**Name:**

1. **All living systems require constant input of free energy.**
   1. Organisms use free energy to maintain organization, grow and reproduce.
   2. Organisms use various strategies to regulate body temperature and metabolism.
      1. Endothermy (the use of thermal energy generated by metabolism to maintain homeostatic body temperatures)
      2. Ectothermy (the use of external thermal energy to help regulate and maintain body temperature)
   3. There is a relationship between metabolic rate per unit body mass and the size of multicellular organisms — generally, the smaller the organism, the higher the metabolic rate.
2. **Organisms must exchange matter with the environment to grow, reproduce and maintain organization.**
   1. Surface area-to-volume ratios affect a biological system’s ability to obtain necessary resources or eliminate waste products.
      1. As cells increase in volume, the relative surface area decreases and demand for material resources increases; more cellular structures are necessary to adequately exchange materials and energy with the environment. These limitations restrict cell size.
      2. Organisms also use structures to maximize surface area and the exchange of materials*:*

• Cells of the alveoli

• Cells of the villi

• Microvilli

* 1. The surface area of the plasma membrane must be large enough to adequately exchange materials; smaller cells have a more favorable surface area-to-volume ratio for exchange of materials with the environment.

1. **Organisms use feedback mechanisms to maintain their internal environments and respond to external environmental changes.**
   1. Negative feedback mechanisms maintain dynamic homeostasis for a particular condition (variable) by regulating physiological processes, returning the changing condition back to its target set point.
      1. *For example***:** Temperature regulation in animals
2. **Organisms respond to changes in their external environments.**
   1. Organisms respond to changes in their environment through behavioral and physiological mechanisms.
      1. *For example:*Shivering and sweating in humans
3. **Homeostatic mechanisms reflect both common ancestry and divergence due to adaptation in different environments.**
   1. Organisms have various mechanisms for obtaining nutrients and eliminating wastes.

*For example :*

• Gas exchange in aquatic and terrestrial plants

• Digestive mechanisms in animals such as food vacuoles, gastrovascular cavities, one-way digestive systems

• Respiratory systems of aquatic and terrestrial animals

• Nitrogenous waste production and elimination in aquatic and terrestrial animals

* 1. Homeostatic control systems in species of microbes, plants and animals support common ancestry.

*For example:*

• Excretory systems in flatworms, earthworms and vertebrates

• Osmoregulation in bacteria, fish and protists

• Osmoregulation in aquatic and terrestrial plants

• Circulatory systems in fish, amphibians and mammals

• Thermoregulation in aquatic and terrestrial animals (countercurrent exchange mechanisms)

1. **Organisms exhibit complex properties due to interactions between their constituent parts.**

a. Interactions and coordination between organs provide essential biological activities.

*For example:*

• Stomach and small intestines

• Kidney and bladder

b. Interactions and coordination between systems provide essential biological activities.

*For example:*

• Respiratory and circulatory systems

• Nervous and muscular systems

1. **Cooperative interactions within organisms promote efficiency in the use of energy and matter.**
   1. Organisms have areas or compartments that perform a subset of functions related to energy and matter, and these parts contribute to the whole.
      1. Within multicellular organisms, specialization of organs contributes to the overall functioning of the organism.

*For example:*

• Exchange of gases

• Circulation of fluids

• Digestion of food

• Excretion of wastes

1. **Biological systems are affected by disruptions to their dynamic homeostasis.**
   * Disruptions at the molecular and cellular levels affect the health of the organism.

*For**example:*Immunological responses to pathogens, toxins and allergens

1. **Cells communicate with each other through direct contact with other cells or from a distance via chemical signaling**
   * Cells communicate by cell-to-cell contact

*For example*:

* Immune cells interact by cell-to-cell contact: antigen-presenting cells, helper T-cells and killer T-cells.
* Plasmodesmata between plant cells allow material to be transported from cell to cell.
  + Cells communicate over short distances by using local regulators that target cells in the vicinity of the emitting cell.

*For example*:

* + - * Cytokine and interferon release from immune cells.
      * Plant immune response.

1. **Plants and animals have a variety of chemical defenses against infections that affect dynamic homeostasis.**
   * Plants, invertebrates and vertebrates have multiple, nonspecific immune responses.

For *example:*

* Invertebrate immune systems have nonspecific response mechanisms, but they lack pathogen-specific defense responses.
* Plant defenses against pathogens include molecular recognition systems with systemic responses; infection triggers chemical responses that destroy infected and adjacent cells, thus localizing the effects.
* Vertebrate immune systems have nonspecific and nonheritable defense mechanisms against pathogens.

1. **Mammals use specific immune responses triggered by natural or artificial agents that disrupt dynamic homeostasis.**
   * The mammalian immune system includes two types of specific responses: cell mediated and humoral.
   * In the cell-mediated response, cytotoxic T cells, a type of lymphocytic white blood cell, “target” intracellular pathogens when antigens are displayed on the outside of the cells.
   * In the humoral response, B cells, a type of lymphocytic white blood cell, produce antibodies against specific antigens.
   * Antigens are recognized by antibodies to the antigen.
   * Antibodies are proteins produced by B cells, and each antibody is specific to a particular antigen. *Note: Memorization of the structures of specific antibodies is beyond the scope of the course and the AP Exam.*
   * A second exposure to an antigen results in a more rapid and enhanced immune response.