Dryopithecus and Ramapithecus

(b) Australopithecines lived in East and Southern Africa between approximately 4.2 million and 1.9 million years ago

(c) Two key differences between *Homo habilis* and *Homo erectus*:

Feature	Homo habilis	Homo erectus
Brain size (cranial capacity)	Smaller, about 650–800 cc	Larger, about 900–1200 cc
Posture and locomotion	Partially upright; still somewhat ape-like body	Fully upright; modern human-like body structure, efficient bipedal walker

26. (a) Two utilitarian arguments for conserving biodiversity:

1. Economic (Productive) Value:

Biodiversity provides humans with a wide variety of resources such as food, fuel, fibre, timber, and medicinal plants. For example, many modern drugs are derived from plant and animal sources.

2. Ecosystem Service Value:

Biodiversity helps in maintaining ecological balance through vital services such as pollination of crops, nutrient cycling, climate regulation, and purification of air and water — all essential for human survival.

(b) Ethical reason:

We have a moral duty to protect all forms of life because every species has an inherent right to exist, regardless of its economic value to humans. It is our responsibility to pass on a rich and healthy environment to future generations.

27. "The *Plasmodium* protozoan (which causes malaria) requires two hosts – a human and a female Anopheles mosquito – to complete its life cycle and ensure its continuity.

1. In the human body (Asexual stage):

- When an infected mosquito bites a person, sporozoites of Plasmodium enter the bloodstream.
- These travel to the liver, multiply, and later infect red blood cells (RBCs), causing their rupture and releasing toxins — leading to malaria fever.
- This is the asexual reproduction phase (schizogony), producing more parasites that spread in human blood.

2. In the mosquito body (Sexual stage):

- When a female Anopheles mosquito bites an infected human, it ingests male and female gametocytes from the blood.
- In the mosquito's intestine, these gametocytes fuse to form a zygote, which develops into sporozoites.
- These sporozoites migrate to the mosquito's salivary glands, ready to infect another human during the next bite.

OR

Six ways to achieve and maintain good health:

1. Eat a balanced diet – Include all essential nutrients (carbohydrates, proteins, fats, vitamins, and minerals) in proper proportions.
2. Exercise regularly – Engage in physical activities like walking, jogging, or yoga to keep the body fit and active.
3. Get adequate rest and sleep – Proper sleep helps the body recover and maintain mental alertness.
4. Maintain personal hygiene – Regular bathing, handwashing, and clean surroundings prevent infections and diseases.
5. Avoid harmful habits – Stay away from smoking, alcohol, and drug abuse to protect body organs.
6. Manage stress and maintain a positive attitude – Practise relaxation techniques and maintain good social relationships for mental well-being.

28. (a) Brood Parasitism:

- In this interaction, one species lays its eggs in the nest of another species, and the host bird unwittingly incubates and raises the offspring of the parasite. The parasite benefits, while the host is harmed, as it invests time and energy in raising the parasite's young.
- Example: The cuckoo (koel) lays its eggs in the crow's nest. The crow incubates the eggs and feeds the cuckoo chicks, often at the cost of its own offspring.

(b) Co-evolution of Mutualists:

- In this type of interaction, two species interact closely for mutual benefit, and evolve together to enhance this relationship.
- The evolution of one species drives the evolution of the other — a process called co-evolution.
- Example: The relationship between flowering plants and their pollinators (such as bees, butterflies, or birds).

29. (i) Triple fusion takes place in the embryo sac (female gametophyte) of a flowering plant, specifically in the central cell.

OR

(i) A total of five nuclei participate in double fertilization in angiosperms.

Two male nuclei: (from the pollen grain)

One egg nucleus

Two polar nuclei: (from the central cell of the embryo sac)

(ii) The central cell contains two polar nuclei, each haploid (n).

⇒ Together they contribute 2n.

One male gamete (n) fuses with these two polar nuclei during triple fusion.

⇒ Total = n (male) + 2n (polar nuclei) = 3n

The endosperm formed is triploid (3n).

Hence, its chromosome number

$= 3 \times 7 = 21$

(iii) Significance of Double Fertilization:

It ensures that the formation of the endosperm (nutritive tissue) occurs only when the egg is fertilized, thus conserving the plant's energy and resources.

Significance of Triple Fusion:

It leads to the formation of the endosperm, which provides nourishment to the developing embryo.

30. (i) When a vaccine is administered, it contains weakened or inactivated forms of a pathogen or its antigens. These do not cause disease, but stimulate the immune system to produce antibodies and memory cells. This results in an increase in antibody concentration in the blood, preparing the immune system for a real infection.

OR

(i) Vaccination provides acquired active immunity.

(ii) This rapid increase in antibody concentration is due to the presence of memory cells formed during the initial vaccination. These cells recognize the pathogen quickly and stimulate a secondary immune response, which is faster and stronger than the primary response. This helps in quickly neutralizing the pathogen and often prevents illness.

(iii) P = Yes

Q = Getting infected naturally

R = No

S = Yes

T = No

31. (a) (i) Nitrogen-15 (^{15}N) — a heavy isotope

Nitrogen-14 (^{14}N) — a normal/light isotope

Reason: They used these isotopes to label DNA and distinguish "old" (heavy) DNA strands from "new" (light) ones. Since nitrogen is a key component of DNA (in nitrogenous bases), incorporating different isotopes allowed them to track DNA replication through changes in density.

(ii) They took samples at regular intervals to observe the distribution of DNA after each replication cycle. This allowed them to track how DNA strands were passed on over time and to determine whether replication was conservative, semi-conservative, or dispersive.

(iii) Caesium chloride (CsCl) density gradient ultracentrifugation was used to:

- Separate DNA molecules based on their density.
- ^{15}N-labeled DNA (heavier) and ^{14}N-labeled DNA (lighter) settled at different positions in the gradient.
- This allowed visualization of DNA as distinct bands in the centrifuge tube, showing how DNA composition changed with replication.

(iv) Meselson and Stahl concluded that DNA replication is semi-conservative

OR

(b) (i) Alleles used for different traits are

Tall = T (Dominant)

Dwarf = t (Recessive)

Round seeds = R (Dominant)

Wrinkled seeds = r (Recessive)

Genotype of tall and round seed plant

= TTRR

Dwarf and wrinkled seed plant = ttrr

The cross can be represented as

Parents TTRR ↓ Gametes TR × ttrr ↓ tr on crossing

F_1 generation TtRr TtRr TtRr....

All pea plants will be tall with round seeds. All are heterozygous for both traits.

TtRr ↓ Gametes TR Tr tR tr × TtRr ↓ TR Tr tR tr

On self crossing

F_2 generation

	TR	**Tr**	**tR**	**tr**
TR	TTRR	TTRr	TtRR	TtRr
Tr	TTRr	TTrr	TtRr	Ttrr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	ttRr	ttrr

Phenotypic ratio of F_2 generation is –

Tall plant and round seeds = 9

Tall plant and wrinkled seeds = 3

Dwarf plant and round seeds = 3

Dwarf plant and wrinkled seeds = 1

The phenotypic ratio so obtained is

9 : 3 : 3 : 1

(ii) Mendel's Law of Independent Assortment: "When two or more traits are inherited together, the alleles of each trait assort independently of the alleles of the other trait during gamete formation."

32. (a) (i) Plasmids are small, circular, double-stranded DNA molecules found in bacteria that are separate from chromosomal DNA. They play a key role in genetic engineering because of the following reasons:

1. Serve as vectors in rDNA technology

2. Self-replicating, easy to manipulate

Sources from which plasmids can be isolated:

1. Bacterial Cells - Plasmids naturally occur in many bacteria, such as *Escherichia coli* (*E. coli*).

2. Yeast Cells -e.g., Saccharomyces cerevisiae

(ii) Role of 'ori':

- Ensures that the vector replicates inside the host cell, so the foreign DNA is also copied.
- Without 'ori', the introduced DNA would not be replicated or inherited by daughter cells.
- The number of copies of the plasmid (and therefore the gene of interest) inside the host can be influenced by the type of 'ori' used.

In short: 'ori' is essential for the maintenance and amplification of the cloned gene inside the host.

Role of Selectable Marker:

- After transformation, cells are grown on media containing the relevant antibiotic.
- Only those host cells that contain the vector (with the selectable marker) will survive.
- Helps distinguish transformed cells (with plasmid) from non-transformed cells (without plasmid).

(iii) Without restriction enzymes, it would not be possible to:

- Precisely isolate specific genes.
- Create recombinant molecules with compatible ends.
- Insert the gene of interest into a vector for cloning or expression.

OR

(b) (i) Farmers prefer to grow Bt cotton over genetically unmodified cotton for several important reasons:

1. Resistance to Insect Pests (Especially Bollworms):

- Bt cotton contains a gene from the bacterium *Bacillus thuringiensis* (Bt) that produces a protein toxic to certain insect pests, particularly bollworms, which are major cotton pests.
- This built-in resistance reduces crop damage, leading to higher yield and better-quality cotton.

2. Reduced Use of Chemical Insecticides:

- Since Bt cotton naturally defends itself against bollworms, farmers need fewer pesticide sprays.
- This reduces costs and chemical exposure for both farmers and the environment.

3. Increased Yield and Profitability:

- With fewer losses to pests and lower input costs (like pesticides), Bt cotton generally results in higher productivity and greater profits for farmers.

4. Environmentally Friendly:

- Lower pesticide use means less contamination of soil and water, and it helps preserve beneficial insects like pollinators.

(ii) Two insects that are killed by Bt toxin are:

1. Cotton bollworm (*Helicoverpa armigera*)

2. Corn borer (*Ostrinia nubilalis*)

(iii) Bt Produces an Inactive Protoxin:

- The bacterium *Bacillus thuringiensis* produces the Bt toxin in an inactive form called a protoxin (a crystal protein).
- This protoxin is harmless to both the bacterium and non-target organisms, including humans..

33. (a) Graphical representation of the relationship among the organisms at different trophic level.

Pyramid of Energy	Pyramid of Biomass	Pyramid of Numbers
Shows transfer of Energy from one tropic level to other	Shows transfer of amount of food/ biomass from one tropic level to other	Pyramid of Numbers shows numbers of organism at each tropic level.
Always upright	Mostly upright but can be inverted	Mostly upright can be Inverted

(b) It does not accommodate the food web / does not take into account the same species belonging to two or more tropic levels. Saprophytes are not given any place.

OR

(a)

J shaped - growth curve	S shaped- growth curve
Resources are unlimited	Resources are limited
Growth is exponential	Logistic Growth
As resources are unlimited all individuals survive and reproduce	Fittest individual will survive and reproduce
Growth Equation dN/dt=Rn	Growth Equation dN/dt=rN (k-N/K)

(b) When resources are limited, Competition occurs between individuals, fittest will survive, who reproduce to leave more progeny.