SQP SOLUTIONS

1. (d) : The male gamete will be haploid (n) and polar nuclei will be diploid ($2n$). Endosperm formed by fusion of gamete with two polar nuclei will be pentaploid.

Male gamete + 2 polar nuclei $\longrightarrow$ Endosperm
(n) ($2n$) + ($2n$) ($5n$)

2. (b) **3. (b)**

4. (b) : The palindromes in DNA are base pair sequences that are the same when read forward (left to right) or backward (right to left) from a central axis of symmetry.

For example,

(i) 5' – G A A T T C – 3'
3' – C T T A A G – 5'

(ii) 5' – G G A T C C -3'
3' – C C T A G G -5'

5. (c)

6. (a) : Benign tumor remain confined to their original location and do not spread to other parts of body and cause little damage.

7. (c)

8. (b) : In given fragment third codon is UAA, a stop codon thus, will not translate completely.

9. (a) **10. (c)**

11. (a) :

Types of Microbes	Scientific Name	Commercial Product
Bacterium	*Streptococcus* (A)	Clot buster enzyme
Fungus (B)	*Aspergillus niger*	Citric acid
Fungus	*Trichoderma polysporum*	Cyclosporin-A (C)
Bacterium	*Clostridium butylicum* (D)	Butyric acid

12. (a)

13. (c) : Two types of pollination are recognised based on the destination of pollen grains. When pollen grains are transferred from an anther to the stigma of the same flower, the process is called self pollination or autogamy. Cross pollination is further classified depending on whether the pollination has occurred between two flowers on the same plant (geitonogamy) or between two flowers on different plants (xenogamy).

14. (b)

15. (b) : The vector should have single recognition site for the restriction enzymes. The presence of more than one recognition sites within the vector will generate several fragments leading to complication in the cloning.

Ligation of alien DNA is carried out at a restriction site present in one of the two antibiotic resistance genes. Example is ligating a foreign DNA at the *Bam*HI tetracycline resistance gene in the vector pBR322. The recombinant plasmid will lose tetracycline restriction due to insertion of foreign DNA.

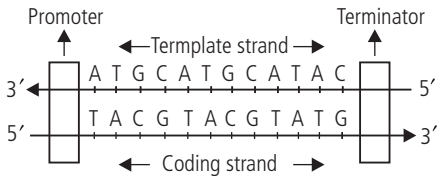
16. (b) : Darwin was convinced that interspecific competition is a potent force in organic evolution. It is generally believed that competition occurs when closely related species compete for the same resources that are limiting, but it is not entirely true. Totally unrelated species could also compete for the same resource. Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually. This may be true if resources are limiting, but not otherwise.

17. A. (i) Paternity disputes can be resolved with the help of DNA fingerprinting, in which differences in repetitive DNA sequence of bases in the DNA strands of chromosomes are used to compare one biological sample with another to investigate genetic relationship.

(ii) The technique used in paternity identification, *i.e.*, DNA fingerprinting also has applications in paleontology, archaeology, forensic science, determining population and genetic diversities.

OR

B. (a)



(b)

18. A. (i) A – Scutellum B – Coleoptile
C – Epiblast D – Coleorhiza

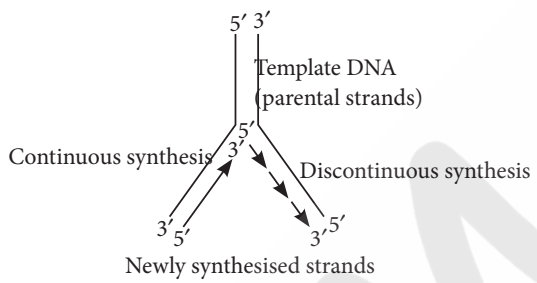
(ii) The given figure is L.S. of an embryo of a plant belonging to grass family. B represents coleoptile and D-represents coleorhiza. Coleoptile is a foliar structure that encloses the epicotyl bearing shoot apex and leaf primordia. It protects the plumule during emergence from soil. Coleorhiza is a sheath encapsulating both radicle and root cap. It does not protect the radicle during its passage into the soil.

19. A. In the given figure
A - Gas holder, B - Sludge, C - Digester, D - Dung and water

B. Once the BOD of sewage water is reduced significantly, the effluent is passed into a settling tank where aerobic bacterial flocs undergo sedimentation. The sediment of settling tank is called activated sludge.

20. Blastocyst gets implanted in human female. In a blastocyst, the blastomeres are arranged into an outer layer called trophoblast and an inner group of cells called the inner cell mass. The trophoblast then gets attached to the endometrium and the inner cell mass gets differentiated as the embryo. After attachment the uterine cells divide rapidly and cover the blastocyst. As a result, the blastocyst becomes embedded in the endometrium of the uterus. This whole phenomenon is called implantation and it leads to pregnancy.

21. (i) Diagrammatic representation of replicating fork is as follows:



(ii) Due to high energy requirement whole of DNA does not open in one stretch. The point of separation proceed slowly towards both directions. It gives the appearance of Y-shaped structure called replication fork.

22. A. In the given figure, 'A' – Antigen binding site,'B' – Variable region of heavy chain, 'C'– Light chain.

B. This diagram illustrates the structure of an antibody molecule.

C. Humoral immune response is an antibody mediated immune response, which is regulated by antibodies in body fluids.

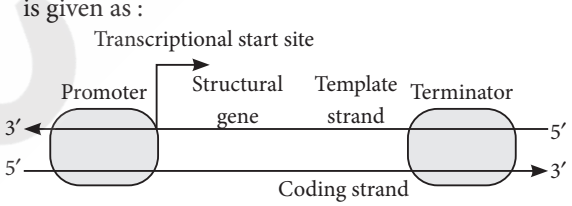
23. The phenomenon behind the deviation of F_2 ratio from 9 : 3 : 3 : 1 to 3 : 1 is termed as linkage. Linkage is of two types: complete and incomplete. This deviation was seen due to incomplete linkage in *Drosophila* for body and eye colour. Morgan observed that when yellow bodied white eyed female was crossed with brown bodied red eyed male, F_1 progeny was brown bodied red eyed. On intercrossing F_1 progeny, Morgan observed that the two genes did not segregate independently of each other and therefore, F_2 ratio deviated. He found 98.7% to be parental and only 1.3% recombinants. Thus, these genes were very tightly linked and showed very low recombination.

24. A. In gel electrophoresis, DNA molecules migrate in the direction of electrode bearing opposite charge on the basis of size. The smaller the fragment, the farther it moves.

B. The most commonly used medium or matrix is agarose which is a polysaccharide extracted from sea weeds.

C. The separated DNA fragments can be seen only after staining the DNA with a compound known as ethidium bromide followed by exposure to UV radiations as bright orange coloured bands.

25. Transcription unit comprises three regions : promoter, structural gene and terminator. Promoter is a region to which RNA polymerase binds and initiates transcription. Terminator usually defines the end of the process of transcription. Structural gene is an area that is involved in transcription or formation of RNA. The schematic structure of a transcription unit is given as :



26. In angiosperms, double fertilisation produces two structures — a diploid zygote and a triploid primary endosperm cell. The later gives rise to tissue called endosperm. Zygote forms the embryo and endosperm provides nourishment to the growing embryo. With the growth of embryo, the central part of the endosperm is utilised. In some seeds, the endosperm persists in the seed as food storage tissue. Such seeds are called endospermic or albuminous seeds, *e.g.*, castor, cereals, etc. In others the endosperm is completely eaten up by growing embryo. In such seeds the food for later development of embryo is then stored in cotyledons which become massive. Such seeds are called non-endospermic or ex-albuminous, seeds *e.g.*, groundnut, pea, etc.

OR

(i) Given figure represents the egg apparatus showing the entry of pollen tube into synergids.

(ii) A-Male gametes; B - Synergid; C - Polar nuclei; D - Egg nucleus.

27. Klinefelter's syndrome is one of the genetic disorders in males that occurs when a male baby is born with an extra X chromosome resulting into a karyotype of 47 chromosomes. Klinefelter's syndrome is found in one out of 1000 males. The unwanted additional sex chromosome is a result of a random error in the formation of sperm or the egg. Women with pregnancies after the age of 35 have slightly more chances of having a baby with this syndrome.

Klinefelter's syndrome may adversely affect testicular growth, resulting in smaller than normal testicles, which can lead to lower production of testosterone. The syndrome may also cause enlarged breast, *i.e.,* gynaecomastia and sterility.

28. A. In this table, A is Mutualism, B is Predation, C is Commensalism and D is Amensalism.

(i) Mutualism-It is an interaction where both species derive benefit from the interaction, *e.g.*, lichens.

(ii) Competition-This is an interaction, where both species suffer due to same requirement of resources, that are limited, *e.g.,* In some South American lakes, visiting flamingoes and resident species compete for the common food.

(iii) Predation-It is an interaction between two species in which one species (parasite) depends on the other species (host) for food and shelter and in the process damages the host, *i.e.*, one is benefited and other is harmed, *e.g.* tiger and the deer.

B. Phytophagous insects feed on plant sap and other parts.

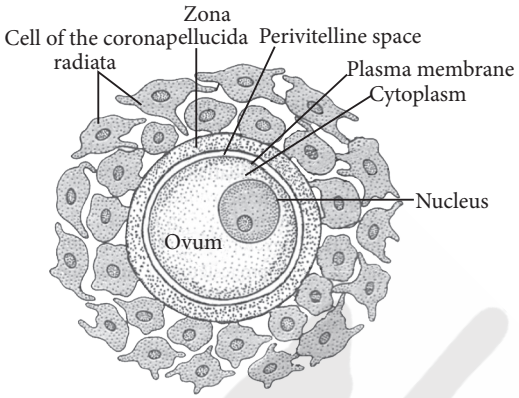
29. A. C is developing follicle under the influence of FSH. H is regressing corpus luteum under the influence of reduction of LH.

B. 'F' illustrates ovulation. It represents secondary oocyte.

LH is the pituitary hormone that causes ovulation.

C. The corpus luteum degenerates in absence of fertilisation.

D. The labelled structure of a human ovum prior to fertilisation is as follows:



30. A. Species A is most successfully controlled by Bt corn plant as the proportion of leaf area damage reduced significantly when they fed on Bt crop.

B. Species B of corn borer shows least impact of toxin produced by Bt genes as % change of leaf area damage between non bt crop and Bt crop by species B is not significant.

C. *CryIAb* controls corn borer.

OR

D. Since species B of corn borers is more resistant to this particular Bt corn variety, the farmer should be advised to grow different variety of Bt corn to get maximum yield.

31. A.(i) A - Secondary effluent, B - River water
C - Primary effluent, D - Untreated sewage water

(ii) Untreated sewage water (D) contains large amount of microbes, which are pathogenic.

(iii) If sample D *i.e.*, untreated sewage water is disposed off in a freshwater body (a river) *i.e.*, sample B, then BOD in B will increase and dissolved oxygen will decrease.

(iv) High value of BOD in sample D is due to high amount of organic wastes and aerobic microbes present in it. Sample D requires physical removal of particles from the sewage through filtration and sedimentation.

OR

B. (i) (a) Antibiotics - Antibiotics are medicines produced by certain microorganisms to kill other disease causing microorganisms. These medicines are commonly obtained from bacteria and fungi, *e.g.*, penicillin, streptomycin.

(b) Biogas - Biogas is a mixture of gases mainly methane (CH_4) and carbon dioxide produced by the microbial activity. Biogas is used for cooking and lighting. It is a methane rich fuel gas produced by anaerobic breakdown of biomass with the help of methanogenic bacteria.

(c) Sewage - The wastewater that flows down drains and though pipes from toilets and sinks is called sewage.

(ii) The natural methods of pest and pathogen control involving use of viruses, bacteria and other insects

which are their natural predators and pests are called biocontrol agents. For example, Lady bird beetles feed on aphids while dragonflies prey upon mosquitoes. Free living fungus, *Trichoderma* exerts biocontrol over several plant pathogens. An example of microbial biocontrol agents that can be introduced in order to control butterfly caterpillars is the bacterium *Bacillus thuringiensis.*

Biofertilisers are the microorganisms such as bacteria, cyanobacteria, fungi, etc, which bring about soil nutrients enrichment, maximise the ecological benefits and minimise the environmental hazards. Bacteria and cyanobacteria have the property of nitrogen fixation while mycorrhizal fungi preferentially withdraw minerals from organic matter for the plant with which they are associated. Insoluble forms of soil phosphorus are converted into soluble forms by certain micro-organisms. This makes the phosphorus available to the plants. Phosphate is also solubilised by some bacteria and by some fungi that form association with plant roots.

32. A. *In situ* strategy emphasises on protection of whole ecosystems. The *in situ* approach includes protection of group of typical ecosystem through a network of protected areas. It is conservation and protection of the whole ecosystem and its biodiversity at all levels in order to protect the threatened species.

Two *in situ* methods used to save biodiversity are hotspots and protected areas.

(a) Hotspots – These are areas of high endemism and high level of species richness. Some 36 hotspots have been identified. Four of them occur in India – Western Ghats, Indo-Burma region (North East India), Himalaya and Sundaland. If Hotspots are properly conserved they will reduce extinction by about 30%.

Hotspots are rich in unique biodiversity but are declared sensitive due to direct or indirect human interference. Biodiversity hotspots were originally identified by Norman Myers in 1990s. Hotspots are determined by four factors (i) Number of species or species diversity, (ii) Degree of endemism, (iii) Degree of threat to habitat and (iv) Degree of exploitation.

(b) Protected areas – These are areas of land and/or sea specially dedicated to the protection and maintenance of biological diversity, and of the natural and associated cultural resources. These are managed through legal or other effective means. Examples of protected areas National Parks and wildlife sanctuaries. World Conservation Monitoring Centre has recognised about 37000 protected areas around the world. As of February 2022, there are 987 protected areas in India including 106 National parks, 564 wildlife sanctuaries, 99 conservation reserves and 218 community reserves covering 5.26% coverage of country. The Jim Corbett National Park was the first National Park established in India. Some of the main benefits of protected areas are:

(i) Maintaining viable populations of all natural species and sub species.

(ii) Maintaining the number and distribution of communities and habitats, and conserving the genetic diversity of all the present species and varieties.

(iii) Preventing anthropogenic introductions of alien exotic species.

(iv) Making it possible for species habitats to shift in response to environmental changes.

OR

B. *Ex-situ* conservation strategies include offsite collections and gene banks. It is the conservation of selected rare plants/animals in places outside their natural homes.

The *ex situ* conservation includes:

(i) Seed banks - They are institutes that maintain stocks of viable seeds (seed banks).

Seed banks are of two types, orthodox and recalcitrant. Orthodox seeds are those seeds which can tolerate reduction in moisture content (upto 5%), anaerobic conditions and long temperature of –10°C to –20°C or even lower for prolonged periods, *e.g.*, cereals, legumes. At intervals the seeds are allowed to germinate from plants and develop fresh seeds for storage.

Recalcitrant seeds are those which get killed on reduction of moisture and exposure to low temperature, *e.g.*, tea, cocoa, jackfruit, coconut. They can be stored for shorter duration after treatment with fungicides in rooms having humid air and normal oxygen.

(ii) Tissue culture – It is carried out through callus formation, embryoids, pollen grain culture and shoot tip culture for those plants which are either seedless, have recalcitrant seeds, non viable seed progeny or where clone is to be maintained. This method is useful in maintaining a large number of genotypes in small area, rapid multiplication of even endangered species and for hybrid rescue.

33. A. (i) Natural selection is the process by which those organisms that are best suited to their environment and are able to reproduce well in changed environmental conditions do survive. One of the most striking examples, which demonstrates the action of natural selection in the wild is the case of peppered moth, *Biston betularia* that lives in all parts of England.

Due to industrial smoke and soot, the pale tree trunks became more and more blackened. As a result, the light moths stood out in contrast to its background, increasing the possibility of being easily detected and eaten by their predators, such as birds. Decrease in

the number of light-winged moths and increase in the number of dark variety was the ultimate result. Therefore, evolution favoured the dark-winged melanic moths to reproduce more successfully for their adaptation in the polluted areas of England. Evolution of darker form in response to industrial pollution is known as industrial melanism.

(ii) Darwin's finches of the Galapagos islands represent adaptive radiation. Adaptive radiation (divergent evolution) is the evolution from a common ancestral form to a number of different forms.

Darwin's finches had a common ancestor but now have different types of modified beaks according to their food habits. As the original population of finches increased in size, it spreaded out from its centre of origin to exploit new habitats and food sources. After some time, it resulted in evolution of a number of populations, each adapted to its particular habitat. Eventually these populations differed from each other sufficiently to become new species. Darwin differentiated thirteen species of finches and grouped them into six main types – (i) Large ground finches (ii) Cactus ground finches feeding on cacti (iii) Vegetarian tree finches (iv) Insectivorous tree finches (v) Warbler finches (vi) Tool-using or Wood pecker finches.

OR

B. **(i)** Anthropogenic actions such as excessive use of herbicides, pesticides, etc., has only resulted in selection of resistant varieties in a much lesser time scale which is equally true for microbes against which we employ antibiotics or drugs. As a result of which resistant organisms or cells are appearing in a time scale of months or years or centuries. For example, when DDT was used for the first time, maximum mosquitoes died but few survived due to variation in the population. These mosquitoes showed resistance to DDT and survived to reproduce successfully in the presence of DDT, thus lead to evolution.

(ii) According to Darwin, the fitness of an organism is measured by its reproductive ability. Also the appearance of new forms is linked to the lifespan of an organism. The greater its lifespan, the more it can reproduce and hence greater new forms would appear.

☺☺☺