Bradykinin is a small peptide hormone and is a vasodilator, leading to a drop in blood pressure. It also causes contraction of non-vascular smooth muscle in the bronchus and gut, increases vascular permeability and is also involved in the mechanism of pain.

Bradykinin raises internal calcium levels in neocortical astrocytes causing them to release the neurotransmitter, glutamate.

Bradykinin is also thought to be the cause of the dry cough in some patients on angiotensin-converting enzyme (ACE) inhibitor drugs. **ACE inhibitors are used to lower blood pressure.** It is thought that bradykinin is converted to inactive metabolites by ACE, therefore inhibition of this enzyme leads to increased levels of bradykinin, which causes a dry cough via bronchoconstriction.

The following is the primary structure of the small peptide hormone Bradykinin:

**Arg-Pro-Pro-Gly-Phe-Ser-Pro-Phe-Arg**
This hormone was once part of a larger pre-pro-hormone, however we will not consider that for this activity. 1.) **Use the codon table at the top of the page to determine the mRNA sequence that coded for this hormone, and then 2.) the DNA sequence that coded for the mRNA.** 3.) Both humans and gorillas possess this hormone with the same primary structure. However the gorilla homolog (gene) varies by a few nucleotides. Point out where those differences most likely are and explain how they can exist without changing the hormone itself.
Station II: TRANSFORMATION:
Use the following information to answer questions 1-3.

A eukaryotic gene has "sticky ends" produced by the restriction endonuclease EcoRI. The gene is added to a mixture containing EcoRI and a bacterial plasmid that carries two genes conferring resistance to ampicillin and tetracycline. The plasmid has one recognition site for EcoRI located in the tetracycline resistance gene. This mixture is incubated for several hours, exposed to DNA ligase, and then added to bacteria growing in nutrient broth. The bacteria are allowed to grow overnight and are streaked on a plate using a technique that produces isolated colonies that are clones of the original. Samples of these colonies are then grown in four different media:

- Media 1: nutrient broth plus ampicillin,
- Media 2: nutrient broth plus tetracycline,
- Media 3: nutrient broth plus ampicillin and tetracycline,
- Media 4: nutrient broth without antibiotics.

You are observing the growth of the bacteria in each of the 4 media.

1.) Create a model (drawing) that illustrates the above experiment.
2.) Develop a hypothesis for each of the 4 media being plated in regards to the bacterial growth expected.
3.) If the bacteria were to contain the plasmid, but not the Eukaryotic gene, predict the results for each of the four media? Justify your prediction.
Station III: Fermentation of Grapes

A. Yeast and Rising Alcohol Concentrations. One of the oldest uses of fermentation by people is to make alcoholic beverages such as wine. However, fermentation also occurs without human intervention. Once grapes ripen on the vine, tiny breaks in the skin of the fruit enable the entry of microbes such as bacteria and fungi. The interior of the grape provides both a high concentration of sugars and low pH. Fermentative yeasts thrive in this environment and metabolize the grape sugars for energy. The products carbon dioxide and ethanol are rapidly transported out of the cells as wastes. When people make wine by fermenting grapes, the process occurs within an airtight container. Alcohol continues to build up in the container until the alcohol tolerance level of the specific yeast population is reached, ending the fermentation cycle. Figure 2.2 shows the results from a simulation of wine fermentation over a 10-day period.

![Graph showing changes in grape sugar, yeast population, and percentage alcohol over a 10-day period.](Image)

Figure 2.2 Results from a simulation of wine fermentation (Stanley et al., 2003). The graph shows changes in grape sugar, yeast population, and percentage alcohol over a 10-day period. (Note: Read grape sugar on the left axis. Yeast and alcohol are shown on the right axis.)
1. Examine Figure 2.2 and fill in the information below.
   a. The grape sugar level starts at ____ g and ends at ____ g.
   b. The yeast population reaches its highest level of ___ approximately on Day ____.
   c. The alcohol level starts at ____% and ends at approximately ____%.
   d. Look at the graphs showing the correlation between yeast population and percentage alcohol. At what percentage alcohol does this yeast population begin to decline? ____%

2. Why isn’t the remaining grape sugar converted to ethanol and carbon dioxide?

3. What product of alcohol fermentation is not shown in the preceding graph?

4. If you removed the alcohol as it was produced, would you predict an increase or a decrease in the amount of grape sugars at 10 days? An increase or decrease in the population of yeast at 10 days? Explain.

5. A bottle of wine may spoil if it is allowed to sit for some time after being opened or if its cork does not form a tight seal. Explain what causes the wine to spoil under these conditions. (Hint: Available grape sugar declines.)
Station IV: Macromolecule Review

1. Name the four classes of macromolecules:

2. Name the monomers of each group for question #1.

3. Draw the following structures:
   a. Glucose
   b. Nucleotide
   c. Lipid (saturated fatty acid)
   d. Protein (dipeptide)

4. What are the structural difference between a saturated and an unsaturated fat?

5. What is the difference between starch and cellulose?

6. What would be the starch homolog in animals?

7. Name an area in an animal cell would you find the following:
   a. Lipids
   b. Carbohydrates
   c. Nucleic acids
Station V: Cell Membranes

1. The membrane of an animal cell would be impermeable to all of the following EXCEPT
   I. a large and primarily polar protein
   II. a small lipid based molecule
   III. starch
   (A) I only                        (D) I and II only
   (B) II only                      (E) I and III only
   (C) III only

2. The passive transport of an ion through a protein carrier into a cell represents which of the following?
   (A) facilitated diffusion          (D) phagocytosis
   (B) osmosis                        (E) active transport
   (C) exocytosis

3. All of the following statements regarding membranes are correct EXCEPT
   (A) Polar heads of phospholipids are located on the periphery of the cell membrane.
   (B) Cell surface receptor proteins transfer small polar substances into the cell.
   (C) Peripheral proteins may display enzymatic functions.
   (D) Phospholipids are amphipathic.
   (E) Glycoproteins are involved in cell-to-cell recognition.

4. Which of the following signaling mechanisms represent a correctly matched pair?
   (A) endocrine- neural communication
   (B) synaptic- intravenous communication
   (C) paracrine- communication with nearby, surrounding cells
   (D) gap junction- communication via hormones
   (E) receptor- substrate communication

<table>
<thead>
<tr>
<th>Cell</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 M sucrose</td>
<td>0.2 M sucrose</td>
</tr>
<tr>
<td>0.2 M glucose</td>
<td>0.1 M glucose</td>
</tr>
<tr>
<td>5% starch</td>
<td>2% starch</td>
</tr>
</tbody>
</table>
5. Assume that the “cell” above is permeable to sucrose, glucose, and water but impermeable to starch. Which of the following statements is correct?
   (A) Starch will diffuse into the cell.
   (B) Starch will diffuse out of the cell.
   (C) There will be no net movement of glucose.
   (D) Glucose will diffuse into the cell.
   (E) None of these are correct.

6. Assume the “cell” is permeable to water only. If the cell contains a 0.3 M solution of glucose and the environment contains a 0.1 M solution of glucose, which of the following statements would be true?
   (A) The cell will decrease in volume.
   (B) Glucose will enter the “cell.”
   (C) Pinocytosis will occur.
   (D) There would be a net movement of water into the “cell.”

7. The value for Ψ in root tissue was found to be -3.3 bars. If you take the root tissue and place it in a 0.1 M solution of sucrose at 20°C in an open beaker, (a) what is the Ψ of the solution, (b) and in which direction would the net flow of water be?
Station VI:
Fruit flies (*Drosophila melanogaster*) with a wild-type phenotype have gray bodies and red eyes. Certain mutations can cause changes to these traits. Mutant flies may have a black body and/or cinnabar eyes. To study the genetics of these traits, a researcher crossed a true-breeding wild-type male fly (with gray body and red eyes) with a true-breeding female fly with a black body and cinnabar eyes. All of the F₁ progeny displayed a wild-type phenotype. Female flies from the F₁ generation were crossed with true-breeding male flies with black bodies and cinnabar eyes. The table below represents the predicted outcome and the data obtained from the cross. 1.) Explain the difference between the expected data and the actual numbers observed. 2.) Find the chi square value for the null hypothesis that any variation between the observed and the expected is due to chance alone.

<table>
<thead>
<tr>
<th>F₂ Generation Phenotypes</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Color</td>
<td>Eye Color</td>
<td>Number Predicted</td>
<td>Number Observed</td>
</tr>
<tr>
<td>Gray</td>
<td>Red</td>
<td>244</td>
<td>455</td>
</tr>
<tr>
<td>Black</td>
<td>Cinnabar</td>
<td>244</td>
<td>432</td>
</tr>
<tr>
<td>Gray</td>
<td>Cinnabar</td>
<td>244</td>
<td>42</td>
</tr>
<tr>
<td>Black</td>
<td>Red</td>
<td>244</td>
<td>47</td>
</tr>
</tbody>
</table>
Station VII:

VII-A: The following data were collected by observing subcellular structures of three different types of eukaryotic cells.

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Smooth ER</th>
<th>Rough ER</th>
<th>Mitochondria</th>
<th>Cilia</th>
<th>Golgi Bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Small amount</td>
<td>Small amount</td>
<td>Large number</td>
<td>Present</td>
<td>Small amount</td>
</tr>
<tr>
<td>Y</td>
<td>Large amount</td>
<td>Large amount</td>
<td>Moderate number</td>
<td>Absent</td>
<td>Large amount</td>
</tr>
<tr>
<td>Z</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
<td>Absent</td>
</tr>
</tbody>
</table>

Based on an analysis of the data, identify a likely primary function of each cell type and explain how the data support the identification.

VII-B:

The figure above represents a generalized hormone-signaling pathway. Briefly explain the role of each numbered step in regulating target gene expression.
Station VIII: Evolution & Natural Selection

Table VI.1 Population of Canadian Mounty-Mice

<table>
<thead>
<tr>
<th>Years ago</th>
<th>Population of Brown-furred mice</th>
<th>Population of White-furred mice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>4,500</td>
<td>139,000</td>
<td></td>
</tr>
<tr>
<td>4,200</td>
<td>138,500</td>
<td></td>
</tr>
<tr>
<td>3,900</td>
<td>139,400</td>
<td>10</td>
</tr>
<tr>
<td>3,600</td>
<td>140,100</td>
<td>0</td>
</tr>
<tr>
<td>3,300</td>
<td>138,900</td>
<td>0</td>
</tr>
<tr>
<td>3,000</td>
<td>139,200</td>
<td>0</td>
</tr>
<tr>
<td>2,700</td>
<td>130,400</td>
<td>1,000</td>
</tr>
<tr>
<td>2,400</td>
<td>120,100</td>
<td>2,500</td>
</tr>
<tr>
<td>2,100</td>
<td>90,700</td>
<td>25,000</td>
</tr>
<tr>
<td>1,800</td>
<td>70,000</td>
<td>60,000</td>
</tr>
<tr>
<td>1,500</td>
<td>30,000</td>
<td>110,000</td>
</tr>
<tr>
<td>1,200</td>
<td>5,000</td>
<td>140,000</td>
</tr>
<tr>
<td>900</td>
<td>50</td>
<td>138,800</td>
</tr>
<tr>
<td>600</td>
<td>0</td>
<td>139,100</td>
</tr>
<tr>
<td>300</td>
<td>0</td>
<td>140,000</td>
</tr>
</tbody>
</table>

1. Examine Figure VI.1 and fill in the information below.
   a. Create a graph that accurately depicts the information from this data table.
   b. Create a hypothetical story to explain what happened to this population of mice using concepts from Darwin’s Theory of Natural Selection. Use his major observations that led him to this theory in your story. To be complete, you must account for how Evolution has occurred and where the new traits came from.
ANSWERS:

Station 1:

1.) mRNA Sequence: ________________________________
2.) DNA Sequence: ________________________________
3.) ________________________________________________
   ________________________________________________
   ________________________________________________

Station 2:

1.) Draw Model Here:

2.) Hypothesis:

   Media 1:
   ________________________________________________
   ________________________________________________

   Media 2:
   ________________________________________________

   Media 3:
   ________________________________________________

   Media 4:
   ________________________________________________

3.) ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________
Station 3:

1.) __________
   a. _____ g; _____ g
   b. ______; ______
   c. _____% ; _____%
   d. _____%

2.) __________________________________________________________________________________

3.) __________________________________________________________________________________

4.) __________________________________________________________________________________

5.) __________________________________________________________________________________

Station 4:

1.) __________; __________; __________; __________

2.) __________; __________; __________; __________

3.) __________________________________________________________________________________

4.) __________________________________________________________________________________

5.) __________________________________________________________________________________

6.) __________________________________________________________________________________

7.) a.) __________; b.) __________; c.) __________

Station 5:

1.) _____

2.) _____

3.) _____

4.) _____

5.) _____

6.) _____

7.) a.) _____  b.) _____
Station 6:

1.) ______________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

2.) Chi Square = ______________

Station 7:

1.)
  a. ______________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

  b. ______________________________________________________________________

Station 8:

1.)
  a. Create a graph:

  b. ______________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________