

# AP Biology Concept Checklist

## Theme 1: Evolution and the Diversity of Life

### Evolution and Genetic Change (9 requirements)

- Can you identify the mechanisms of how variation occurs in genetic populations? Mention the role of mutations, crossing over, random assortment, random fertilization and diploidy.
- Can you explain how natural selection acts as a mechanism for change?
- Can you explain the Hardy-Weinberg theory, and the 5 conditions within a non-evolving population?
- Can you compare and contrast genetic drift from gene flow?
- Can you define each component of the Hardy-Weinberg equation?
- Can you compute genotypic and allelic frequencies in a population in Hardy-Weinberg equilibrium?
- Can you compare/contrast stabilizing, directional and disruptive selection, and give examples of each?
- Can you explain why sexual selection occurs in populations, and give an example?
- Can you explain how an analogous structure is different from a homologous structure?

### Connections in Ancestral History (4 requirements)

- Can you determine relative relatedness between organisms as represented by a cladogram?
- Can you draw a cladogram using information of organism name and specific characteristic?
- Can you infer common ancestry among organisms?
- Can you discuss similarities and differences between the three domains (Bacteria, Archae, Eukarya)?

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## Drivers of Evolution (3 requirements)

- Can you compare and contrast allopatric and sympatric speciation?
- Can you explain how polyploidy can lead to a new species particularly in plants?
- Can you define prezygotic and postzygotic reproductive isolating mechanisms and give an example of each?

## The Origins of Life (3 requirements)

- Can you explain the theory of endosymbiosis?
- Can you describe the universal ancestor of all life according to the Heterotroph Hypothesis?
- Can you describe the sequence of changes that led about the evolution of life's ancestor to present?

## Theme 2: Requirements of Biological Systems

### Free energy and matter (4 requirements)

- How does energy move through biological systems?
- Explain how entropy is affected by biological processes.
- Compare and contrast endothermy and ectothermy as strategies to regulate body temperature
- Compare and contrast heterotrophic and autotrophic nutrition as strategies to capture free energy.

### Cellular respiration (3 requirements)

- Compare and contrast anaerobic and aerobic respiration
- Describe the stages of aerobic respiration.
- How is oxidative phosphorylation considered a coupled reaction?

### Photosynthesis (6 requirements)

- Compare and contrast chemosynthesis with photosynthesis.

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- Describe the light-dependent reactions of photosynthesis including reactants and products.
  - Describe how light energy is converted to ATP and NADPH in noncyclic photophosphorylation.
  - Compare and contrast chemiosmosis in cellular respiration with chemiosmosis in the light reactions of photosynthesis.
  - How do both the mitochondria and the chloroplast the electron transport chains for their cellular reactions.
  - Describe the evolutionary pathway of photosynthetic prokaryotes to eukaryotic photosynthesis
- Dynamic Homeostasis** (*13 requirements*)
- Describe how carbon is cycled through the ecosystem.
  - Describe how nitrogen is cycled through the ecosystem.
  - What are the unique properties of water that make it possible for life to exist?
  - Explain how the relationship between surface area to volume affects biological systems and the efficiency of cells.
  - Explain how the ability of the plasma membrane to be selectively permeable maintains homeostasis within a cell.
  - Describe the structure of the fluid mosaic model of the cell membrane.
  - Describe what can move through the phospholipid bilayer of the membrane and explain why they can be transported this way.
  - Describe what can move through the integral proteins of the membrane and explain why they can be transported this way.
  - Compare and contrast different forms of passive transport giving examples of each: simple diffusion, facilitated diffusion, osmosis.
  - Compare and contrast passive and active transport giving examples of each.
  - Compare and contrast endocytosis with exocytosis, giving examples of each.
  - Why is compartmentalization in eukaryotic cells helpful in maintaining homeostasis?
  - Give examples of membrane bound organelles in eukaryotes, describing both structure and function for each.

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## Feedback Mechanisms (4 requirements)

- Define negative feedback and give an example.
- Define positive feedback and give an example.
- Describe how an alteration in either negative or positive feedback can have harmful consequences.
- Describe how organisms use feedback mechanisms incorporating behavioral or physiological mechanisms when changes occur in the environment.

## Biotic and Abiotic Interactions (5 requirements)

- Explain how biotic and abiotic factors affect cells, organisms, populations, communities and ecosystems, giving examples of each.
- Compare and contrast mutualism, commensalism, and parasitism giving examples of each.
- Compare and contrast osmoregulation in different organisms living in a variety of environments.
- Compare and contrast thermoregulation in different organisms living in a variety of environments.
- Describe various forms of human impact on the environment which has led to the disruption of global balance.

## Timing and Coordination of Biological Processes (13 requirements)

- Describe a non-specific immune response and give an example.
- Compare and contrast a mammalian specific immune responses: cell mediated vs. humoral
- How is the function of a T cell different from the function of a B cell?
- What is the relationship between antigens and antibodies?
- How does the second exposure to an antigen differ from the first exposure?
- What is the function of a homeotic gene?
- Describe 3 ways that genes are regulated in eukaryotes?
- Define apoptosis and describe how it occurs.
- Define photoperiodism and explain its role in natural selection.

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- Explain how circadian rhythms act as physiological clocks.
- Explain quorum sensing in bacteria.
- Compare and contrast innate and learned behavior.
- What is an example of cooperative behavior within or between populations and how it relates to the survival of populations?

## Theme 3: Biological Information

### DNA and Genetic Coding (5 requirements)

- Can you explain what experimental research led to the discovery of DNA's structure?
- Can you explain the structure of DNA, specifically?
- Can you explain how DNA replicates itself?
- Can you describe which enzymes and other related proteins are used in DNA replication?
- Can you explain the difference between the leading and lagging strand?

### Cell Division and Heritability (8 requirements)

- Can you describe the cell cycle?
- Can you describe the stages of mitosis?
- Can you explain how mitosis and cytokinesis differ in plant vs. animal cells?
- Can you explain the stages of meiosis?
- Can you explain how mitosis compares and contrasts to meiosis?
- Can you explain what events in meiosis and in sexual reproduction lead to variation?
- Can you explain how Mendel contributed to our basic understanding of genetics?
- Can you predict the outcome of a genetic problem involving a. One trait where a dominant and recessive allele exist b. A dihybrid cross (using a Punnett square)? c. A multihybrid cross (using the product law)? d. Sex linked traits? e. A pedigree chart? f. Linked genes and mapping chromosomes?

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## Genetic Expression (2 requirements)

- Can you explain how prokaryotes use operons to turn on and off genes (ex. Lac and Tryp operon)?
- Can you explain how eukaryotes use several different methods to regulate gene activity?

## Cell Communication (6 requirements)

- Do you know the three types of cell signaling pathways?
- Can you compare and contrast protein and steroid signals in a communication pathway?
- Can you explain three ways that cells communicate?
- Can you describe the three parts of a cell communication pathway?
- Can you list examples of plant and animal cell signaling pathways?
- Can you explain what disruptions can occur to interfere with cell signaling, and what the consequences are of this disruption?

## Genetic Processing and Variation (8 requirements)

- Can you define a mutation and explain how it occurs?
- Can you compare gene mutations to chromosomal mutations and give examples of both?
- Can you explain how genetic variation occurs in sexually reproducing organisms?
- Can you explain how genetic variation in prokaryotes occurs through horizontal transfer?
- Can you describe the structure of a virus?
- Can you explain how viruses infect cells, and use their host to reproduce?
- Can you compare the virus lytic cycle to the lysogenic cycle?
- Can you explain what it means that HIV is a retrovirus?

## Non-Heritable Information (1 requirements)

- Can you describe how epigenetic markers can affect gene expression in future generations?

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## Theme 4: Interactions between Biological Systems

### Biochemistry and Cell Biology (19 requirements)

- Can you distinguish between the term monomer and polymer?
- Can you identify the structural components of a nucleotide?
- Can you explain how DNA differ from RNA?
- Can you describe the primary, secondary, tertiary and quaternary structures of a protein?
- Can you describe the R group interactions that help proteins maintain their shape?
- Can you identify the essential characteristics that define lipids?
- Can you explain how the amphipathic nature of some lipids aid in their function?
- Can you explain how dehydration synthesis combine monosaccharaides to form disaccharides, and then to form polysaccharides?
- Can you describe the antiparallel nature of nucleic acids?
- Can you describe how the amino and carboxyl functional groups are involved in the formation of a peptide bond in proteins?
- Can you describe how the structure of a ribosome is related to its function of producing proteins?
- Can you compare and contrast smooth and rough endoplasmic reticulum?
- Can you explain how the role of Golgi bodies related to lysosomes?
- Can you explain how the structure of mitochondria related to function?
- Can you explain how the structure of a lysosome related to functions of cellular digestion as well as apoptosis?
- Can you describe three functions of vacuoles?
- Can you explain how the structure of a chloroplast related to its function?
- Can you identify the role that chlorophyll play in photosynthesis?
- Can you explain the role of compartmentalization in both mitochondria and chloroplasts?

### Organ, System, and Ecological Interactions (14 requirements)

- Can you explain how the stomach and small intestines interact to aid in digestion?
- Can you explain how the kidney and bladder interact to aid in excretion of urine?

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- Can you describe the interactions between roots, stems and leaves to aid in the plant to function as a complete organism?
  - Can you explain how the human respiratory and circulatory systems function to aid in transport of oxygen and carbon dioxide?
  - Can you explain how the nervous system is integral for muscular function?
  - Can you describe how the xylem and phloem in a dicot leaf work together to aid in the function of the leaf to efficiently perform photosynthesis?
  - Can you compare and contrast the terms species composition and species diversity?
  - Can you draw a predator/prey graph showing changes in each population over time? (Example predator –lynx; prey-arctic hare)
  - Can you draw a population growth curve showing exponential growth and explain the conditions that must exist for this type of growth to occur?
  - Can you draw a population growth curve showing logistic growth and explain the conditions that must exist for this type of growth to occur?
  - Can you define carrying capacity and label where it occurs on a logistic population growth curve?
  - Can you compare and contrast density-dependent and density-independent growth factors, giving an example of each?
  - Can you draw an example of a food chain from a field or from a lake, describing the energy flow through the chain of organisms?
  - Can you give an example of how humans have impacted the ecosystem, including one each for the local, regional and global scale?
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- Competition and Cooperation** (9 requirements)
- Can you describe how the shape of an enzyme alters the ability of the enzyme to function?
  - Can you explain how organelles interaction to contribute to the function of the cell by citing an example?
  - Can you explain how unicellular organisms such as bacteria can interact together similar ways to cells of a multicellular organism to increase efficiency? Be sure to give an example.



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- Can you define each type of symbiosis, mutualism, parasitism and commensalism and give a specific example of each?
  - Can you explain how negative feedback illustrated in the functioning of an ecosystem? Give an example.
  - Can you explain how positive feedback illustrated in the functioning of an ecosystem? Give an example.
  - Can you explain how the loss of a keystone species affects a population?
  - Can you explain how the introduction of a new, invasive species changes a population?
  - Can you explain how the impact of El Nino impacted global patterns involving weather and population shifts?
- Importance of Biological Diversity** (*5 requirements*)
- Can you explain why the presence of two types of chlorophyll (a and b) increase the functioning of photoautotrophs?
  - Can you explain why the sickle cell allele will not diminish from the population due to the heterozygote advantage and malaria resistance?
  - Can you give an example of how an environmental factor may influence gene expression?
  - Can you explain why species with little biodiversity may be more at risk for extinction, and give an example to illustrate your point?
  - Can you explain why genetic diversity may cause a higher survival rate in individuals in a population, and include an illustrative example?