

**2021 – SPRING**

## MIDTERM I

1. All the organisms on earth have a DNA genome with deoxyribonucleotides consisting of only 4 bases: Adenine, Guanine, Cytosine, Thymine. How do these 4 nucleotides contribute to the enormous diversity of life forms on earth? (10 points)
  
  
  
  
  
  
  
  
  
  
2. Answer the below questions regarding the structure and replication of DNA.
  - a. What does the sugar phosphate backbone refer to in nucleic acid structure? (5 points)
  
  
  
  
  
  
  
  
  
  
  - b. Comment on polarity (sidedness) and antiparallel nature of DNA strands? ( 5 points)  
What is the consequence of antiparallelity in terms of DNA replication? (5 points)

c. What is the consequence of the fact that a purine always base pairs with a pyrimidine? (5 points) What is the type of interaction between complementary bases? (5 points)

3. Answer the below questions about DNA replication.

a. Compare and contrast the origins of replication in eukaryotes and prokaryotes? (10 points)

b. Discuss the problems associated with replicating the ends of a chromosome. How are these problems solved for prokaryotes and eukaryotes? (10 points)

4. What do the genes in the genome code for? (5 points)

5. In eukaryotes, transcription takes place in the nucleus, but protein synthesis takes place on ribosomes in the cytoplasm. So, before a eukaryotic mRNA can be translated into protein, it must be transported out of the nucleus through small pores in the nuclear envelope. Which steps are required for the transport of mRNA through nuclear pores? (5 points)
6. The same mRNA sequence can specify three completely different amino acid sequences, depending on where translation begins. However, only one of those reading frames code for the correct aminoacid sequence. What determines the correct reading frame? (5 points) What is the consequence of this in terms of aminoacids in the resulting protein structure? (5 points)
7. Compare and contrast a skin cell and a neuron in terms of gene expression. (10 points)

**Hint:** I do not ask for specific gene names which are active in one cell type but not the other. I ask in general how do they differ, which type of genes are active in both, which type of genes are specific to one.

8. In cell biology, a master regulator is a gene at the top of a gene regulation hierarchy, particularly in regulatory pathways related to cell fate and differentiation. MyoD, which converts the fibroblasts to muscle like cells, is one of those **positive** master regulator of transcription in muscle cells. Similarly, transcription factor REST is a **negative** master regulator of transcription in neurogenesis during embryogenesis and adulthood. It is active in undifferentiated neurons and stem cells in the brain providing plasticity to those cells. In this regard, it is a target gene for the treatment of Alzheimer's disease. (15 points)

Given this information suggest a mechanism for the role of REST in neurogenesis and for the treatment of Alzheimer's disease.

**Hint:** You do not need to search REST on the internet. It will be very confusing and waste of time. Try to think what could REST do as a negative master transcription regulator in neuronal gene expression and answer in the light of what you have learned during the class.

**Plasticity:** The ability of cells to gain characteristics of other cell types.

GOOD LUCK!

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