ALE 11. The Genetics of Viruses, Control of Gene Expression, and Recombinant DNA Technology

Chapter 19: The Genetics of Viruses (pp. 381-395, *Biology* by Campbell/Reece, 8th ed.)

1. a.) How many viruses could fit on the head of a pin?

- b.) Which is larger, a *ribosome* or a *virus*? (Circle your choice.)
- 2. List and describe the structural components of viruses.

3. a.) Explain why viruses are *obligate parasites*.

b.) List some characteristics that viruses share with living organisms and explain why viruses do dot fit our usual definition of life.

4. Describe how viruses recognize host cells.

5. Describe the *lysogenic* and *lytic cycles*. Use T₄ and Lambda phages as examples. *Make a labeled diagram to clarify your response*.

- 6. Describe the reproduction cycles of animal viruses with envelopes and animal RNA viruses, giving an *example of each*:
 - (a) Animal viruses with envelopes

(b) Animal RNA viruses

7. Discuss the life cycle of a *retrovirus such as HIV*. What role does *reverse transcriptase* play? Do retroviruses use the lytic and/or the lysogenic cycle? <u>Make a labeled diagram illustrating the life cycle of HIV to clarify your explanation</u>.

8. *Vaccines* are usually effective against DNA viruses, but relatively ineffective in preventing the spread of RNA viruses such as the influenza virus and HIV. *Explain why this is so*.

9. How have bacteria evolved to defend themselves against phage infection.

10. *Viral Evolution*: What evidence exists to support the idea that viruses evolved from fragments of their host cell's genetic material?

Chapter 20: Recombinant DNA Technology (pp. 396-425, Biology, 8th ed.)

- 1. *Restriction enzymes* are found naturally in bacteria. What is the natural function of restriction enzymes in bacteria?
- 2. Explain how *restriction enzymes* and *gel electrophoresis* are used to isolate DNA fragments.

3. Why is the creation of *sticky ends* by restriction enzymes very useful in producing a recombinant DNA molecule?

4. How are *plasmids*, *bacteriophages*, and *viruses* used as vectors to insert foreign DNA into host cells?

5. How *radioactively labeled nucleic acid probes* (e.g. Labeled mRNA) used to identify genes of interest? What role does *gel electrophoresis* play in separating and isolating genes of interest?

6. Retroviruses such as HIV use reverse transcriptase to turn the virus's genetic material, RNA, into DNA. *Explain how reverse transcriptase is used in genetic engineering to make genes of interest*.

7. Explain how recombinant DNA technology is used to produce bacteria that can produce eukaryotic gene products such as human insulin or human growth hormone. *Include a labeled diagram in your response*.

8. Suppose you are a physician interested in cloning the CFTR gene from the cheek cells of healthy people to use in gene therapy trials to treat patients with cystic fibrosis. Starting with a small sample of human DNA (i.e. human cheek cells on a cotton swab) explain how PCR (polymerase chain reaction) could be used to make millions of copies of the CFTR gene. Your explanation should include the roles of each of the following: primers, *taq* DNA polymerase (a heat-stable DNA polymerase from a bacterium that lives in hot springs), DNA nucleotides, repeated cycling of temperatures: 94°C to 55°C to 72 °C and back to 94 °C. In addition to an explanation, include a *labeled diagram* that shows *three cycles* of the PCR process.

9. List some of the practical applications of DNA technology in such fields as medicine, pharmaceuticals, forensics, agriculture, etc.

Chapter 18: The Control of Gene Expression in Prokaryotes (pp. 351-380, *Biology*, 7th ed.)

- 1. Cells can regulate the rates of specific metabolic pathways in either of the two ways listed below. Under what circumstances would each of these strategies be appropriate? Explain your reasoning.
 - a.) Regulating gene expression, thus controlling the number of specific enzymes present

b.) Allosterically adjusting the activity of enzymes already present by feedback inhibition

2. Using the *trp operon* as an example, explain the concept of a *repressible operon*. Discuss the functions of the following in controlling the expression (transcription) of the *trp* operon: regulatory gene, promoter, operator, genes of the operon, repressor, and the corepressor, tryptophan. Make a labeled diagram of the trp operon to help clarify your explanation.

3. Using the *lac operon* as an example, explain the concept of an *inducible operon*. Discuss the functions of the following in controlling the expression of the *lac* operon: regulatory gene, promoter, operator, genes of the operon, repressor, and the inducer, allolactose. Make a labeled diagram of the *lac* operon to help clarify your explanation.

We all prefer certain foods. *E. coli* prefers to burn glucose as its energy source. Explain how *E. coli* "knows" when to turn <u>off</u> the *lac* operon when <u>both</u> glucose and lactose are present, and when to turn <u>on</u> the *lac* operon and other catabolic pathways when glucose is in short suppy and lactose or other energy sources are plentiful. Include these terms in your response: cAMP, CRP (<u>c</u>AMP receptor protein), CRP binding site

4. Explain why grouping genes into an *operon* is advantageous and efficient.

5. Distinguish between structural and regulatory genes.

- 6. *Repressible operons* control the gene expression for the enzymes involved with <u>anabolic / catabolic</u> (circle one) metabolic pathways, while *inducible operons* control the gene expression for the enzymes involved with <u>anabolic / catabolic</u> (circle one) metabolic pathways.
- 7. It was through the effects of mutations that enabled Jacob and Monod to decipher how the *lac* operon works. Predict how the following mutations would affect *lac* operon function in the presence and absence of allolactose. <u>Note: use this question to test your knowledge of the *lac* operon. Study the how the *lac* operon works, then attempt this question, using only your cerebral cortex as a reference.</u>

	Effect of mutation on <i>lac</i> operon when	
Mutation	Allolactose present	Allolactose absent
Mutation of regulatory gene:		
Repressor will not bind to		
allolactose		
Mutation of operator:		
Repressor will not bind to		
operator		
Mutation of regulatory gene:		
Repressor will not bind to		
operator		
Mutation of promoter:		
RNA polymerase will not bind		
to promoter		