Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Molecular Biology and genetics
Semester: II
Program: M.Sc. Microbiology **Time : 03 hrs.**
Course Code: HSMB70276 **Max. Marks: 100**

Instructions:

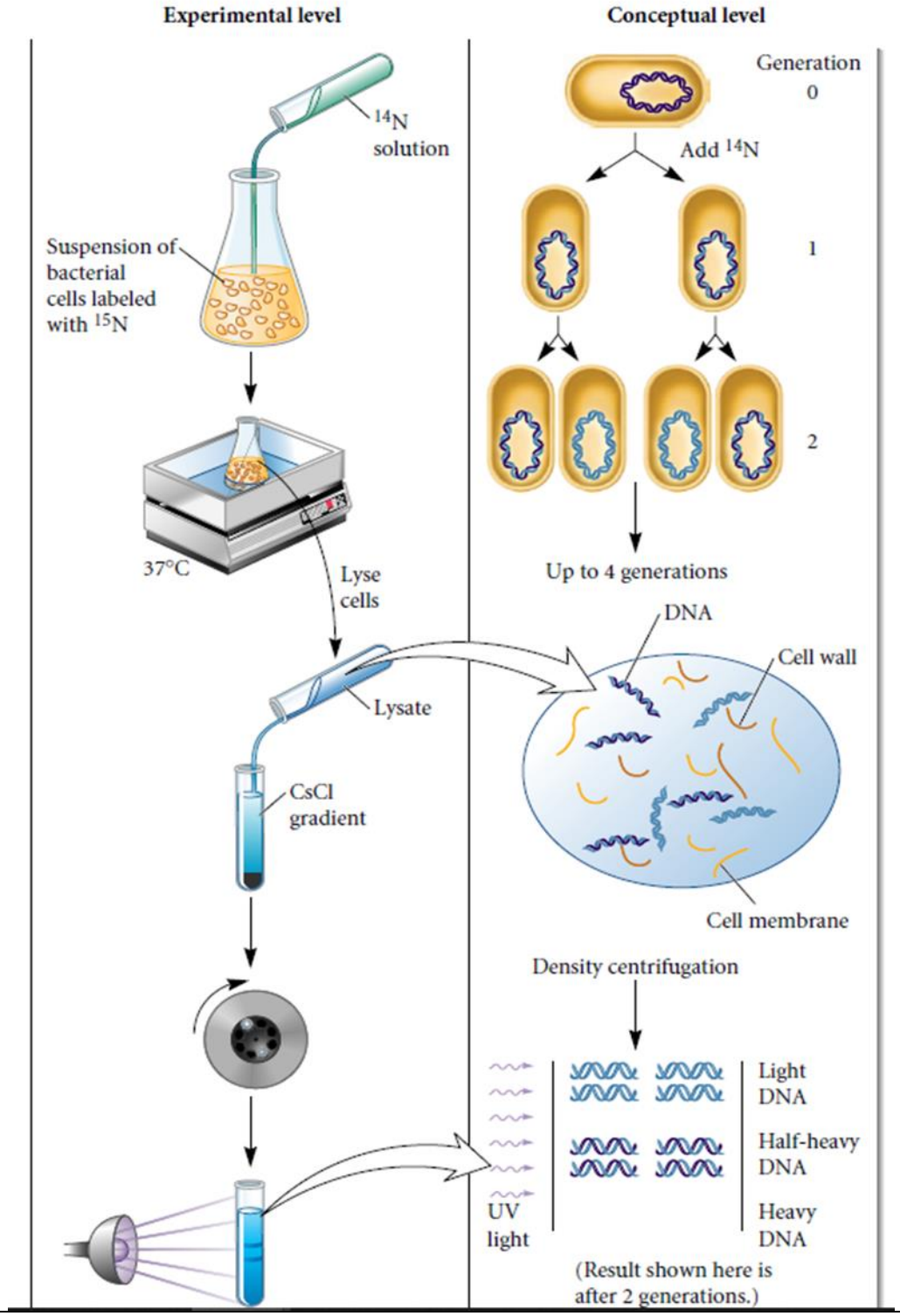
Q.No	Section A Short answer questions/ MCQ/True & False	(20Q x1.5M= 30 Marks)	COs
1.	What structural feature allows DNA to store information?	1.5	CO1
2.	An organism has a G + C content of 64% in its DNA. What are the percentages of A, T, G, and C?	1.5	CO1
3.	Hershey and Chase experiment for the validation of DNA as a genetic material was based on which principle? a) Transformation b) Transduction c) Conjugation d) None of the above	1.5	CO1
4.	Match the following to their functions: (a) topoisomerase (b) Primase (c) Helicase with: (1) Relieves stress of overwound DNA (2) Unwinds DNA (3) Joins sugar phosphate backbone (4) Synthesizes short RNA nucleotides For example: b-1 means that Primase relieves the stress of overwound DNA	0.5+0.5+0.5	CO2
5.	A DNA strand can serve as a template strand on many occasions. 1. True 2. False Justify your choice.	0.5 + 1	CO2
6.	To which region of a gene does an RNA polymerase bind to initiate transcription? a) 5' UTR b) 3' UTR c) CDS	1.5	CO3

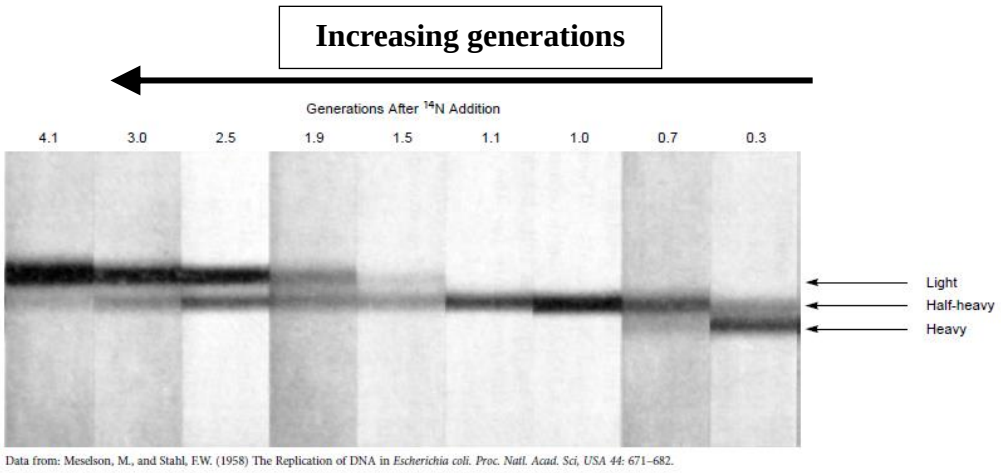
	d) Promoter		
7.	In what direction is RNA polymerized? 1. 5' to 3' 2. 3' to 5' 3. N to C 4. C to N 5. 5 to 3 6. 3 to 5	1.5	CO3
8.	More than one codon typically encodes each amino acid. 1. True 2. False Justify your choice with an example.	0.5 + 1	CO4
9.	ACUAGCUACGAUGCAUGCUCGAUGCUAGCAUCGCUGUAGCUAGCA..... This is the sequence of an mRNA molecule. If the 1st nucleic acid in the above sequence is the start of the transcript or its 5' end denoted at "position 1". At which position will translation begin? 1. 11 2. 9 3. 1 4. 2 5. 15	1.5	CO4
10.	How does lactose (allolactose) promote transcription of LacZ? 1. Lactose binds to a repressor protein, and alters its conformation to prevent it from binding to the DNA and interfering with the binding of RNA polymerase. 2. Lactose binds to the polymerase and increases efficiency. 3. Lactose binds to an activator protein, which can then help the RNA polymerase bind to the promoter and begin transcription. 4. Lactose prevents premature termination of transcription by directly binding to and bending the DNA	1.5	CO4
11.	Which molecule signals presence of high tryptophan amount in the environment in the trp operon? 1. Tryptophan 2. cAMP 3. Glucose	1.5	CO4

	4. Lactose		
12.	An operon is repressible, in which a small effector molecule turns off transcription. Which combinations of small effector molecules and regulatory proteins could be involved? A. An inducer plus a repressor B. A corepressor plus a repressor C. An inhibitor plus an activator D. An inducer plus an activator	1.5	CO4
13.	For each of the following mutations, mention whether it is a transition, transversion, addition, or deletion? The original DNA strand is 5′–GGACTAGATAC–3′ (Note: Only the coding DNA strand is shown.) A. 5′–GAACTAGATAC–3′ B. 5′–GGACTAGAGAC–3′ C. 5′–GGACTAGTAC–3′	(0.5 x 3)	CO6
14.	How would each of the following types of mutations affect the amount of functional protein that is expressed from a gene? A. Nonsense B. Missense C. Up promoter mutation	(0.5 x 3)	CO6
15.	In a typical Mendelian inheritance, a dihybrid ratio of 9:3:3:1 is expected. But several deviations to the rule occur as indicated below. Explain the phenomenon which lead to such deviations.	1.5	CO5
16.	Hemophilia is an X-linked recessive trait in humans. A heterozygous woman has children with Normal man. A. Give the genetic cross for offspring when a heterozygous woman has children with Normal man. B. What is the probability that a son will be a hemophilic?	(1+0.5)	CO5
17.	In a table form, describe the difference between dominance and incomplete dominance.	1.5	CO5

18.	Which of the following descriptions best fits the relationship amongst the terms gene, allele, locus, and chromosome? A. Alleles are different forms of a gene, which can be found at a locus on a chromosome. B. Genes are made up of chromosomes, which can be found at a locus on an allele. C. Chromosomes are different forms of a gene, which can be found at an allele on a locus. D. A locus is made up of alleles, which can be found at a gene on a chromosome.	1.5	CO5
19.	Explain germ cell mutations. Why are they harmful?	1.5	CO6
20.	In four o'clock flowers, red flower color (R) is incompletely dominant over white (r), and heterozygous plants (Rr) have pink flowers. What gametes will be produced by each parent in the following crosses, and what will be the phenotypes of the offspring? a. Rr × RR b. rr × Rr c. RR × rr	(0.5x3)	CO5
	Section B	**(4Qx5M=20 Marks)**	CO
1.	A. What are charged tRNAs? B. Briefly describe steps of translation.	1+4	CO4
2.	A. What is the meaning of the term consensus sequence? Give an example. B. Describe the locations of consensus sequences within bacterial promoters. C. What are the functions of consensus sequences within bacterial promoters?	1+2+2	CO3
3.	A. During mismatch repair, why is it necessary to distinguish between the template strand and the newly made daughter strand? B. With the help of diagrams, describe the process of mismatch repair.	2+3	CO6
4.	A. What is meant by the term ‘attenuation’ in trp operon? B. Is attenuation an example of gene regulation at the level of transcription or translation? Explain your answer.	1+4	CO4
	Section C	**(2Qx15M=30 Marks)**	

1.	Answer the following questions that pertain to the experiment of following figure Figure 1. **Starting material**: A strain of E. coli that has been grown for many generations in the presence of ^{15}N. At the start of the experiment, shown in Figure 11.3 (generation 0), Messelson and Stahl switched the bacteria to a medium that contained only ^{14}N and then collected samples of cells after various time points. Under the growth conditions they employed, 30 minutes is the time required for one doubling, or one generation time. Meselson and Stahl then analyzed the density of the DNA by centrifugation at different generations, using a cesium chloride (CsCl) gradient.	15 (4+4+4+1.5+ 1.5)	CO2





Data from: Meselson, M., and Stahl, F.W. (1958) The Replication of DNA in *Escherichia coli*. *Proc. Natl. Acad. Sci, USA 44*: 671–682.

Figure shows an original gel image from the experiment conducted by Meselson and Stahl. DNA molecules containing ^{14}N and ^{15}N DNA are shown.

Answer the following questions based on the study described above:

A. What would be the expected results if the Meselson and Stahl experiment were carried out for four generations?

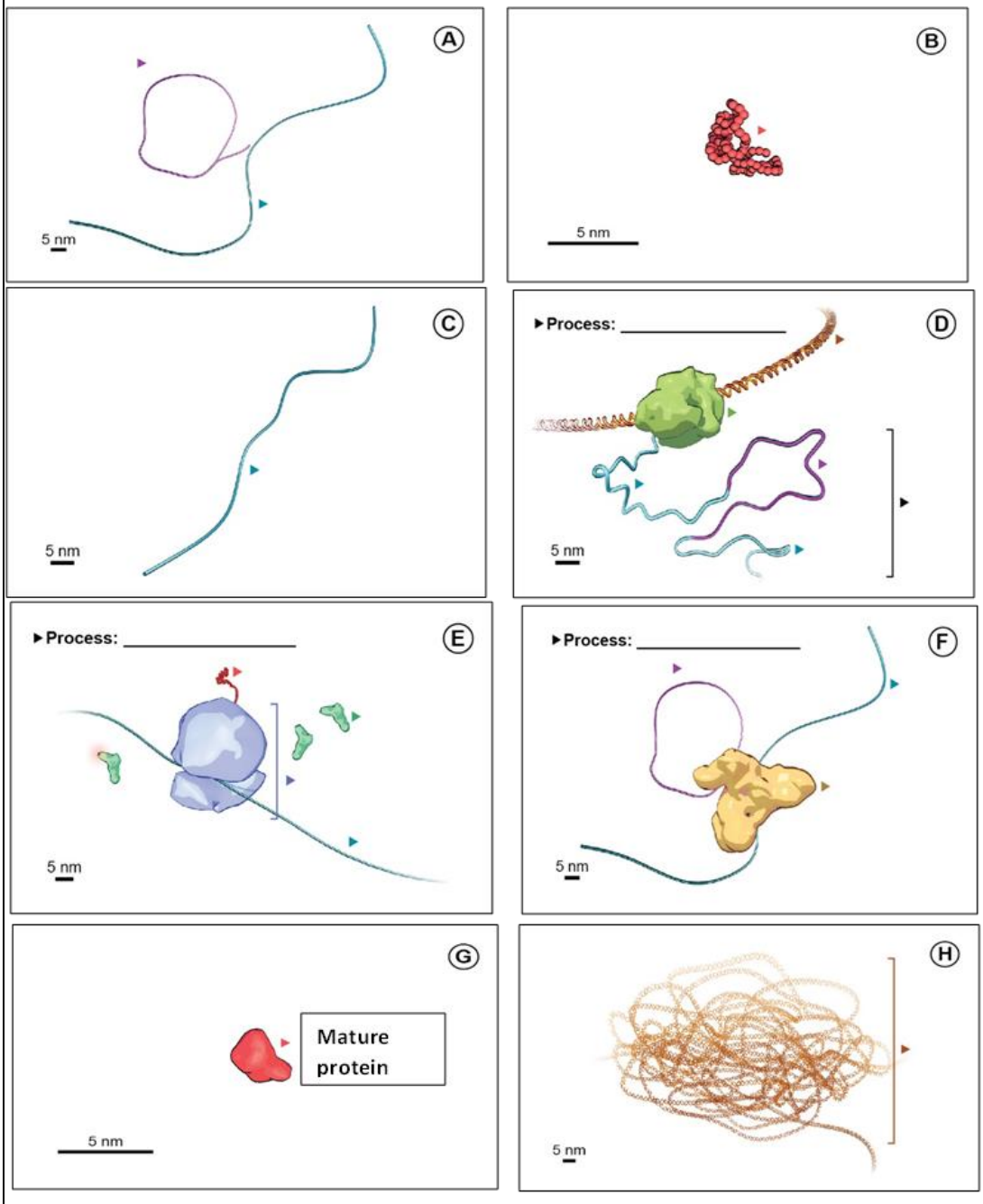
B. What would be the expected results of the Meselson and Stahl experiment after three generations if the mechanism of DNA replication was dispersive?

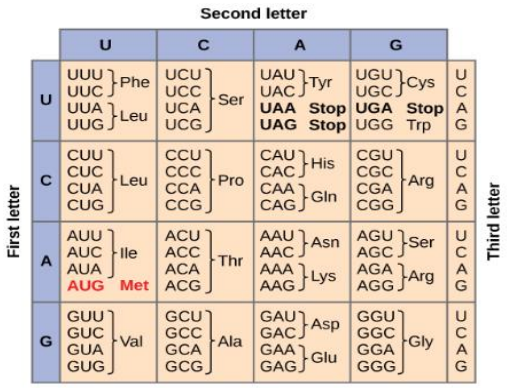
C. As shown in the data, explain why three different bands (i.e., light, half-heavy, and heavy) can be observed in the CsCl gradient.

D. Carefully observe the gel above (Figure 2) and briefly explain why light DNA band is darker at 4 generations compared to 0.3 generations.

E. If you start with one DNA molecule, how many DNA molecules would you have after three generations?

2.	Below are the molecules that are involved in different stages of central dogma. Label the components or molecules indicated with a triangle (▶). Name the process wherever applicable. Arrange images A to H in an order that best depicts steps or order of central dogma. Panel G is labelled for you reference. (5+2)	7+8	CO1



	(B) Cystic fibrosis transmembrane conductance regulator (CFTR) is a membrane protein and chloride channel in vertebrates that is encoded by the CFTR gene. This gene is found on chromosome 7 and is 4400 nucleotides in length. The gene encodes the CFTR protein that acts as a channel across the membrane to transport chloride ions. More than 1,000 mutations in the *CFTR* gene have been identified in people with cystic fibrosis. Most of these mutations change single protein building blocks (amino acids) in the CFTR protein or delete a small amount of DNA from the *CFTR* gene.  **Below is an abbreviated DNA sequence from the Wild-Type CFTR gene. Wild-type refers to the most common form of the gene, in this case, it is the normal sequence for a fully functioning CFTR protein.** 1. (a) Use the base code to transcribe each letter into RNA to form an mRNA strand. Write the mRNA below the DNA (1) (b)Use the codon chart to translate the mRNA into the amino acid sequence. Write the amino acid sequence below the mRNA. (1) TAG TAG AAA CCT CAA AGG ATA mRNA: Amino acids: 2. The ΔF508 mutation occurs when three nucleotides have been removed as shown below in bold. Rewrite this sequence with the deleted section removed and determine the amino acids it now codes for. (2) T A G T A **G A A** A C C T C A A A G G A T A New DNA Sequence: mRNA: Amino Acids: 3. (A) Compare the two amino acid sequences. How many amino acids are changed in the mutant version? (1) (B) Why are the first 2 amino acids the same even though the second codon is different in the mutated version? (2) 4. Explain in your own words what kind of mutation occurred in the above case. (1)		
	Section D	**(2Qx10M=20 Marks)**	
1.	What are different steps in DNA replication? Sketch suitable diagrams describing the main events that occur during these three stages.	3+7	CO2
2.	Discuss different types of changes affecting the number, size, or structure of chromosomes that causes chromosome aberrations.	10	CO5