The Molecular Basis of Inheritance and Gene Expression

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1. Diagram the "Central Dogma" of molecular genetics. How does it allow for DNA to serve as both the heritable molecule and code for protein sequence?
2. Explain the experiment conducted by Meselson and Stahl. How did the results of their experiment demonstrate the semi-conservative model of DNA replication was the accurate model?
3. Explain how each of the following enzymes contributes to the process of DNA replication:
    a. helicase
    b. single-stranded binding proteins
    c. DNA polymerase
    d. primase
    e. ligase
    f. Topisomerase/gyrase
4. How does replication of the leading strand differ from replication of the lagging strand? Why can't both strands of DNA be replicated in the same fashion?
5. Diagram the replication fork. Include:
    a. the leading strand
    b. the lagging strand
    c. prime orientation of both parent strand and both daughter strands.
    d. Okazaki fragments
6. Why is telomerase necessary during the replication of eukaryotic chromosomes?
7. How to recognize the 5′ and 3′ ends of a DNA strand.
8. The structural differences between free nucleotides (nucleoside tri-phosphates), and nucleotides in a nucleic acid.
9. Why replication is necessary for cells, where it happens, its inputs and its outputs.
10. The specific details of the process of replication.
11. The mechanisms in replication that reduce the error rate.

12. The major differences in replication between prokaryotes and eukaryotes.

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13. How did Beadle and Tatum's work on auxotroph's suggest that metabolism was controlled by protein enzymes?
14. How does RNA polymerase identify where to begin transcription of a gene?
15. Explain the relationship between the promoter, enhancers, and transcription factors.
16. Diagram each of the following phases of transcription.
    1. initiation
    2. elongation
    3. termination
17. Explain what happens during each of the following post-transcriptional modifications of eukaryotic transcripts:
    a. splicing
    b. 5' capping
    c. poly adenylation.
18. How do eukaryotic cells utilize alternative splicing to maximize variety of gene products that they can produce?
19. The relationship between DNA, RNA, Protein, Cells and the Organism.
20. Why transcription is necessary for cells, where it happens, its inputs and its outputs.
21. The major structural differences between RNA and DNA.
22. The specific details of the process of transcription.
23. The major differences in transcription between prokaryotes and eukaryotes.
24. Explain the meaning of this statement: "The genetic code is punctuated, unambiguous, and redundant."
25. How does the structure of a tRNA molecules enable its function?
26. How does the structure of a ribosome enable its function?

27. Diagram what happens during each of the following phases of translation. Include the location (A, P, or E site) of incoming tRNA molecules, incoming amino acids, the growing polypeptide chain, uncharged tRNA molecules and release factors as appropriate:
    1. initiation
    2. elongation
    3. termination
28. Diagram a complete eukaryotic transcription unit. Define each part.
29. Explain the effect that point mutations and frameshift mutations can have on gene products. Make sure to differentiate between:
    1. neutral (silent) mutations
    2. missense mutations
    3. nonsense mutations
    4. Why insertion/deletion of three bases is less deleterious than insertion/deletion of one or two bases.
30. How mRNA sequence dictates protein sequence.
31. Why translation is necessary for cells, where it happens, its inputs and its outputs.
32. How amino acids are associated and disassociated from tRNA molecules.
33. The major differences in translation between prokaryotes and eukaryotes.
34. How and why the meaning of the term "gene" has changed over the past 100 years.