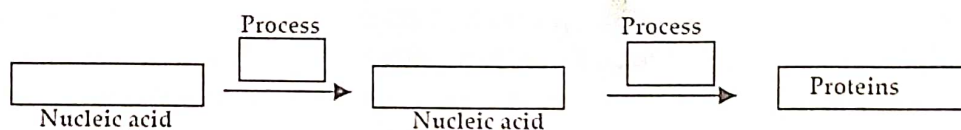


Introduction to Biology: Quiz 1

Course outcomes: CO-1, CO-4

Time: 25 min, Marks: 15

1. What is the difference between Adenosine and Adenine? [1]
2. In samples of DNA isolated from two unidentified species of bacteria, X and Y, adenine makes up 32% and 17%, respectively, of the total bases. What relative proportions of adenine, guanine, thymine, and cytosine would you expect to find in the two DNA samples? [2]
3. Explain the difference between paralogous and orthologous genes. [1]
4. Explain the difference between euchromatin and heterochromatin. [1]
5. What is nucleosome? [1]
6. Fill in all the boxes below: [2]



7. What type of bonds would hold two **adjacent** nucleotides together in a growing nucleic acid chain? [1]
8. 5'GGCCANACCA3' [1]
For the nucleic acid sequence that is given above
Which nucleotide base has a free phosphate group?
Which nucleotide base has a free hydroxyl group?
9. In the table below, name the sub-cellular location or organelle(s) of the eukaryotic cell that will fluoresce when the following macromolecules are tagged with a fluorescent dye. [1.5]

Macromolecules tagged with fluorescent dye	Sub-cellular location or organelle(s) of cell that will fluoresce
Proteins that add carbohydrates or lipids to the newly synthesized proteins	
Proteins that are a part of functional ribosomes	
DNA	

10. Write the term specific to below definitions: [1.5]
 - (a) The totality of the genetic information carried in the DNA of a cell or an organism
 - (b) Full set of chromosomes of a cell arranged with respect to size, shape, and number.
 - (c) Constricted region of a mitotic chromosome that holds sister chromatids together.
11. Explain the processes that contributed to the evolution of new genes. [2]

Introduction to Biology: Quiz 2

Course outcomes: CO-1, CO-4

Time: 40 min, Marks: 20

1. Cells that rarely divide, if at all, will spend most of their time in what phase of the cell cycle? [1 mark]
2. Which phase of mitosis is characterized by the reappearance of the nuclear envelope? [1 mark]
3. How Cdk1 is inactivated during mitotic exit? [1 mark]
4. Where does Q-cycle occur? Why it occurs? [2 marks]
5. How checkpoints control G2 to M and metaphase to anaphase transitions? [2 marks]
6. Why DNA replication occurs in the discontinuous way in the lagging strand? [2 marks]
7. Why DNA polymerase require a primer? [2 marks]
8. What contributes to switch-like activation of Cdk1? [3 marks]
9. How redox potential and free energy of electron changes along the mitochondrial electron transport chain? Provide an explanation for your answers [3 marks]
10. When bidirectional replication forks from adjacent origins meet, a leading strand always runs into a lagging strand. True or False. Draw and explain. [3 marks]

Introduction to Biology – Monsoon 2022

End Semester Examination

(Course outcomes: CO-2, CO-4 and CO-5)

Max. Time: 3.0 hrs

Max. Marks: 65

1. The following is the DNA sequence for the transcription initiation region of Gene A. *Note: Part of the promoter region is boxed. Transcription begins at and includes the bold and underlined A/T base pair.*

```

5' --- TGGACTGCTA TAATAGCAGG GCTGCCGAAT GTGCTGCCAT ACGGCCATGG TTCTTAAAGT---3'
3' --- ACCTGACGAT ATTATCGTCC CGACGGCTTA CACGACGGTA TGCCGGTACC AAGAATTTCA---5'
    
```

- (A) Which DNA strand (choose from top or bottom) serves as the template strand for transcription? Explain. [2 marks]

- (B) Fill in the first 6 nucleotides of the primary/ nascent mRNA transcribed from Gene A. [1 mark]

5' _____ 3'

- (C) Fill in the first four amino acids of Protein A encoded by Gene A. *Note: A codon chart is provided on the last page.* [1 mark]

N _____ C

- (D) The last 5 amino acids (amino acid¹⁰⁵- amino acid¹⁰⁹) at the C- terminus of wild-type Protein A are indicated below. Each of these amino acids is critical for the proper folding of this protein.

N - pro¹⁰⁵ -asn¹⁰⁶ -ser¹⁰⁷ -met¹⁰⁸ -leu¹⁰⁹ -C

The DNA sequence encoding the above 5 amino acids is included within the sequence below

Wild-type

```

      C UUGGCUUAGGUAACAUAU C
      5' -AACCGAATTCATGTTATAGC-3'
      3' -TTGGCTTAAGGTACAATATCG-5'
    
```

You isolate and sequence the following two different mutant alleles of Gene A that encode the above 5 amino acids. Each mutant allele is due to a point mutation that is bold and underlined. Which of these mutants will ALTER the folding of Protein A

Mutant 1 5' -AACCAATTCCATGTTATAGC-3' Mutant 2 5' -AACCGTATTCCATGTTATAGC-3'
3' -TTGGTTTAAGGTACAATATCG-5' 3' -TTGGCATAAGGTACAATATCG-5'

Explain, in terms of the change in the reading frame and/ or amino acid sequence, why you selected this mutant and NOT the other. [3 marks]

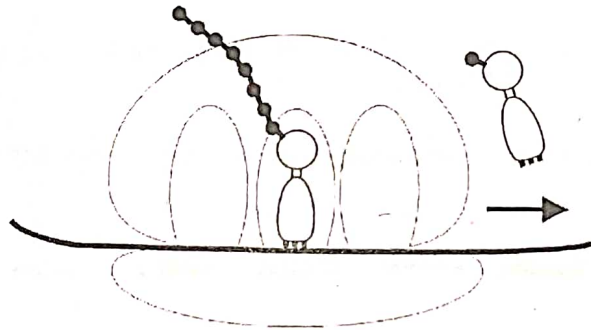
2. What is the sequence (1 to 4) in which these proteins function during DNA replication

- ____ RNA primase ____ DNA helicase
 ____ DNA ligase
 ____ DNA polymerase

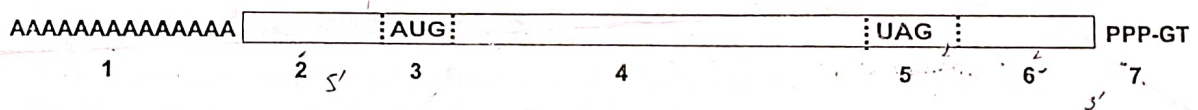
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Briefly explain their functions: Which enzyme relieves a replicating segment of DNA from super-coiling? [5 marks]

3. In the diagram, label the three tRNA sites, codons and anticodons, peptide and mRNA. List the sequence of events that will occur when the in-coming tRNA sets into its binding site. Redraw the diagram as it will appear immediately after the next peptide bond is formed. [4 marks]



4. The diagram below shows an mRNA molecule with various regions labelled:



(A) There is a problem with above diagram. True or False. Explain your choice [1.5 marks]

(B) Identify by number the region(s) that is/are: [2.5 marks]

- a) coding (i.e. contains codons that are part of the peptide) ____
 b) non-coding ____
 c) 3' end ____
 d) 5' end ____
 e) ribosome binding site ____

2 not explained

3 what explanation

5. Draw and explain the (a) pattern of chromosome segregation in mitosis and meiosis and (b) the contrasting regulation of recombination during mitotic and meiotic programs. [4 marks]

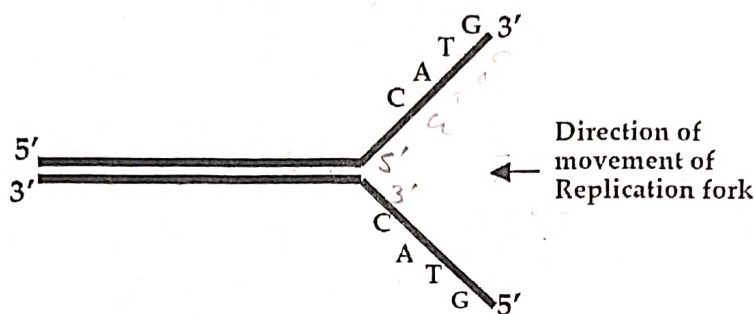
6. Explain the underlying principle of: [4 marks]

- (a) Polymerase chain reaction
 (b) Sanger Sequencing

7. In response to hypoxia (lack of oxygen), mammalian cells induce expression of group of genes. How will you identify the transcription factor regulating them? [3 marks]

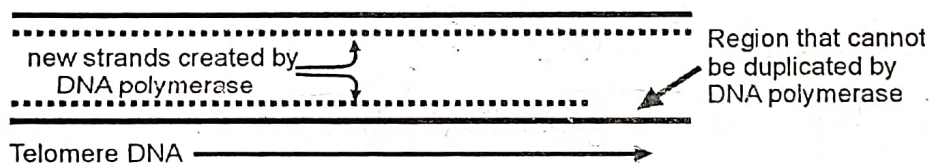
8. Explain the process of translation initiation [3 marks]

9. Shown below is a segment of replicating DNA



- (A) On the schematic, draw the elongating DNA strands and label their 5' and 3' ends
 (B) To which strand (*choose from top, bottom or both*) can primer 5'CATG3' bind during replication?
 (C) Which strand (*choose from top or bottom*) is the template for discontinuous (lagging) strand synthesis? [3 marks]

10. Explain how telomerase and DNA polymerase operate together to lengthen the chromosomes. Label the 3' and 5' ends of the strands and modify this diagram to show where DNA polymerase and telomerase will lengthen the strands. Also, explain why DNA polymerase alone cannot accomplish the task of telomere DNA synthesis. [3 marks]



11. During protein synthesis, the thermodynamics of base pairing between tRNAs and mRNAs sets the upper limit for the accuracy with which protein molecules are made. True or False. Explain your choice. [3 marks]

12. One indication of the relative importance of various ATP-producing pathways is the V_{\max} of certain enzymes of these pathways. The values of V_{\max} of several enzymes from chest muscles used for flying of pigeon and pheasant are listed below.

Enzyme	V_{\max} ($\mu\text{mol substrate/mln/g tissue}$)	
	Pigeon	Pheasant
Hexokinase	3.0	2.3
Glycogen phosphorylase	18.0	120.0
Phosphofructokinase-1	24.0	143.0
Citrate synthase	100.0	15.0
Triacylglycerol lipase	0.07	0.01

- (a) Discuss the relative importance of glycogen metabolism and fat metabolism in generating ATP in the chest muscles of these birds.
 (b) Compare oxygen consumption in the two birds.
 (c) Judging from the data in the table, which bird is the long-distance flyer? Justify your answer. [3 marks]

13. Which function

1. Insertion of a single nucleotide near the end of the coding sequence. ✓
2. Removal of a single nucleotide near the beginning of the coding sequence. ✓
3. Deletion of three consecutive nucleotides in the middle of the coding sequence.
4. Deletion of four consecutive nucleotides in the middle of the coding sequence.
5. Substitution of one nucleotide for another in the middle of the coding sequence. ✓

14. What
adapt

15

~~16. Plac~~

☐ Translation ☐ Transcription ☒ Polyadenylation
☐ RNA processing ☐ Nuclear export

~~17. Wol~~

- A. AUG and UGG
B. AAA and UUU
C. GGA and GGC
D. UAG and UGA

What does wobble hypothesis explains?

~~18. Exp~~

19. What

20. Why

21. Although

Codon table

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