2015

BIOCHEMISTRY

Paper – BCT – 204

(Molecular Biology – I)

Full Marks – 25

The figures in the margin indicate full marks

Candidates are required to give their answers in their own words as far as practicable

Group – A

1. Answer ***any five*** questions :

(a) The chromosome of E. coli contains 4.6 million bp. How long will it take to replicate DNA assuming DNA replication in *E. coli* is bidirectional ? Discuss the similarities and differences in the synthesis of DNA in the lagging and leading strands. $1+1\frac{1}{2}$

(b) Why did Reji Okazaki conclude that both strands of DNA strands could not replicate continuously ? What evidence led him to establish this conclusion ? $1+1\frac{1}{2}$

(c) An organism contains 20% highly repetitive DNA, 10% moderately repetitive DNA and 70% unique sequences. Draw an expected Cot curve that would be obtained from the organism and provide explanation. $1+1\frac{1}{2}$

(d) Several years after Griffith described the transforming principle, Avery, MacLeod and McCarty investigated the same phenomenon. List the steps they used to show that DNA from dead *S. pneumonia* cells was responsible for the change from a non-virulent to a virulent state. What was the role of enzymes in these experiments? Did their work conform or disconfirm Griffith's work and how ? $1+\frac{1}{2}+1$

(e) Distinguish between LINEs and SINEs with respect to their length and abundance in different higher eukaryotic genomes, distribution within a genome and whether and how they are able to move within a genome. $1+\frac{1}{2}+1$

(f) Name three types of chemical changes that lead to spontaneous mutations. Describe any two of these changes using appropriate diagrams. $\frac{1}{2}+2$

(g) Name three types of chemical mutagens that alter DNA structure. Describe the function of any two categories of the above chemicals mentioning the nature of mutation they produce and its possible impact on the organism. $\frac{1}{2}+2$

(h) Write down the key events involved in SOS response and double strand break repair. $1\frac{1}{2}+1$

(i) Describe the structures of a nucleosome and a 30 nm fiber. How does the level of compaction change as cell progresses through the cell cycle? $1\frac{1}{2}+1$

(j) What mechanism do eukaryotic cells employ to keep their chromosomes from replicating more that once per cell cycle? Mention the sequence of events. $1+1\frac{1}{2}$

Group – B

2. Answer ***any five*** questions :

(a) Methionine is one of two amino acids with only one codon. How does the single codon for methionine specify both the initiating residue and interior Met residues of polypeptides synthesized by *E. coli* ? $2\frac{1}{2}$

(b) Why is it said that the genetic code is nonoverlapping and degenerate? $2\frac{1}{2}$

(c) How is RNA polymerase correctly positioned to start transcription in prokaryotes? $2\frac{1}{2}$

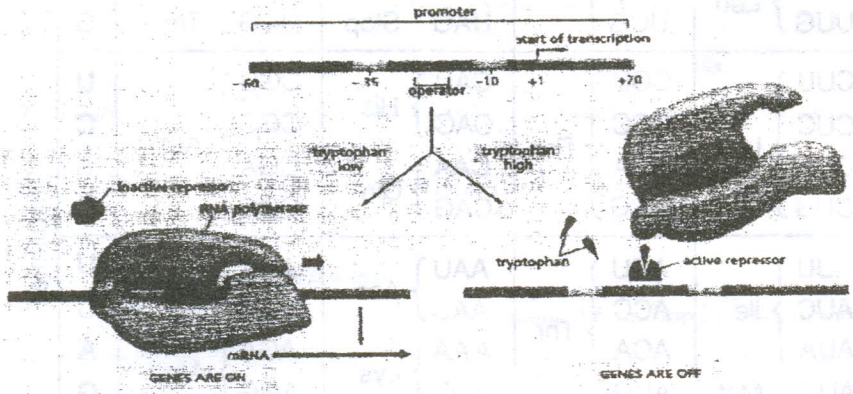
(d) Some transcription regulators bind to DNA and cause the double helix to bend at a sharp angle. Such "bending proteins" can stimulate the initiation of transcription without contacting either the RNA polymerase, any of the general transcription factors, or any other transcription regulators. Can you devise a plausible explanation for how these proteins might work to modulate transcription? Draw a diagram that illustrates your explanation. $1+1\frac{1}{2}$

(e) The enzymes for arginine biosynthesis are located at several positions around the genome of *E. coli*, and they are regulated coordinately by a transcription regulator encoded by the *ArgR* gene. The activity of ArgR is modulated by arginine. Upon binding arginine, *ArgR* alters its conformation, dramatically changing its affinity for the DNA sequences in the promoters of the genes for the arginine biosynthetic enzymes.

Given that ArgR is a ***repressor*** protein, would you expect that ArgR would bind more tightly or less tightly to the DNA sequences when arginine is abundant?

Explain your answer with a suitable schematic diagram. $\frac{1}{2}+2$

(f) Bacterial cells can take up the amino acid tryptophan (Trp) from their surroundings, or if there is an insufficient external supply they can synthesize tryptophan from other small molecules. The Trp repressor is a transcription regulator that shuts off the transcription of genes that code for the enzymes required for the synthesis of tryptophan (see following figure).



What would happen to the regulation of the tryptophan operon in cells that express a mutant form of the tryptophan repressor that (i) cannot bind to DNA, (ii) cannot bind tryptophan, or (iii) binds to DNA even in the absence of tryptophan ? $\frac{1}{2}+1+1$

(g) Use the supplied codon table to complete the below table. Assume that reading is from left to right and that the columns represent transcriptional and translational alignments.

Label the 5' and 3' ends of DNA as well as the amino and carboxyl ends of protein. $1+1\frac{1}{2}$

C											DNA double helix
					T	G	A				
	C	A			U						mRNA transcribed
								G	C	A	Appropriate tRNA anticodon
			Trp								Amino acids incorporated into protein

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU Phe	UCU Ser	UAU Tyr	UGU Cys	U
	UUC Phe	UCC Ser	UAC Tyr	UGC Cys	C
	UUA Leu	UCA Ser	UAA Stop	UGA Stop	A
	UUG Leu	UCG Ser	UAG Stop	UGG Trp	G
C	CUU Leu	CCU Pro	CAU His	CGU Arg	U
	CUC Leu	CCC Pro	CAC His	CGC Arg	C
	CUA Leu	CCA Pro	CAA Gln	CGA Arg	A
	CUG Leu	CCG Pro	CAG Gln	CGG Arg	G
A	AUU Ile	ACU Thr	AAU Asn	AGU Ser	U
	AUC Ile	ACC Thr	AAC Asn	AGC Ser	C
	AUA Ile	ACA Thr	AAA Lys	AGA Arg	A
	AUG Met	ACG Thr	AAG Lys	AGG Arg	G
G	GUU Val	GCU Ala	GAU Asp	GGU Gly	U
	GUC Val	GCC Ala	GAC Asp	GGC Gly	C
	GUA Val	GCA Ala	GAA Glu	GGA Gly	A
	GUG Val	GCG Ala	GAG Glu	GGG Gly	G

(h) Ribosomes markedly accelerate the hydrolysis of GTP bound to the complex of EF-Tu and aminoacyl-tRNA. What is the biological significance of this enhancement of GTPase activity by ribosomes? Suppose that a slowly hydrolyzable analog of GTP were added to an elongating system. What would be the effect on rate of protein synthesis and why? $1+1\frac{1}{2}$

(i) What is the nucleophile in the reaction catalyzed by peptidyl transferase? Write down a plausible mechanism for this reaction. $\frac{1}{2}+2$

(j) An mRNA transcript of a T7 phage gene contains the base sequence

5'-AACUGCACGAGGUAACACAAGAUGGCU-3'. Predict the effect of a mutation that changes the G marked by an arrow to A and explains your prediction. $1+1\frac{1}{2}$