**CONCEPT 5 – MOLECULAR GENETICS**

1. DNA Structure
2. Discovery
3. Avery-MacLeod- Marty- 1944 isolated DNA from Griffith’s transformation experiment
4. Hershey-Chase- 1952 elegant experiment with virus and bacteria showing DNA was injected not protein
5. Watson, Crick, Wilkins, and Franklin- 1953 W and C published work showing structure of DNA (used Wilkins and Franklins work to do so)
6. Structure of DNA
7. Deoxyribose nucleic acid
8. Double helix (two twisted stsrands) made of nucleotides (monomers)
9. Nucleotide = phosphate + 5C deoxyribose sugar + nitrogen base
10. Antiparallel strands- one runs 3’ to 5’ the other runs 5’ to 3’,sides of phosphates and sugars (backbone), rungs of paired bases with hydrogen bonds in between
11. Purines (adenine,guanine; double rings) pair with Pyrimidines (cytosine, uracil, thymine; single ring)
12. A - T- double H bond
13. C – G- triple H bond
14. Location
15. In eukaryotes DNA is found in nucleus on multiple linear chromosomes (a chromosome IS a strand of DNA with proteins etc. associated).
16. In prokaryotes DNA is not in a nucleus and is usually a single circular chromosome
17. Prokaryotes, viruses, and eukaryotes (yeast) can contain plasmids (small extra-chromosomal DNA that is double stranded DNA)
18. DNA replication
19. Process of making exact copies of DNA (i.e. for mitosis or meiosis)
20. Process is semi conservative (original strand is copied)
21. Steps
22. Enzyme (helicase) unzip strands by breaking hydrogen bonds
23. “Spare” nucleotides are added bidirectionally to bond complementarily with use of DNA polymerases (DNA pol)
24. DNA pol only can add to the 3’ to 5’ side and new DNA is made in the 5’ to 3’direction
25. Replication bubbles open up and a replication fork is created because bubble is in half and it has one side 3/5 and one 5/3
26. RNA primers must be laid down to start process (RNA primase makes primers)
27. Leading strand makes DNA continuously (3/5)
28. Lagging strand makes DNA discontinuously (5/3), Okazaki fragments
29. Lagging strand requires enzyme (ligase) to fuse fragments
30. RNA
31. Ribonucleic acid
32. Single stranded, different sugar called ribose, different base called uracil INSTEAD of thymine
33. Base pair rules in RNA, A-U and C-G
34. messenger RNA or mRNA carries information from DNA to the ribosome
35. transfer RNA or tRNA bind amino acids and are used in translation at ribosome
36. ribosomal RNA or rRNA are part of ribosomes that have catalytic function
37. RNAi are molucules that are used for regulation of gene expression (turn on or off)
38. Transcription
39. making mRNA in nucleus
40. enzyme RNA pol reads the DNA in 3’ to 5’ direction and synthesizes complementary mRNA
41. Ex. 3’ to 5’ DNA is ATG CAT then the 5’ to 3’ mRNA made will be UAC GUA
42. Steps
43. TATA Box where RNA pol binds and begins
44. Transcription Factors (proteins that enhance transcription and help RNA pol into correct shape)
45. Elongation (adding of RNA nucleotides- does not stay attached to DNA)
46. Termination, ends when RNA pol reaches a termination sequence
47. mRNA editing
48. introns are excised (cut out)
49. exons are left and spliced together using spliceosomes (snRNP’s)
50. add polyA tail to 3’
51. add GTP cap to 5’
52. each 3 are called a codon
53. go to ribosome (free or in RER)
54. Translation
55. mRNA code is read and matched with tRNA (brings amino acids) to construct a polypeptide using the ribosome
56. Ex. mRNA codon is AAA then tRNA anticodon will be UUU and will have a corresponding amino acid for that codon of mRNA
57. Initiation: 5’ end of mRNA attaches to small ribosome, tRNA with anticodon UAC attaches to start codon AUG ; large ribosomal subunit binds and tRNA is in P site
58. Elongation: new tRNA enters A site; peptide bond forms when a.a. is transferred from tRNA in P site to A site; translocation occurs and tRNA in A site moves to P
59. Termination: Ribosome encounters stop codon (UAA, UAG, UGA)
60. If in ER then: polypeptide is released into ER, then to Golgi complex, vesicle to cell membrane, then exocytosis (may be given signals for exit/destination)
61. Free ribosomes typically make products for the cell and are not exported
62. Mutations
63. any change of DNA sequence, can be inheritable if it is in egg or sperm
64. point mutations- one nucleotide error; substitutions (i.e. A instead of G)
65. frame shift mutations- one or more bases deleted or inserted
66. silent mutations can occur, i.e. substitution codes for same a.a. or deletion/insertion is of three nucleotides

***Vocabulary***

amino acids

anticodon

base-pairing rules

cell differentiation

coding strand

codon

DNA

DNA ligase

DNA polymerase

DNA replication

exons

genetic code

helicase

hydrogen bonding

inducible genes

introns

lagging strand

leading strand

micro RNA (miRNA)

mutation

nucleic acids

nucleotides

Okazaki fragments

protein

replication fork

repressor

RNA (mRNA, rRNA, tRNA)

start codon/stop codon

template strand

transcription

transcription factors

translation

***Thinking Questions***

1. Compare the two DNA sequences shown below. Transcribe them into mRNA and translate them into an amino acid sequence.

 CAC GTG GAG TGA GGT CTC CTC(Normal Hemoglobin)

mRNA 🡪

amino acids 🡪

 CAC GTG GAG TGA GGT CAC CTC (Sickle Cell Hemoglobin)

mRNA 🡪

amino acids 🡪

1. Circle any differences there are in the DNA, RNA and amino acid sequences that might exist between these two sequences.
2. Identify the type of mutation that is represented AND EXPLAIN, IN DETAIL, what effect this would have on the protein/pigment (be sure to mention the types of functional groups on the amino acids and how this would affect shape of the molecule).
3. In prokaryotic cells, translation begins before transcription is finished. Give two reasons why this would not be possible in eukaryotic cells.
4. The restriction enzyme EcoRI cleaves double-stranded DNA at the sequence 5'-GAATTC-3' and the restriction enzyme HindIII cleaves at 5'-AAGCTT-3'. A 20 kb circular plasmid is digested with each enzyme individually and then in combination, and the resulting fragment sizes are determined by means of electrophoresis. The results are as follows:



Make a diagram of the circular molecule and indicate the relative positions of the EcoRI and HindIII restriction sites. (Hint: place one EcoRI site at '12 o'clock' and position the remainder relative to this site.)

**Molecular Genetics Short Free Response (4 points)**

When DNA replicates, each strand of the original DNA molecule is used as a template for the synthesis of a second, complementary strand. Compare and contrast the replication of the two new strands, **listing** and **explaining** at least one similarity and one difference in the methods of synthesis. You may draw a diagram to help answer the question, but be sure to explain your diagram in your answer.