Important Questions from the Previous Years' Board Papers
Unit: Genetics and Evolution
2009 (Delhi Region)
Set 1

One mark Questions:

Q.1 Why hnRNA is required to undergo splicing?

Answer: The heterogeneous nuclear RNA (hnRNA) is required to undergo splicing because the primary transcript contains both exons and introns. Introns are non-functional; hence, they are removed by splicing. **(Chapter 6, Pg.no. 111)**

Q.5 Mention the type of evolution that has brought the similarity as seen in potato tuber and sweet potato.

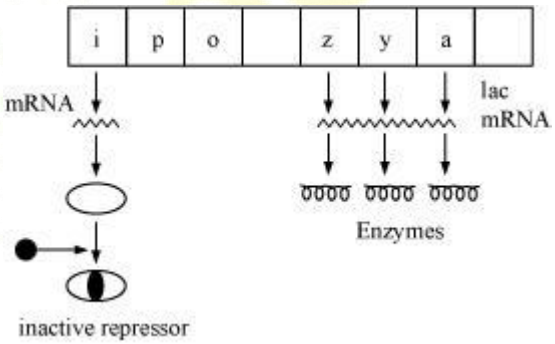
Answer: Convergent evolution has brought about the similarity between potato tuber and sweet potato. **(Chapter 7, Pg.no. 131)**

Two Mark Questions:

Q.12 How is the translation of mRNA terminated? Explain.

Ans: The mRNA is translated into a complete polypeptide by the ribosome as it proceeds through the mRNA sequence. Amino acids linked to the complementary tRNA anticodon are added one by one along the sequence. At the end, when the stop codon is encountered, a release factor binds to it, which then terminates translation and enables the release of a complete polypeptide chain from the ribosome. **(Chapter 6, Pg.no. 115)**

Q.18 Study the figure given below and answer the questions:



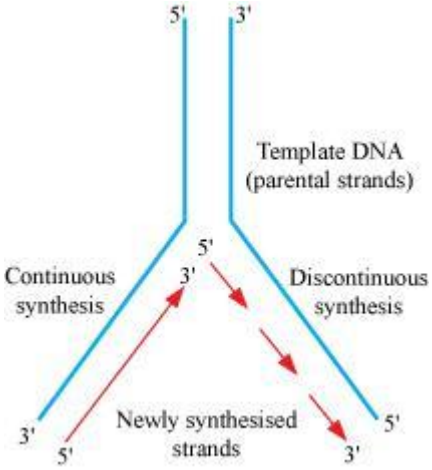
(a) How does the repressor molecule get inactivated?
(b) When does the transcription of lac mRNA stop?
(c) Name the enzyme transcribed by the gene 'Z'.

Answer:
(a) The repressor gets inactivated by the binding of the inducer. In the case of lac operon, molecules such as lactose and allolactose act as the inducer.
(b) In the absence of the inducer, when the repressor protein synthesised by the gene 'I' binds to the operator region, the transcription of lac mRNA stops.
(c) The gene 'Z' codes for the enzyme β-galactosidase. **(Chapter 6, Pg.no. 117)**

Three mark Questions:

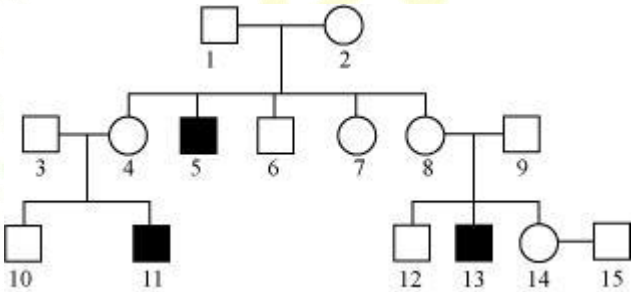
Q.22 Draw a labelled schematic sketch of replication fork of DNA. Explain the role of the enzymes involved in DNA replication.

Answer:



Enzymes involved in DNA replication:
The main enzyme involved in DNA replication is the DNA-dependent DNA polymerase. This enzyme catalyses the polymerisation of deoxynucleotides along the 5′ → 3′ direction, and hence, replication is continuous along the 3′ → 5′ strand, and discontinuous along the template, i.e., the 5′ → 3′ direction. This discontinuous strand is joined by another enzyme called DNA ligase. **(Chapter 6, Pg.no. 106, 107)**

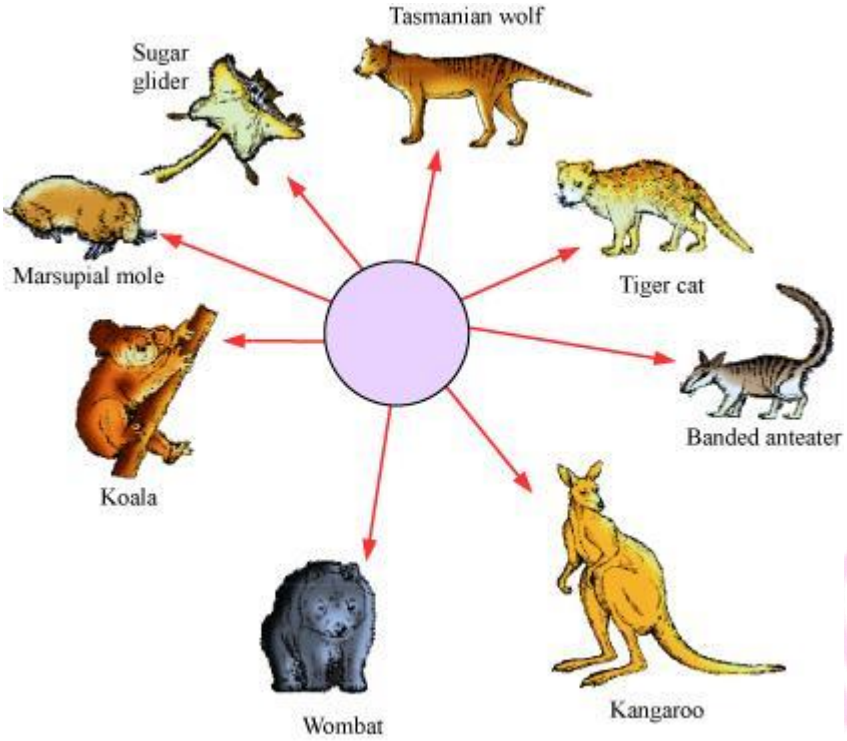
Q.24. Haemophilia is a sex-linked recessive disorder of humans. The pedigree chart given below shows the inheritance of haemophilia in one's family. Study the pattern of inheritance and answer the question given.



(a) Give all the possible genotypes of the members 4, 5 and 6 in the pedigree chart.
(b) A blood test shows that the individual 14 is a carrier of haemophilia. The member numbered 15 has recently married the member numbered 14. What is the probability that their first child will be a haemophilic male?

Ans: (a) 4 − Carrier female with genotype X^*X
5 − Affected male with genotype X^*Y
6 − Normal male with genotype XY
Here, X^* represents the trait for haemophilia.
(b) There is a 25% probability that their first child will be a haemophilic male.
(Chapter 5, Pg.no. 88)

Q.25.



(a) Mention the specific geographical region where these organisms are found.
(b) Name and explain the phenomenon that has resulted in the evolution of such diverse species in the region.
(c) Explain giving reasons the existence of placental wolf and Tasmanian wolf sharing the same habitat.

Answer:

(a) The figure represents the adaptive radiation of marsupials, in Australia.
(b) The phenomenon that has resulted in the evolution of these diverse animals is adaptive radiation. It is the process of evolution of different species in a given geographical area, starting from a point and radiating to other geographical locations or habitats. The marsupials of Australia have evolved from an ancestral stock, but each one is different from the other and also inhabits different habitats.
(c) Placental wolf and Tasmanian wolf share the same habitat because in Australia, placental mammals also exhibit adaptive radiation and show similarities in appearance to a corresponding marsupial mammal.
(Chapter 7, Pg. no. 133)

Five mark Question:

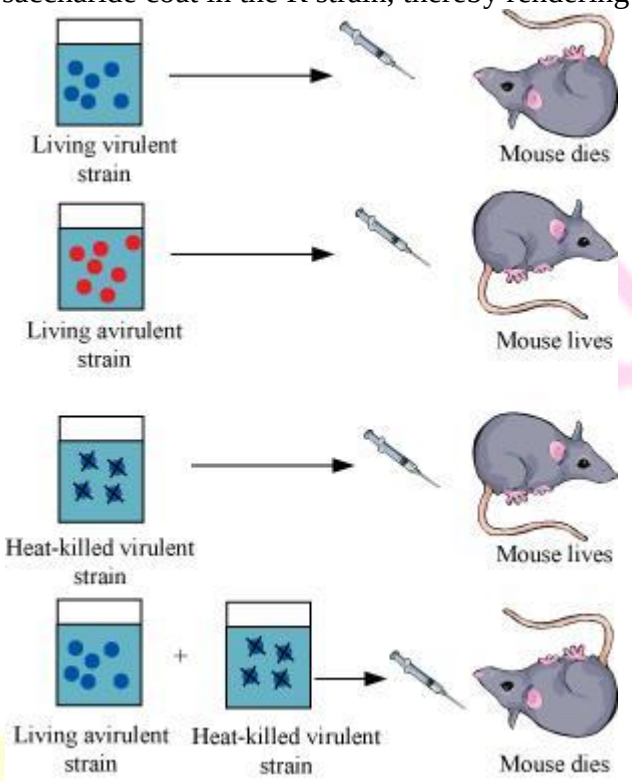
Q.29 (a) Explain the experiment performed by Griffith on *Streptococcus pneumoniae*. What did he conclude from this experiment?
(b) Name the three scientists who followed up Griffith's experiments.
(c) What did they conclude and how?

Ans: (a)

- In 1928, Fredrick Griffith performed some experiments on *Streptococcus pneumoniae*. When the bacteria were grown on culture medium, some produced smooth shiny colonies (S), while the others produced rough colonies (R). This is because the S strain contained a polysaccharide mucus coat, while

the R strain lacked it.

- Mice infected with the S strain died of pneumonia, while those infected with the R strain survived.
- Griffith then heat-killed the S strain bacteria and injected them into mice. He noticed that the mice did not develop pneumonia.
- He then mixed the heat-killed S strain with the live R strain and injected it into mice. The mice died as a result. He was also able to recover live S strain bacteria from the dead mice.
- He then concluded that some transforming principle was transferred from the heat-killed S strain to the R strain, which enabled the synthesis of the polysaccharide coat in the R strain, thereby rendering it virulent.



(b) Avery, MacLeod and McCarty were the three scientists who followed up Griffith's experiment.

(c) They purified proteins, DNA and RNA from the heat-killed S strain, and transferred them to the live R strain cells to see which biomolecule had the capacity to render the R strain virulent. From their experiments, they concluded that only the DNA of the S strain had the capacity to transform the R strain. They also noticed that proteases and RNAses did not affect the transformation of the R strain, and hence, concluded that the transforming principle was neither RNA nor protein. They suggested that DNA caused transformation and could be the genetic material.

(Chapter 6, Pg.no. 100, 101)

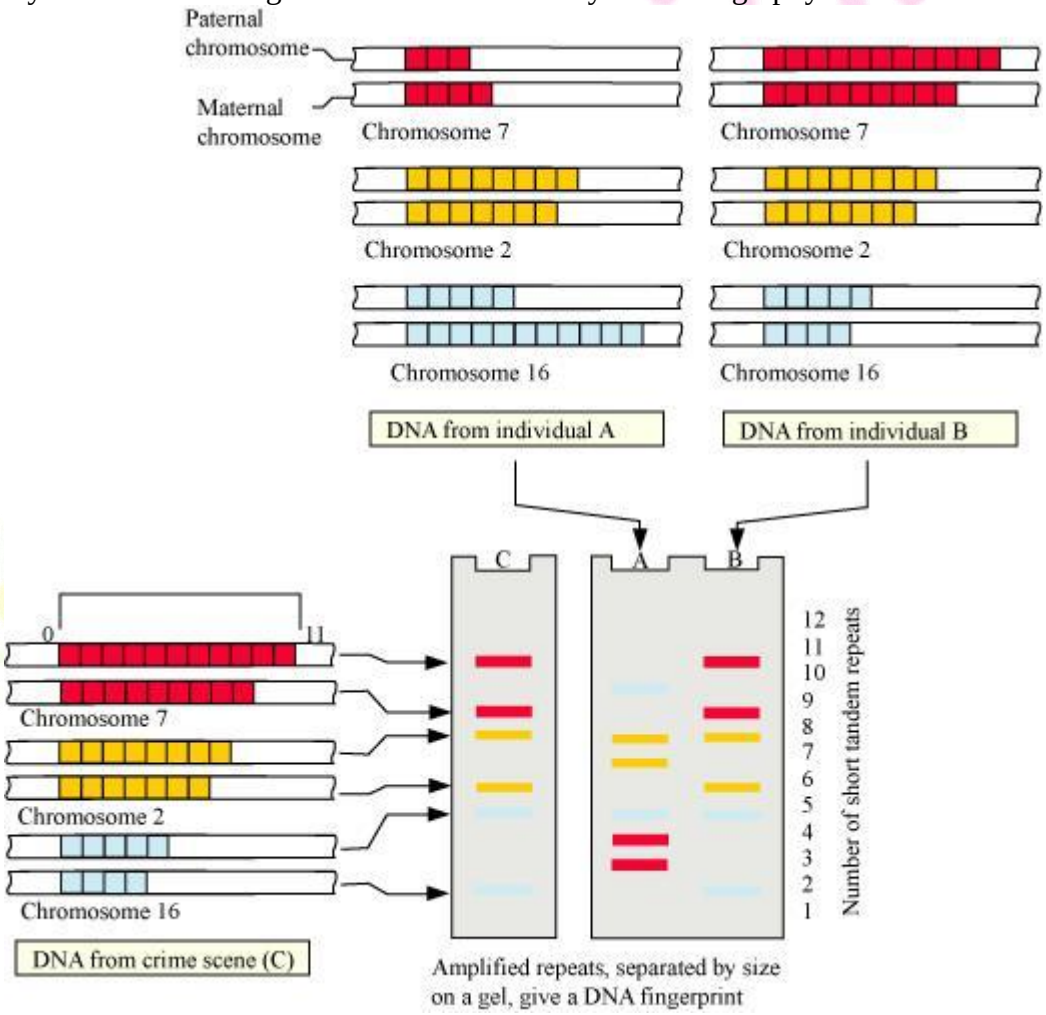
Q.29 (OR) Two blood samples A and B picked up from the crime scene were handed over to the forensic department for genetic fingerprinting. Describe how the technique of genetic fingerprinting is carried out. How will it be confirmed whether the samples belonged to the same individual or to two different individuals?

Answer: DNA fingerprinting is based on the identification of difference between some specific

regions of DNA, called the repetitive DNA. These stretches of DNA are repeated many times and are separated from the bulk genomic DNA as different peaks during density gradient centrifugation. The genomic DNA forms a major peak and the other smaller peaks are called satellite DNA. These sequences show high degree of polymorphism, called the VNTR (variable number of tandem repeats). Since the DNA isolated from any tissue of a particular individual shows the same degree of polymorphism, it forms the basis of forensic applications.

Steps involved in the process of DNA fingerprinting are as follows −

- First of all, the DNA from an individual is isolated and cut with restriction endonucleases.
- Fragments are separated according to their size and molecular weight on electrophoresis gel.
- Fragments separated on electrophoresis gel are blotted (immobilised) on a synthetic membrane such as nylon or nitrocellulose.
- Immobilised fragments are hybridised with a VNTR probe.
- Hybridised DNA fragments can be detected by autoradiography.



In the given situation, the DNAs can be tested for the degree of polymorphism exhibited in the case of both the blood samples. If the DNAs show the same degree of polymorphism, then it can be concluded that the blood samples are from the same individual. If the DNAs exhibit different degrees of polymorphism, then they are from different individuals. **(Chapter 6, Pg.no.122, 123)**

Set 2

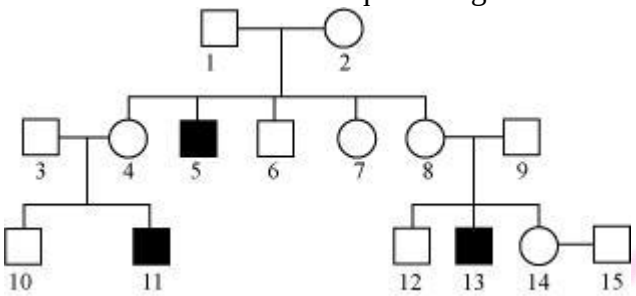
One mark Questions

Q.1. Why are the wings of a butterfly and of a bat called analogous?

Answer: The wings of a butterfly and a bat are considered to be analogous because they have different structures, but perform the same function.
(Chapter 7, Pg.no. 130)

Three mark Questions

Q.6. Haemophilia is a sex-linked recessive disorder of humans. The pedigree chart given below shows the inheritance of haemophilia in once family. Study the pattern of inheritance and answer the question given.



(a) Give all the possible genotypes of the members 4, 5 and 6 in the pedigree chart.
(b) A blood test shows that the individual 14 is a carrier of haemophilia. The member numbered 15 has recently married the member numbered 14. What is the probability that their first child will be a haemophilic male?

Answer: (a) 4 − Carrier female with genotype X^*X
5 − Affected male with genotype X^*Y
6 − Normal male with genotype XY
Here, X^* represents the trait for haemophilia.
(b) There is a 25% probability that their first child will be a haemophilic male.
(Chapter , Pg.No. 88)

Q.6 (OR) Inheritance pattern of ABO blood groups in humans shows dominance, codominance and multiple allelism. Explain each concept with the help of blood group genotypes.

Answer: The inheritance of ABO blood groups in humans exhibits dominance, codominance and multiple allelism. In humans, the ABO blood groups are controlled by a gene called gene 'I'. It has three alleles, namely I^A, I^B and *i*.
Dominance: The alleles I^A and I^B exhibit complete dominance over the allele *i*; hence, if both I^A and *i* are present in an individual, then I^A is expressed. Similarly, in an individual with I^B and *i*, I^B is expressed.
Co-dominance: If both I^A and I^B are present in an individual, then they both are expressed because of the phenomenon of co-dominance.
Multiple allelism: Since the blood grouping is governed by more than two alleles, it is a good example of multiple allelism.

Table Showing the Genetic Basis of Blood Groups in Human Population is given as follows:

Allele from Parent 1	Allele from Parent 2	Genotype of offspring	Blood-types of offspring
I^A	I^A	$I^A I^A$	A
I^A	I^B	$I^A I^B$	AB
I^A	i	$I^A i$	A
I^B	I^A	$I^A I^B$	AB
I^B	I^B	$I^B I^B$	B
I^B	i	$I^B i$	B
i	i	$i\ i$	O

(Chapter 5, Pg.no. 77)

Set 3

One mark Questions:

Q.2. Are the thorn of *Bougainvillea* and tendril of *Cucurbita* homologous or analogous? What type of evolution has brought such a similarity in them?

Answer: The thorns of *Bougainvillea* and the tendrils of *Cucurbita* represent homology because they are anatomically similar structures, but perform different functions.
(Chapter 7, Pg.no. 130)

Q.3. Mention the two additional processing which hnRNA needs to undergo after splicing so as to become functional.

Answer: The two additional processing which the hnRNA undergoes after splicing are −
5′ capping with methyl guanosine triphosphate
3′ tailing with adenylate residues (200 − 300 residues)
(Chapter 6, Pg.no.111)

Five mark Questions:

Q.8 (a) What did Meselson and Stahl observe when

- They cultured *E. coli* in a medium containing $^{15}NH_4Cl$ for a few generations and centrifuged the content.
- They transferred one such bacterium to the normal medium of NH_4Cl and cultured for 2 generations?

(b) What did Meselson and Stahl conclude from this experiment? Explain with the help of diagrams.

(c) Which is the first genetic material? Give reasons in support of your answer.

Answer: (a) (i) When Meselson and Stahl cultured *E. coli* in $^{15}NH_4Cl$ for a few generations, they found that the ^{15}N was incorporated into the newly synthesised DNA.

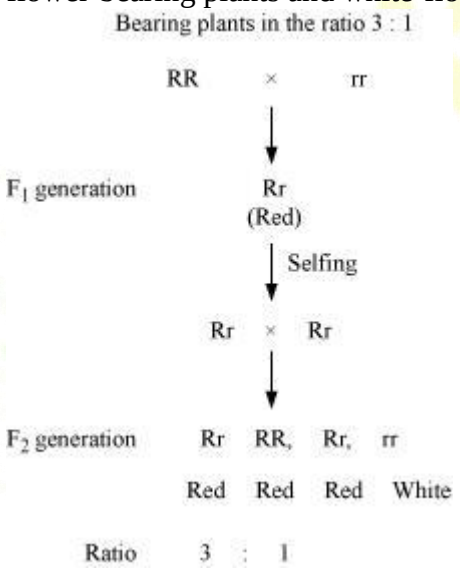
(ii) When they transferred the bacterium into normal medium and cultured for 2 generations, they observed that it contained equal amounts of hybrid DNA and normal DNA.

(b) From the above experiment, Meselson and Stahl concluded that the DNA in the chromosomes replicate semi-conservatively.

(c) RNA is the first genetic material. Evidences suggest that essential life processes evolved around RNA, which can be used as a genetic material as well as a catalyst. **(Chapter 6, Pg.no.105)**

Q.8 (OR) You are given a red flower-bearing pea plant and a red flower-bearing snapdragon plant. How would you find the genotypes of these two plants with respect to the colour of the flower? Explain with the help of crosses. Comment upon the pattern of inheritance seen in these two plants.

Answer: The genotype of a red-flower-bearing pea plant could be either homozygous dominant (RR) or heterozygous (Rr). Both these genotypes would have a phenotype expressing red flowers. If the red-flower-bearing pea plant with genotype 'RR' is crossed with a homozygous recessive white-flower-bearing plant with genotype 'rr', then the all the plants of the F_1 generation would be red, while the F_2 generation would have both red-flower-bearing plants and white-flower-bearing plants in the ratio 3 : 1.



These plants follow the Mendelian pattern of inheritance, i.e., complete dominance and the law of dominance.

(Note: Red-flower-bearing pea plants do not exist.)

A red-flower-bearing snapdragon plant will have a genotype of RR (homozygous dominant). If a red-flower-bearing plant is crossed with a homozygous recessive white-flower-bearing 'rr' plant, then all the plants of the F_1 generation will bear pink flowers. When these plants are selfed, the F_2 generation so produced will have plants bearing red flowers, pink flowers and white flowers in the ratio 1 : 2 : 1.

	RR (Red)	×	rr (White)
	↓		
F_1 generation	Rr (Pink)		
	↓ Selfing		
F_2 generation	RR,	Rr,	rr
	Red	Pink	White
Ratio	1 :	2 :	1

The inheritance of flower colour in the snapdragon plant follows the phenomenon of incomplete dominance. **(Chapter 5, Pg.no. 76)**