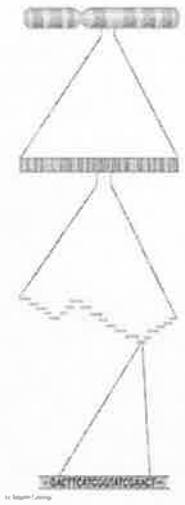
Name KCY **Period** _____

Chapter 21: Genomes and Their Evolution

Most AP Biology teachers think this chapter involves an advanced topic. The questions posed here will help you understand the general concepts over much of the chapter as well as a few more detailed questions in areas that are considered more typical of biology courses at the freshman college level.

Concept 21.1 New approaches have accelerated the pace of genome sequencing

1. The *Human Genome Project* sequenced the entire human genome utilizing a three-stage approach. Use the unlabeled Figure 21.2 below to name and explain each of the three stages.



(1) Linkage mapping - ordering of genetic markers like RFLPs, STRs + other polymorphisms

(2) physical mapping - ordering of large overlapping fragments + then smaller fragments

(3) DNA sequencing - determine nucleotide sequence

2. *Craig Venter* used an approach to genome sequencing that he termed the *whole-genome shotgun approach.* Explain how this concept can be used to sequence genomes.

skips linkage mapping + physical mapping and begins with sequencing of DNA fragments from randomly cut DNA.

-cut DNA
-clone fragments
-sequence the fragment
-order the sequence w/ software

Concept 21.2 Scientists use bioinformatics to analyze genomes and their functions

3. What is *bioinformatics*?

Bio (DNA) information about organisms
DNA sequence (human genome)

4. What is the goal of scientists who study *proteomics*?

To find out when/where proteins are produced and how they interact in networks

5. How might a human gene microarray chip be of medical importance?

people could carry a catalog of their DNA sequence along with their medical records
- beneficial for disease prevention + treatment

Concept 21.3 Genomes vary in size, number of genes, and gene density

6. How do prokaryotic genomes of the two domains Bacteria and Archaea compare to eukaryotic genomes?

smaller; fewer genes

larger; more genes

7. What relationship, if any, does a comparison of eukaryotic genomes indicate? Explain your response.

number of genes is lower than expected, based on genome size

8. How are humans able to successfully compete in nature even though they have about the same number of genes as the nematode *C. elegans*?

extensive alternative splicing of RNA transcripts
- produces more than one functional protein from a single gene

* polypeptide diversity

9. What relationship does Chart 21.1 indicate for gene density comparisons between prokaryotes and eukaryotes?

Eukaryotes are substantial more diverse
greater genome and more genes

Concept 21.4 Multicellular eukaryotes have much noncoding DNA and many multigene families

10. Define the following two terms.

pseudogene former genes that have accumulated mutations and no longer produce functional proteins

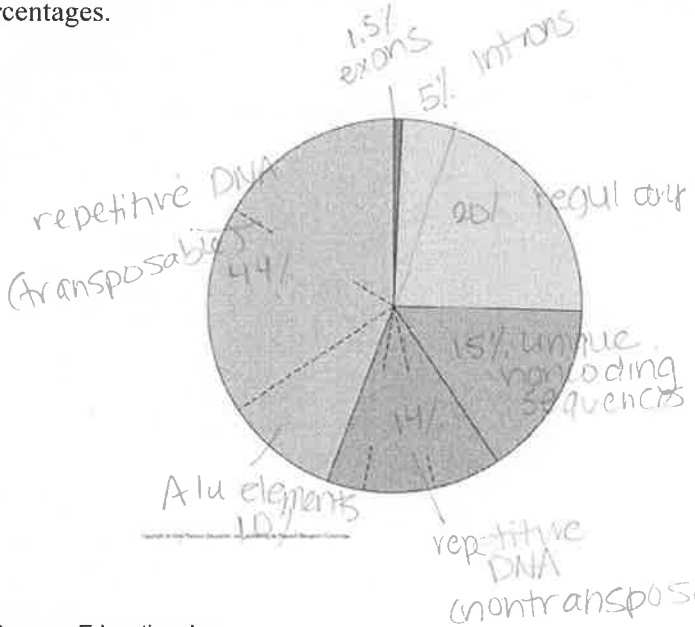
repetitive DNA sequences found in multiple copies in the genome

11. What are *transposable elements*, and what percentage of our genome is made of them?

stretches of DNA that can move from one location to another within the genome

44% repetitive/transposable

12. Using Figure 21.7 as a guide, label the types of DNA sequences in the human genome and give their percentages.

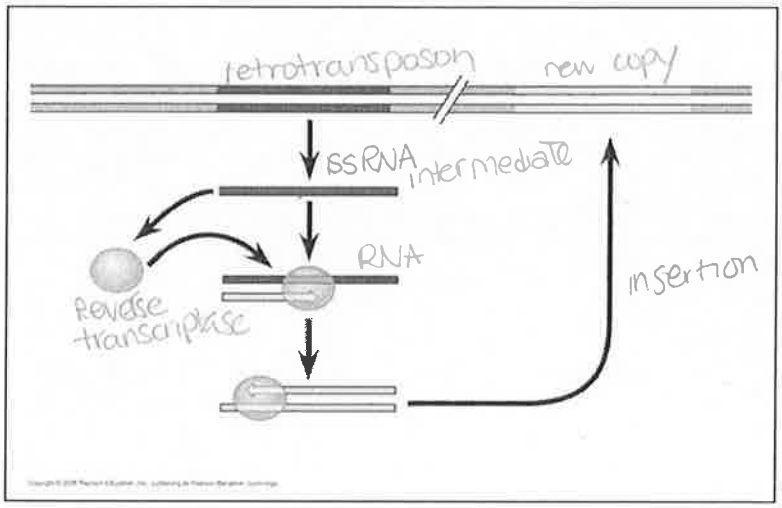


13. What is the difference between a "copy and paste" transposon and a "cut and paste" transposon?

moves but leaves a copy behind

✓ moves but removes the element from the original site

14. *Retrotransposons* move by means of an RNA intermediate. Label and explain how these common transposons accomplish this movement in Figure 21.9 below.



15. What is the significance of the enzyme involved with retrotransposons?

Reverse transcriptase is encoded by retroviruses

The RNA intermediate has to be converted back to DNA by the reverse transcriptase

16. With transposons and retrotransposons comprising such a large percentage of vertebrate genomes, what possible function might they have?

may impact gene expression
may have differential effects

17. What are *short tandem repeats (STRs)*, and why is Earl Washington (see page 420) interested in them?

repeated segment of nucleotides

Earl Washington- former death row inmate who was fully exonerated of murder charges because of DNA testing (STRs)

18. Explain the significance of the following concepts:

multigene families of identical DNA sequences

collections of two or more identical or very similar genes - quick production of ribosomes

multigene families of nonidentical genes

genes on different chromosomes that encode for a similar protein
- express a protein at a different time of development

The selective advantage of having one of the ß-globin family genes expressed in the embryo

different affinity for O_2 - higher as fetus to ensure efficient O_2 transfer from mother to fetus

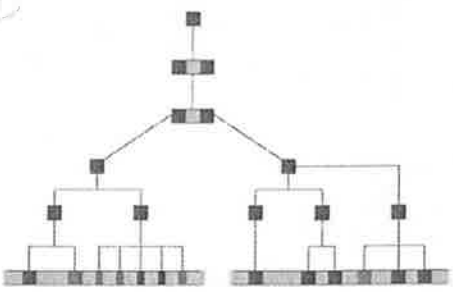
Concept 21.5 Duplication, rearrangement, and mutation of DNA contribute to genome evolution

19. What is the evolutionary significance of the relationship between the genes on human chromosome 16 and those same blocks of genes on mouse chromosomes 7, 8, 16, and 17?

DNA sequences on Human 16 are found on mouse 7, 8, 16 + 17
- suggests that the DNA sequence in each block has stayed together in the mouse + human since they diverged from a common ancestor

20. A good summary of several processes involved in genomic evolution can be found in the globin gene families. Label and explain these processes as described in Figure 21.13.

- Duplication of ancestral gene
- mutation in both copies
- transposition to different chromosomes
- further duplications and mutations



21. Using the concept of a protein domain in your answer, explain why exon shuffling could lead to a novel protein.

If an exon is inserted and retained during RNA splicing, the protein that is made would have an additional domain + possibly a new function

Concept 21.6 Comparing genome sequences provides clues to evolution and development

22. The more similar in sequence the genes and genomes of two species are, the more closely related those species are in their evolutionary history.

23. What are three genes that are evolving much faster in humans than chimpanzees?

- FOXP2
- gene involved in defense against malaria + TB
- gene that regulates brain size

24. What is *evo-devo*, and how does it relate to understanding the evolution of genomes?

evolutionary developmental biology - compare developmental processes + understand how they evolved and how changes in them can modify existing features a lead to new ones

25. Explain what a *homeobox* is, and describe how it functions.

180 nucleotide sequence which specified a 60-amino-acid homeodomain in the encoded proteins in Drosophila (specify the identity of body segments in the fruit fly)

Testing Your Knowledge: Self-Quiz Answers

Now you should be ready to test your knowledge. Place your answers here:

1._____ 2._____ 3._____ 4._____ 5._____ 6._____