Type: DES

Q11. (a) If Meselson and Stahl's experiment is continued for 4 generations in E. coli, then what would be the ratio of 15N/15N : 15N/14N : 14N/14N types of DNA at the end? Explain with a diagram. (2 Marks)

Ans:

After 4 generations, the ratio of ratio of 15N/15N : 15N/14N : 14N/14N in the end would be: **0:1:7**

1 mark for correct answer and 1 mark for diagrammatic representation.

(b) Assume that Meselson and Stahl had carried out their experiment by growing cells in a medium with ^{14}N and then transferring the cells to medium containing ^{15}N. How would the bands within the centrifuge tubes have appeared if the replication were conservative, and if the replication were semiconservative? (2 Marks) (4)

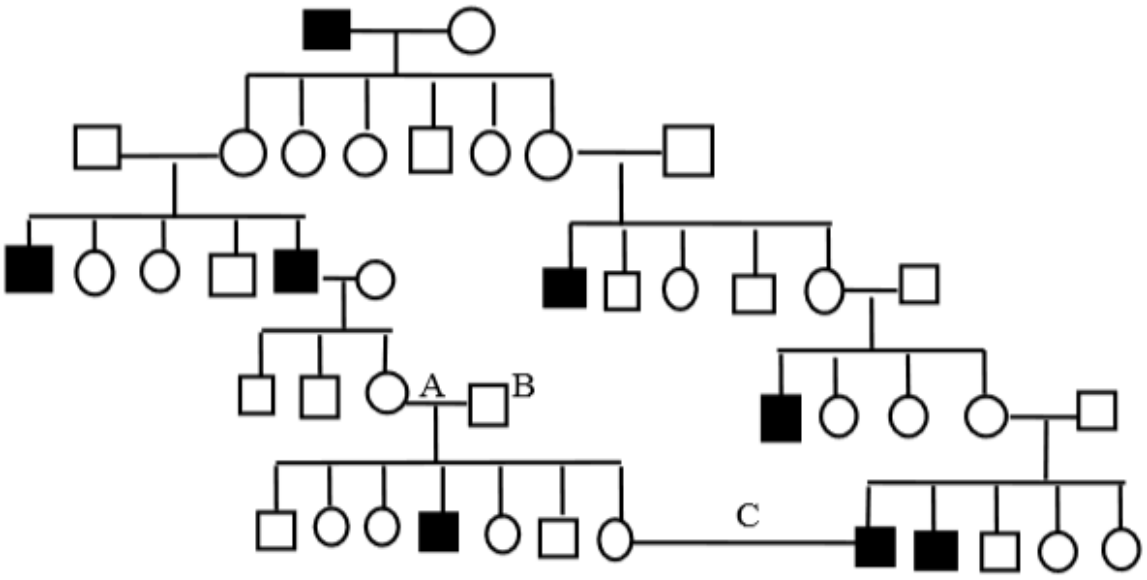
Ans:

In this experiment, in all cases, the original DNA from the parental generation would appear as a single light 14N DNA band.

For conservative replication, the first generation offspring would show 2 DNA bands of equal intensity, one of light 14N DNA and one of heavy 15N DNA. In the second generation light 14N DNA and heavy 15N DNA bands would be present in a 1:3 ratio. In the third generation the ratio would be 1:7. From then on, progressive generations would show an increasing concentration of heavy 15N DNA as this became incorporated into the replicating cells and the original parental chromosome remained as a single light DNA copy. (1 mark)

For semiconservative replication, the first generation offspring would all show a hybrid 14N DNA/15N DNA. In the second generation hybrid DNA and heavy 15N DNA bands would be present in equal numbers. From then on, progressive generations would show an increasing concentration of heavy 15N DNA as this became incorporated into the replicating cells. (1 mark)

Q12.



The inheritance of a particular trait has been represented in the given pedigree chart. Based on the family tree, answer the following questions.

(a) Based on this data, which of the following one or more mechanisms of inheritance for the trait are POSSIBLE? Justify your answer. (select among autosomal dominant, autosomal recessive, X-linked dominant, X-linked recessive, and Y-linked inheritance) (2 Marks)

(b) What is the genotype of female A and male B? (1 Mark)

(c) What is the probability that a child from marriage C will show this trait, if both the mother and father are homozygous? (1 Mark) (4)

Ans:

(a) Autosomal recessive (0.5 mark) and X-linked recessive (0.5 mark).

1 mark for proper justification.

(b) Either (Aa and Aa) or (XXa and XY) (0.5 mark for female genotype and 0.5 mark for male genotype)

(c) None of the offspring will show the trait phenotypically, as the condition is recessive in nature. (1 mark)

Q13. (a) A chromosome containing 240 Million base pairs replicates in 600 minutes. If one DNA polymerase can add 6 Kilo base pairs in one minute, and the length of the chromosome is 6 micrometres, calculate the number of replication forks per micrometre? (2 Marks)

Ans:

(a) For 600 min, one DNA pol. can add 3.6 Mbp (6kbp*600 min)
For 240Mbp long chromosome = 240/3.6 = 66.66 = 67 DNA pol. or replication forks.
Therefore, for 6µm = 67/6 = 11.167 = approximately 11 replication forks per µm.

(1 mark for correct answer and 1 mark for proper calculation/steps)

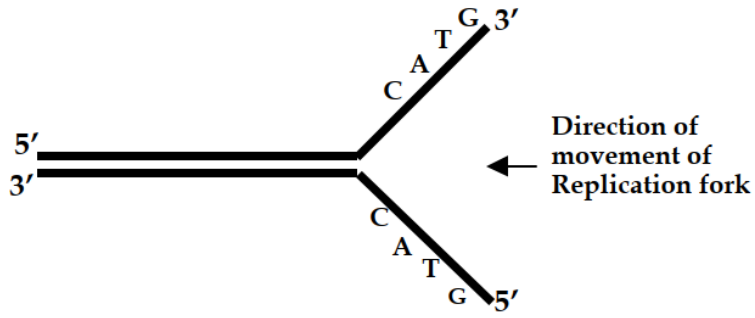
(b) A single strand of DNA contains 20% A, 30% G and 10% C nucleotides. What is the T% in the double stranded DNA? Explain. (1 Mark) (3)

Ans:

T% in the double stranded DNA would be 30% (1 mark)

Strand-1 (given)	Strand-2
20 A	20 T
40 T	40 A
30 G	30 C
10 C	10 G

Q14. Shown below is the segment of replicating DNA in mouse.



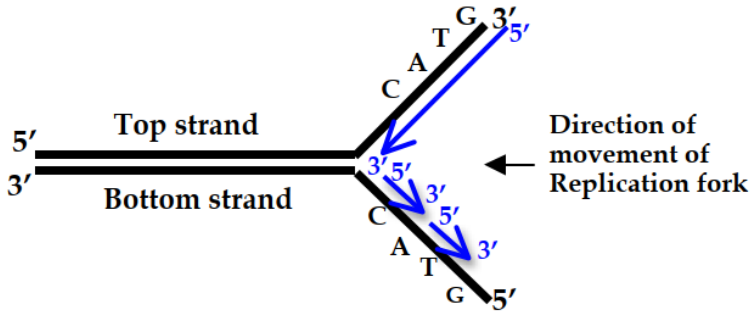
(a) On the schematic, draw the elongating/new DNA strands and label their 5' and 3' ends. Show the direction of replication for both top and bottom strands. Which strand is template for discontinuous strand synthesis? (1 Mark)

(b) Name the enzyme that relives a replicating segment of DNA from supercoiling. (1 Mark)

(c) When you treat mouse cells with the drug TAT-2, it was observed that the treated cells show DNA fragments following replication. Name the replication enzyme that serves as a target for the drug and state whether the drug activates or inhibits the enzyme. (1 Mark) (3)

Ans:

(a) Bottom strand acts as a template for discontinuous strand synthesis (0.5 mark).
Another 0.5 mark if the 5' and 3' ends are labeled correctly.



(b) Topoisomerase (1 mark)
(c) DNA Ligase is the target for the drug (0.5 mark), The drug inhibits the enzyme (0.5 mark).

Q15. A fruit fly that is heterozygous for gray body color and normal wings is crossed with a black fly having vestigial wings. It was observed that gray body color is dominant over black body color, normal wings are dominant over vestigial wings. The offspring have the following phenotypic distribution: wild type 780; black-vestigial 790; black-normal 149; gray-vestigial 165.

(a) Construct a Punnett square illustrating this cross. (1 Marks)

(b) What is the recombination frequency and map distance between these genes for body color and wing size? Are the two genes linked? Justify. (2 Marks) (3)

Ans:

(a) BbGg X bbgg (0.5 mark)

Gametes: BG, Bg, bG, and bg

	BG	Bg	bG	bg
bg	BbGg	Bbgg	bbGg	bbgg

(0.5 mark for correct gametes and Punnett square)

(b) Recombination Frequency = (Recombinants /Total Offspring)

= (149+165)/ (780 + 790 + 149 + 165)

= 0.1667 (0.5 mark)

Map distance 16.67cM. (0.5 mark)

The two genes are linked (0.5 mark).

Because, the test cross ratio is not 1:1:1:1 (or) the RF is less than 0.5 (0.5 mark)

Q16. (a) What is the reason behind selecting 32P and 35S for Hershey and Chase experiment? A student wanted to revisit the same experiment by using isotopes of carbon and oxygen. Guide him. (1 Mark)

(b) The origin site of DNA replication is rich in AT base pairs. Is this advantageous? Explain. (1Mark)

(c) Loss of SSBP (Single strand binding proteins) and deficient polymerase I is found in an organism. How will this affect the DNA replication. (1 Mark) (3)

Ans:

(a) Proteins contain sulfur in the amino acids cysteine and methionine. However, proteins do not typically contain phosphorous. DNA contains much phosphorous due to its sugar-phosphate backbone but no sulfur. Hershey and Chase chose the isotopes 32P and 35S because these radioactive elements would allow them to distinguish between proteins and DNA molecules. Only DNA would contain the isotope 32P, and only proteins would contain the isotope 35S. (0.5 mark)

It is not advisable to use radioactive isotopes of oxygen and carbon. Both DNA and proteins contain significant amounts of carbon and oxygen. Since both proteins and DNA contain carbon and oxygen, both molecules in the phage progeny would receive the radioactive isotopes. The student would have been unable to isolate only DNA molecules or proteins that contain radioactive isotopes of these elements. (0.5 mark)

(b) Yes it is advantageous because at the origin of replication the two DNA strands will gets separated to initiate the replication process, there are two hydrogen bonds between A and T where as GC has three hydrogen bonds which requires more energy to break. (1 mark)

(c) Loss of SSBP may lead to rewinding of separated DNA strands interrupting the replication process (0.5 mark)

Dificient DNA polymerase I may lead to error bases by affecting the proof reading mechanism and RNA primer may not be removed (0.5 mark)

Q17. In cattle, black coat color (B) is dominant over brown (b) and a solid pattern (S) is dominant over white spotted color (s). Spots are controlled by genes that assort independently. A homozygous black spotted cattle is crossed with a homozygous solid brown cattle. All the F1 cattle are black and solid.

(a) Give the genotype of the parents and F1 generation. (1 Mark)

(b) Illustrate the F2 generation with a Punnett square. Give the phenotype ratio of the F2 progeny. (1 Mark)

(c) Show the test cross and mention the genotype and phenotype ratios. (1 Mark) (3)

Ans:

(a) Parents: BBss X bbSS (0.5 mark)

F1: BbSs (0.5 mark)

(b) 9:3:3:1 (0.5 mark)

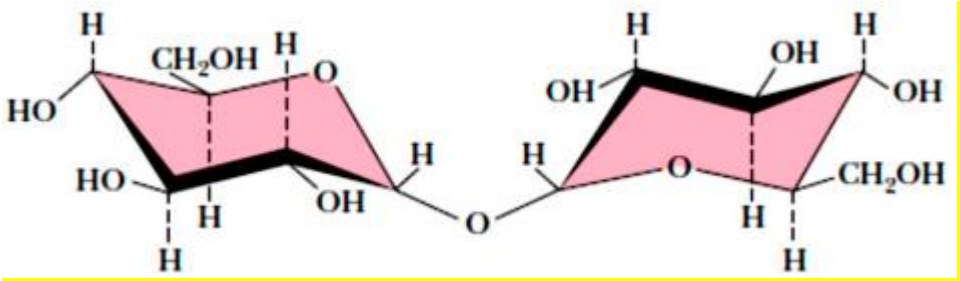
Another 0.5 mark for Punnett square.

(c) BbSs X bbss (0.5 mark)

Phenotype and genotype ratio 1:1:1:1 (0.5 mark if both the ratio are correct)

Q18. (a) What type of linkage is present in the molecule given? Explain. (1 Mark)

(b) How does the type of glycosidic linkage with similar monomers form different types of polymers? Explain with suitable example. (1 Mark)



(2)

Ans:

It is an α-1,1-glycosidic linkage (0.5 mark).

Another 0.5 mark for correct explanation i.e., why it is α-1,1-glycosidic linkage.