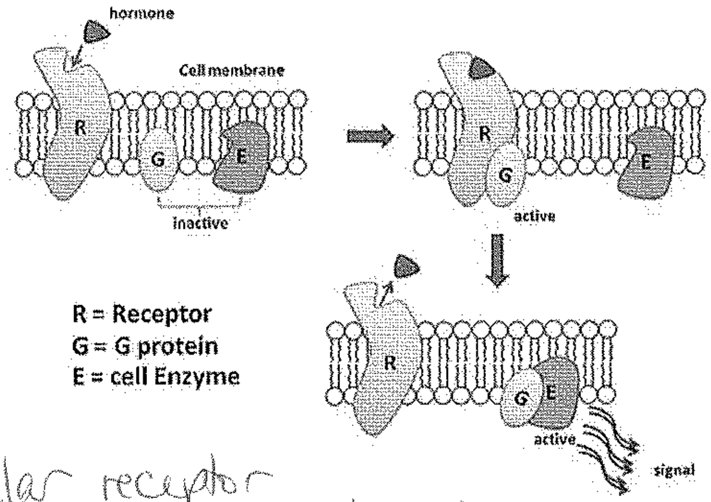
Concept 6: Regulation

Thinking Practice

1. Refer to the diagram at the right to respond to the following questions.



   a. Is the hormone hydrophobic or hydrophilic? How do you know?

   Hydrophilic because it cannot cross through the phospholipids.

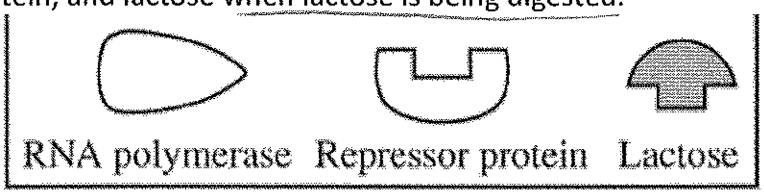
   b. Explain how the action of the hormone might be different if it could move through the cell membrane.

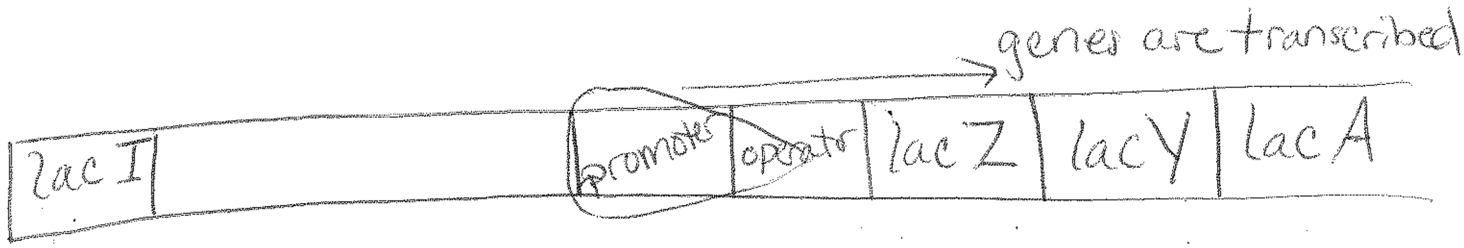
   The hormone may have joined with an intracellular receptor and together moved into the nucleus to alter transcription.

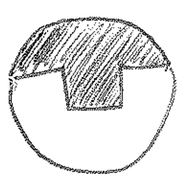
   c. Explain what is happening in this picture and make a prediction about what will be the end result in the cell to which this hormone has bound.

   The hormone binds to the receptor which then activates a G-protein. The G-protein then activates an enzyme which will activate a secondary messenger. This begins a signaling cascade which results in activation of proteins.

2. Lactose digestion in *E. coli* begins with its hydrolysis by the enzyme *b*-galactosidase. The gene encoding *b*-galactosidase, *lacZ*, is part of a coordinately regulated operon containing other genes required for lactose utilization. Use the legend below to draw the gene and its interaction with RNA polymerase, the repressor protein, and lactose when lactose is being digested.



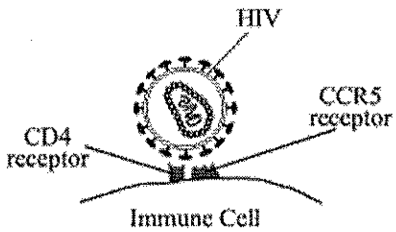




lactose inactivates the repressor.

3.

Despite multiple exposures to HIV, human immunodeficiency virus, a small number of people do not develop AIDS and show no evidence of HIV-infected cells. By comparing these individuals' genes with that of HIV-positive individuals, researchers discovered that resistant individuals have an unusual form of a gene on the short arm of chromosome 3. This gene codes for an immune cell surface protein called CCR5. It is already known that in order to infect a cell, HIV must bind to the main immune cell surface marker CD4, which has many important functions in the immune system. Now we understand that in addition to CD4, the CCR5 receptor is a coreceptor for HIV infection.



Based on the information provided, propose a possible mechanism for a drug to resist HIV infection.

The drug may interact with CCR5 making HIV unable to attach and infect the cell.

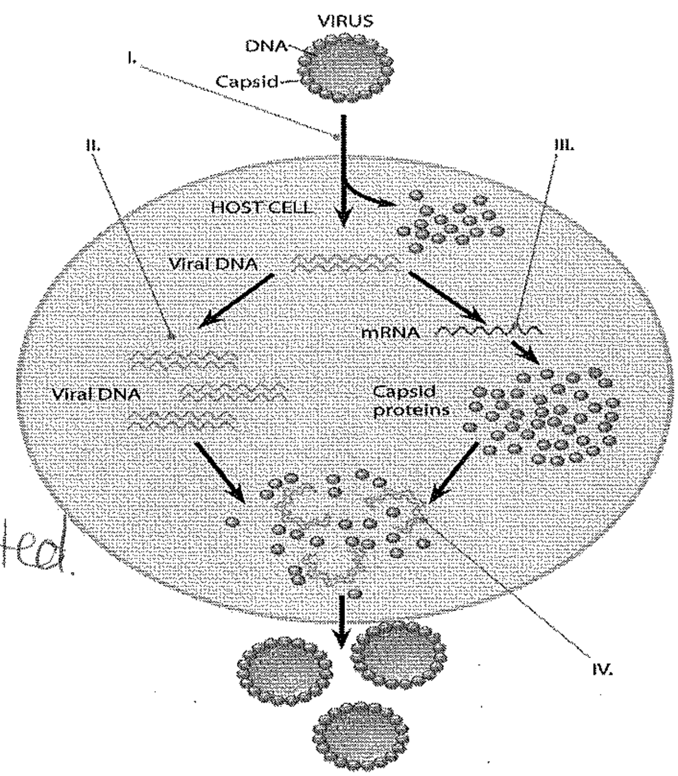
4. Describe the processes occurring at each of the numbered positions (I, II, III, and IV) in the diagram to the right.

I. The virus attaches to a receptor and injects its contents into the host cell.

II. Viral DNA is replicated

III. Viral proteins are transcribed and translated.

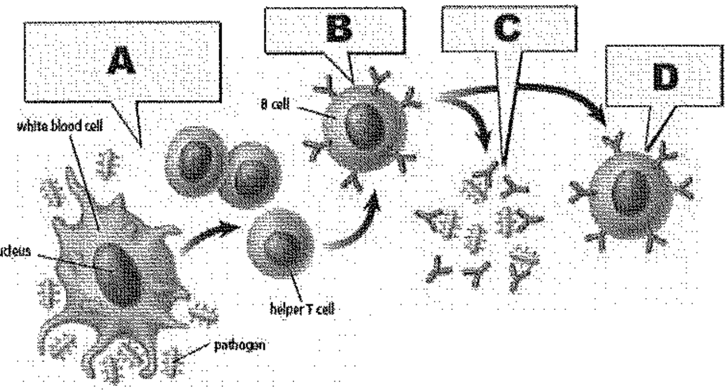
IV. Viral particles are reassembled and virus exits the cell.



Viral reproductive cycle

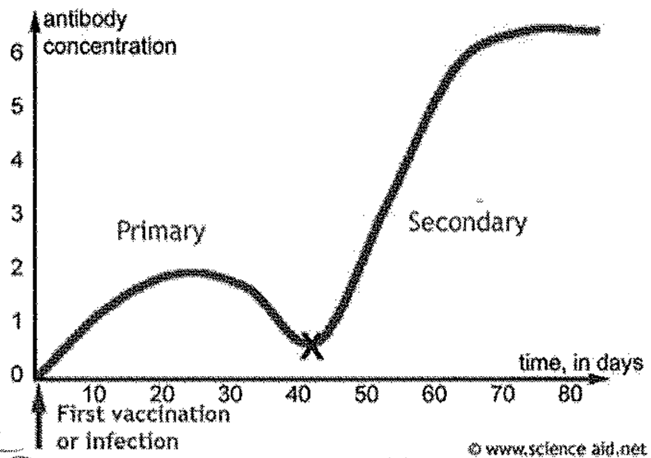
5. Refer to the images at the right to answer the following:
   a. Which immune response in shown: cell mediated or humoral? Explain how you know.

Humoral because antibodies are present.



   b. What are the "Y" shaped molecules called? What is their role in the immune response?

Antibodies - attach to pathogens and tag them for destruction.

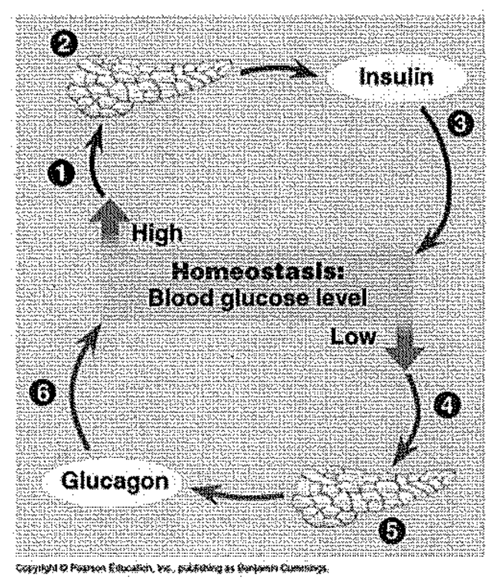


   c. Describe how the "Y" shaped molecules relate to the graph displayed.

The primary response results in fewer antibodies produced due to the lag time in finding B cell "matches" to the antigen and relatively few plasma cells. In the secondary response, the presence of memory B cells allows for a faster, stronger response.

6. One student described an action potential in a neuron by saying "As more gates open the concentration of sodium inside the cell increases and this causes even more gates to open." Is this an example of a positive or negative feedback loop? Justify your reasoning.

This would be a positive feedback loop. The presence of sodium leads to more sodium.



7. The figure to the right shows the feedback mechanism for regulating blood glucose.
   a. Is this a positive or negative feedback loop? Explain your answer. Negative. The system adjusts to a set point. Response is in opposition to the stimulus.
   b. Individuals that suffer from Type I diabetes do not have functional insulin-producing cells. Describe how their blood will differ from that of a healthy individual after a glucose-rich meal.

Diabetics are unable to move the glucose into their cells. The glucose will stay in their blood and eventually be excreted.

8. In a molecular biology laboratory, a student obtained competent *E. coli* cells and used a common transformation procedure to induce the uptake of plasmid DNA with a gene for resistance to the antibiotic kanamycin. The results below were obtained.

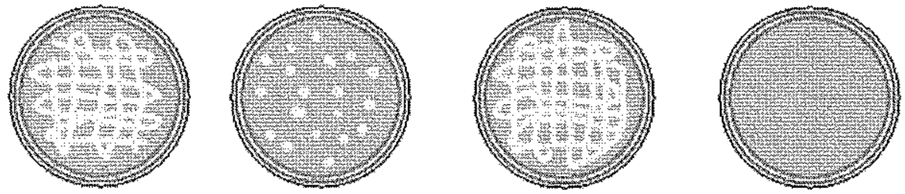


Plate I.	Plate II.	Plate III.	Plate IV.
LB agar +kan plasmid	LB agar with kanamycin +kan plasmid	LB agar no plasmid added	LB agar with kanamycin no plasmid added

a. What is the purpose of Plate IV? This is a control to show that: 1. The kanamycin kills bacteria and 2. The bacteria are not resistant

b. Explain the growth you see and the type of bacteria (transformed vs. non-transformed or both) that would be on Plate 1.

Lots of growth, including both transformed and non-transformed bacteria. Since no kanamycin was added, all bacteria can grow.

c. Explain the growth you see and the type of bacteria (transformed vs. non-transformed or both) that would be on Plate II.

Less growth; only transformed bacteria present due to addition of kanamycin.

d. If the student repeated the experiment, but the heat shock was unsuccessful and the plasmid was unable to be transformed, for which plates would growth be expected? Explain your answer.

Growth would only be on the plates without kanamycin, that is Plates I and III. None of the bacteria were transformed so they do not carry the resistance gene.