Errata sheet for AP Biology

This document lists corrections and/or refinements made to the AP Biology Course and Exam Description since it was published in May of 2019.

Corrections to AP Biology as of September, 2019

The items listed below have been corrected in the online version of the CED. Teachers can print out the individual pages in order to update their printed CED binders.

- Correction to Science Practice 3.B- this has been corrected to say “state the null or alternative hypotheses” instead of “state the null and alternative hypotheses.” This correction was made multiple times in the CED:
  - Science Practices chart (p. 14)
  - Unit at a Glance for Unit 7 (pp. 126-127)
  - Individual topic pages for Topic 7.4 (p. 132), Topic 7.11 (p. 143), and Topic 7.13 (p. 145)
- Topic 2.1 (pp. 48-49) 4 items currently listed as sub-bullets under SYI-1.D.4 are actually separate Essential Knowledge statements.
- Topic 2.3 (p. 52) The formula for the volume of a cube has been corrected to read $V= s^3$
- Specific instances of Science Practice 5.C that had incorrect wording have been revised. The main Sciences Practices Chart (p. 15) is correct. The Unit at a Glance for Unit 5 (p. 96) and the topic page for Topic 5.4 (p. 102) were corrected to say “Perform chi-square hypothesis testing.”
- Topic 6.4 (pp. 116-117), Learning Objective IST-1.O was reworded to say “Explain how”
- Topic 8.7 (p. 162) “small pox” was removed from the list of illustrative examples for Essential Knowledge statement SYI-2.B.2.a

AP BIOLOGY

Science Practices

Science Practice 1	Science Practice 2	Science Practice 3
Concept Explanation 1 Explain biological concepts, processes, and models presented in written format.	***Visual Representations*** 2 Analyze visual representations of biological concepts and processes.	***Questions and Methods*** 3 Determine scientific questions and methods.

SKILLS

1.A Describe biological concepts and/or processes.

1.B Explain biological concepts and/or processes.

1.C Explain biological concepts, processes, and/or models in applied contexts.

2.A Describe characteristics of a biological concept, process, or model represented visually.

2.B Explain relationships between different characteristics of biological concepts, processes, or models represented visually

a. In theoretical contexts.

b. In applied contexts.

2.C Explain how biological concepts or processes represented visually relate to larger biological principles, concepts, processes, or theories.

2.D Represent relationships within biological models, including

a. Mathematical models.

b. Diagrams.

c. Flow charts.

3.A Identify or pose a testable question based on an observation, data, or a model.

3.B State the null or alternative hypotheses, or predict the results of an experiment.

3.C Identify experimental procedures that are aligned to the question, including

a. Identifying dependent and independent variables.

b. Identifying appropriate controls.

c. Justifying appropriate controls.

3.D Make observations, or collect data from representations of laboratory setups or results. (Lab only; not assessed)

3.E Propose a new/next investigation based on

a. An evaluation of the evidence from an experiment.

b. An evaluation of the design/methods.

SUGGESTED SKILL

Concept Explanation

1.A

Describe biological concepts and/or processes.

ILLUSTRATIVE EXAMPLE

- Glycosylation and other chemical modifications of proteins that take place within the Golgi and determine protein function or targeting

TOPIC 2.1
Cell Structure: Subcellular Components

Required Course Content

ENDURING UNDERSTANDING

SYI-1

Living systems are organized in a hierarchy of structural levels that interact.

LEARNING OBJECTIVE

SYI-1.D

Describe the structure and/or function of subcellular components and organelles.

ESSENTIAL KNOWLEDGE

SYI-1.D.1

Ribosomes comprise ribosomal RNA (rRNA) and protein. Ribosomes synthesize protein according to mRNA sequence.

SYI-1.D.2

Ribosomes are found in all forms of life, reflecting the common ancestry of all known life.

SYI-1.D.3

Endoplasmic reticulum (ER) occurs in two forms—smooth and rough. Rough ER is associated with membrane-bound ribosomes—

a. Rough ER compartmentalizes the cell.
b. Smooth ER functions include detoxification and lipid synthesis.

EXCLUSION STATEMENT—*Specific functions of smooth ER in specialized cells are beyond the scope of the course and the AP Exam.*

SYI-1.D.4

The Golgi complex is a membrane-bound structure that consists of a series of flattened membrane sacs—

a. Functions of the Golgi include the correct folding and chemical modification of newly synthesized proteins and packaging for protein trafficking.

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LEARNING OBJECTIVE

SYI-1.D

Describe the structure and/or function of subcellular components and organelles.

ESSENTIAL KNOWLEDGE

EXCLUSION STATEMENT—*The role of the Golgi in the synthesis of specific phospholipids and the packaging of specific enzymes for lysosomes, peroxisomes, and secretory vesicles are beyond the scope of the course and the AP Exam.*

SYI-1.D.5

Mitochondria have a double membrane. The outer membrane is smooth, but the inner membrane is highly convoluted, forming folds.

SYI-1.D.6

Lysosomes are membrane-enclosed sacs that contain hydrolytic enzymes.

SYI-1.D.7

A vacuole is a membrane-bound sac that plays many and differing roles. In plants, a specialized large vacuole serves multiple functions.

SYI-1.D.8

Chloroplasts are specialized organelles that are found in photosynthetic algae and plants. Chloroplasts have a double outer membrane.

SUGGESTED SKILLS

Statistical Tests and Data Analysis

5.A.d

Perform mathematical calculations, including ratios.

Visual Representations

2.D.a

Represent relationships within biological models, including mathematical models.

ILLUSTRATIVE EXAMPLES

SA/V Ratios and Exchange

- Root hair cells
- Guard cells
- Gut epithelial cells

ILLUSTRATIVE EXAMPLES

- Vacuoles
- Cilia
- Stomata

TOPIC 2.3
Cell Size

Required Course Content

ENDURING UNDERSTANDING

ENE-1

The highly complex organization of living systems requires constant input of energy and the exchange of macromolecules.

LEARNING OBJECTIVE

ENE-1.B

Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.

ESSENTIAL KNOWLEDGE

ENE-1.B.1

Surface area-to-volume ratios affect the ability of a biological system to obtain necessary resources, eliminate waste products, acquire or dissipate thermal energy, and otherwise exchange chemicals and energy with the environment.

RELEVANT EQUATIONS

Volume of a Sphere: $V = \frac{4}{3}\pi r^3$

Volume of a Cube: $V = s^2$

Volume of a Rectangular Solid: $V = lwh$

Volume of a Cylinder: $V = \pi r^2 h$

Surface Area of a Sphere: $SA = 4\pi r^2$

Surface Area of a Cube: $SA = 6s^2$

Surface Area of a Rectangular Solid: $SA = 2lh + 2lw + 2wh$

Surface Area of a Cylinder: $SA = 2\pi rh + 2\pi r^2$

r = radius
l = length
h = height
w = width
s = length of one side of a cube

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UNIT AT A GLANCE

Enduring Understanding	Topic	Suggested Skill	Class Periods ~9–11 CLASS PERIODS
IST-1	**5.1 Meiosis**	1.B Explain biological concepts and/or processes.	
IST-1	**5.2 Meiosis and Genetic Diversity**	3.A Identify or pose a testable question based on an observation, data, or a model.	
EVO-2, IST-1	**5.3 Mendelian Genetics**	5.C Perform chi-square hypothesis testing. 6.E.c Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on data.	
IST-1	**5.4 Non-Mendelian Genetics**	5.A.b Perform mathematical calculations, including means. 5.C Perform chi-square hypothesis testing.	
SYI-3	**5.5 Environmental Effects on Phenotype**	1.C Explain biological concepts, processes, and/or models in applied contexts.	
SYI-3	**5.6 Chromosomal Inheritance**	6.E.b Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.	

Go to **AP Classroom** to assign the **Personal Progress Check** for Unit 5.
Review the results in class to identify and address any student misunderstandings.

SUGGESTED SKILLS

Statistical Tests and Data Analysis

5.A.b
Perform mathematical calculations, including means.

5.C
Perform chi-square hypothesis testing.

ILLUSTRATIVE EXAMPLES

- Sex-linked genes reside on sex chromosomes.
- In mammals and flies, females are XX and males are XY; as such, X-linked recessive traits are always expressed in males.
- In certain species, the chromosomal basis of sex determination is not based on X and Y chromosomes (such as ZW in birds, haplodiploidy in bees).

TOPIC 5.4
Non-Mendelian Genetics

Required Course Content

ENDURING UNDERSTANDING

IST-1
Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.J
Explain deviations from Mendel's model of the inheritance of traits.

ESSENTIAL KNOWLEDGE

IST-1.J.1
Patterns of inheritance of many traits do not follow ratios predicted by Mendel's laws and can be identified by quantitative analysis, where observed phenotypic ratios statistically differ from the predicted ratios—

a. Genes that are adjacent and close to one another on the same chromosome may appear to be genetically linked; the probability that genetically linked genes will segregate as a unit can be used to calculate the map distance between them.

IST-1.J.2
Some traits are determined by genes on sex chromosomes and are known as sex-linked traits. The pattern of inheritance of sex-linked traits can often be predicted from data, including pedigree, indicating the parent genotype/phenotype and the offspring genotypes/phenotypes.

IST-1.J.3
Many traits are the product of multiple genes and/or physiological processes acting in combination; these traits therefore do not segregate in Mendelian patterns.

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SUGGESTED SKILLS

Argumentation

6.E.a

Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on biological concepts.

Visual Representations

2.D.b

Represent relationships within biological models, including diagrams.

AVAILABLE RESOURCES

- Classroom Resources > **From Gene to Protein—A Historical Perspective**

TOPIC 6.4
Translation

Required Course Content

ENDURING UNDERSTANDING

IST-1

Heritable information provides for continuity of life.

LEARNING OBJECTIVE

IST-1.0

Explain how the phenotype of an organism is determined by its genotype.

ESSENTIAL KNOWLEDGE

IST-1.0.1

Translation of the mRNA to generate a polypeptide occurs on ribosomes that are present in the cytoplasm of both prokaryotic and eukaryotic cells and on the rough endoplasmic reticulum of eukaryotic cells.

IST-1.0.2

In prokaryotic organisms, translation of the mRNA molecule occurs while it is being transcribed.

IST-1.0.3

Translation involves energy and many sequential steps, including initiation, elongation, and termination.

X EXCLUSION STATEMENT—*The details and names of the enzymes and factors involved in each of these steps are beyond the scope of the course and the AP Exam.*

IST-1.0.4

The salient features of translation include—

a. Translation is initiated when the rRNA in the ribosome interacts with the mRNA at the start codon.

b. The sequence of nucleotides on the mRNA is read in triplets called codons.

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LEARNING OBJECTIVE

IST-1.O

Explain how the phenotype of an organism is determined by its genotype.

ESSENTIAL KNOWLEDGE

c. Each codon encodes a specific amino acid, which can be deduced by using a genetic code chart. Many amino acids are encoded by more than one codon.

d. Nearly all living organisms use the same genetic code, which is evidence for the common ancestry of all living organisms.

e. tRNA brings the correct amino acid to the correct place specified by the codon on the mRNA.

f. The amino acid is transferred to the growing polypeptide chain.

g. The process continues along the mRNA until a stop codon is reached.

h. The process terminates by release of the newly synthesized polypeptide/protein.

EXCLUSION STATEMENT—*Memorization of the genetic code is beyond the scope of the course and the AP Exam.*

IST-1.O.5

Genetic information in retroviruses is a special case and has an alternate flow of information: from RNA to DNA, made possible by reverse transcriptase, an enzyme that copies the viral RNA genome into DNA. This DNA integrates into the host genome and becomes transcribed and translated for the assembly of new viral progeny.

EXCLUSION STATEMENT—*The names of the steps and particular enzymes involved—beyond DNA polymerase, ligase, RNA polymerase, helicase, and topoisomerase—are beyond the scope of the course and the AP Exam.*

UNIT AT A GLANCE

Enduring Understanding	Topic	Suggested Skill	Class Periods ~20–23 CLASS PERIODS
EVO-1	**7.1 Introduction to Natural Selection**	2.A Describe characteristics of a biological concept, process, or model represented visually.	
	7.2 Natural Selection	1.B Explain biological concepts and/or processes.	
	7.3 Artificial Selection	4.B.c Describe data from a table or graph, including describing relationships between variables.	
	7.4 Population Genetics	3.B State the null or alternative hypotheses, or predict the results of an experiment.	
	7.5 Hardy-Weinberg Equilibrium	5.A.a Perform mathematical calculations, including mathematical equations in the curriculum. 1.C Explain biological concepts, processes, and/or models in applied contexts.	
EVO-1 EVO-2	**7.6 Evidence of Evolution**	4.B.a Describe data from a table or graph, including identifying specific data points.	
EVO-2	**7.7 Common Ancestry**	6.E.b Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on a visual representation of a biological concept, process, or model.	

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UNIT AT A GLANCE *(cont'd)*

Enduring Understanding	Topic	Suggested Skill	Class Periods ~20–23 CLASS PERIODS
EVO-3	**7.8 Continuing Evolution**	3.E.a Propose a new/next investigation based on an evaluation of the evidence from an experiment.	
	7.9 Phylogeny	2.D.c Represent relationships within biological models, including flowcharts.	
	7.10 Speciation	6.E.a Predict the causes or effects of a change in, or disruption to, one or more components in a biological system based on biological concepts or processes. 2.B.a Explain relationships between different characteristics of biological concepts, processes, or models represented visually in theoretical contexts.	
	7.11 Extinction	3.B State the null or alternative hypotheses, or predict the results of an experiment.	
SYI-3	**7.12 Variations in Populations**	6.C Provide reasoning to justify a claim by connecting evidence to biological theories.	
	7.13 Origin of Life on Earth	3.B State the null or alternative hypotheses, or predict the results of an experiment.	
	Go to **AP Classroom** to assign the **Personal Progress Check** for Unit 7. Review the results in class to identify and address any student misunderstandings.		

SUGGESTED SKILL

Questions and Methods

3.B

State the null or alternative hypotheses, or predict the results of an experiment.

AVAILABLE RESOURCES

- Classroom Resources > **Evolution and Change**

TOPIC 7.4
Population Genetics

Required Course Content

ENDURING UNDERSTANDING

EVO-1

Evolution is characterized by a change in the genetic makeup of a population over time and is supported by multiple lines of evidence.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
EVO-1.H Explain how random occurrences affect the genetic makeup of a population.	**EVO-1.H.1** Evolution is also driven by random occurrences— a. Mutation is a random process that contributes to evolution. b. Genetic drift is a nonselective process occurring in small populations— i. Bottlenecks. ii. Founder effect. c. Migration/gene flow can drive evolution.
EVO-1.I Describe the role of random processes in the evolution of specific populations.	**EVO-1.I.1** Reduction of genetic variation within a given population can increase the differences between populations of the same species.
EVO-1.J Describe the change in the genetic makeup of a population over time.	**EVO-1.J.1** Mutation results in genetic variation, which provides phenotypes on which natural selection acts.

TOPIC 7.11 Extinction

SUGGESTED SKILL

Questions and Methods

3.B

State the null or alternative hypotheses, or predict the results of an experiment.

AVAILABLE RESOURCES

- Classroom Resources > **Evolution and Change**

Required Course Content

ENDURING UNDERSTANDING

EVO-3

Life continues to evolve within a changing environment.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
EVO-3.G Describe factors that lead to the extinction of a population.	**EVO-3.G.1** Extinctions have occurred throughout Earth's history. **EVO-3.G.2** Extinction rates can be rapid during times of ecological stress.
EVO-3.H Explain how the risk of extinction is affected by changes in the environment.	**EVO-3.H.1** Human activity can drive changes in ecosystems that cause extinctions.
EVO-3.I Explain species diversity in an ecosystem as a function of speciation and extinction rates.	**EVO-3.I.1** The amount of diversity in an ecosystem can be determined by the rate of speciation and the rate of extinction.
EVO-3.J Explain how extinction can make new environments available for adaptive radiation.	**EVO-3.J.1** Extinction provides newly available niches that can then be exploited by different species.

TOPIC 7.13 Origins of Life on Earth

Required Course Content

ENDURING UNDERSTANDING

SYI-3

Naturally occurring diversity among and between components within biological systems affects interactions with the environment.

LEARNING OBJECTIVE

SYI-3.E

Describe the scientific evidence that provides support for models of the origin of life on Earth.

ESSENTIAL KNOWLEDGE

SYI-3.E.1

Several hypotheses about the origin of life on Earth are supported with scientific evidence—

a. Geological evidence provides support for models of the origin of life on Earth.
   i. Earth formed approximately 4.6 billion years ago (bya). The environment was too hostile for life until 3.9 bya, and the earliest fossil evidence for life dates to 3.5 bya. Taken together, this evidence provides a plausible range of dates when the origin of life could have occurred.

b. There are several models about the origin of life on Earth—
   i. Primitive Earth provided inorganic precursors from which organic molecules could have been synthesized because of the presence of available free energy and the absence of a significant quantity of atmospheric oxygen (O_2).
   ii. Organic molecules could have been transported to Earth by a meteorite or other celestial event.

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SUGGESTED SKILL

Questions and Methods

3.B

State the null or alternative hypotheses, or predict the results of an experiment.

AVAILABLE RESOURCES

- Classroom Resources > **Evolution and Change**

SUGGESTED SKILLS

Statistical Tests and Data Analysis

5.D.a
Use data to evaluate a hypothesis (or prediction), including rejecting or failing to reject the null hypothesis.

5.D.b
Use data to evaluate a hypothesis (or prediction), including supporting or refuting the alternative hypothesis.

ILLUSTRATIVE EXAMPLES

SYI-2.A.2
- Kudzu
- Zebra mussels

SYI-2.B.2.a
- Dutch elm disease
- Potato blight

SYI-2.B.2.b
- Global climate change
- Logging
- Urbanization
- Mono-cropping

SYI-2.C.1
- El Niño
- Continental drift
- Meteor impact on dinosaurs

TOPIC 8.7
Disruptions to Ecosystems

Required Course Content

ENDURING UNDERSTANDING

EVO-1
Evolution is characterized by change in the genetic make-up of a population over time and is supported by multiple lines of evidence.

LEARNING OBJECTIVE

EVO-1.O
Explain the interaction between the environment and random or preexisting variations in populations.

ESSENTIAL KNOWLEDGE

EVO-1.O.1
An adaptation is a genetic variation that is favored by selection and is manifested as a trait that provides an advantage to an organism in a particular environment.

EVO-1.O.2
Mutations are random and are not directed by specific environmental pressures.

ENDURING UNDERSTANDING

SYI-2
Competition and cooperation are important aspects of biological systems.

LEARNING OBJECTIVE

SYI-2.A
Explain how invasive species affect ecosystem dynamics.

ESSENTIAL KNOWLEDGE

SYI-2.A.1
The intentional or unintentional introduction of an invasive species can allow the species to exploit a new niche free of predators or competitors or to outcompete other organisms for resources.

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