AP® Biology
2011 Scoring Guidelines
Form B

The College Board

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the College Board is composed of more than 5,700 schools, colleges, universities and other educational organizations. Each year, the College Board serves seven million students and their parents, 23,000 high schools, and 3,800 colleges through major programs and services in college readiness, college admission, guidance, assessment, financial aid and enrollment. Among its widely recognized programs are the SAT®, the PSAT/NMSQT®, the Advanced Placement Program® (AP®), SpringBoard® and ACCUPLACER®. The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities and concerns.

Visit the College Board on the Web: www.collegeboard.org.
AP Central is the official online home for the AP Program: apcentral.collegeboard.com.

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 1

The cell cycle is fundamental to the reproduction of eukaryotic cells.

(a) **Describe** the phases of the cell cycle.
(6 points maximum)

Correct order of cycle phases (1 point for entire correct list)

Interphase → Prophase → (Prometaphase) → Metaphase → Anaphase → Telophase → Cytokinesis

OR

$G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

Correct description of at least one important structural or molecular characteristic of each phase (1 point each; 5 points maximum)

- Interphase (including, if specified, G_1, S, G_2 subphases, correctly ordered): Chromatin dispersed in nucleus; nuclear envelope and nucleoli are intact and functional; DNA is replicated here.
- G1, G2: Cell growth.
- S: DNA replication.
- Mitosis: Nuclear division.
- Prophase: Chromosomes begin to condense from chromatin; spindle apparatus assembled.
- (Prometaphase): Nuclear envelope disperses, nucleoli disperse, chromosomes connect to spindle apparatus fibers and begin to show motility.
- Metaphase: Chromosomes reach maximum condensation and align on metaphase plate/plane.
- Anaphase: Two-chromatid chromosomes split into two daughter (one-chromatid) chromosomes; chromosomes move to opposite poles of the spindle apparatus.
- Telophase: Chromosomes disperse back to chromatin form, nuclear envelope reassembles, nucleoli reassemble.
- Cytokinesis: If this occurs, it is normally coordinated with telophase; cell division.

(b) **Explain** the role of THREE of the following in mitosis or cytokinesis.
(*3 points maximum*)

- Kinetochores
- Microtubules
- Motor proteins
- Actin filaments

Correct explanation of function (1 point each; if all four are chosen, only the first three are scored)

- Kinetochores: Located in centromeres of condensed chromosomes; microtubule attachment sites necessary for chromosome positioning and movement.
- Microtubules: Fundamental structural element of the spindle apparatus; framework on which chromosome motility is generated; define axis of division and cytokinesis.
- Motor proteins (correct location and function must be specified): In kinetochores, move chromosomes during mitosis, including anaphase separation; involves kinesins and dyneins.
  OR
  In animal cell cleavage furrow, generate force to pinch cell in two; involves myosins.
- Actin filaments: Assemble under the membrane at the cytokinesis site; interact with myosin motor proteins to generate force to pinch cell in two; also interact with astral microtubules of the spindle to position the spindle apparatus in the cell.

Question 1 (continued)

(c) **Describe** how the cell cycle is regulated and **discuss** ONE consequence of abnormal regulation. (*3 points maximum*)

Regulation: Correct description of checkpoints, which block cell cycle progress unless specific molecular and/or physical conditions are satisfied (1 point each; 2 points maximum)

- Action of MPF and CDKs in checkpoint regulation
- Contact inhibition of mitosis
- Hormones; growth factor control of cell cycle activity

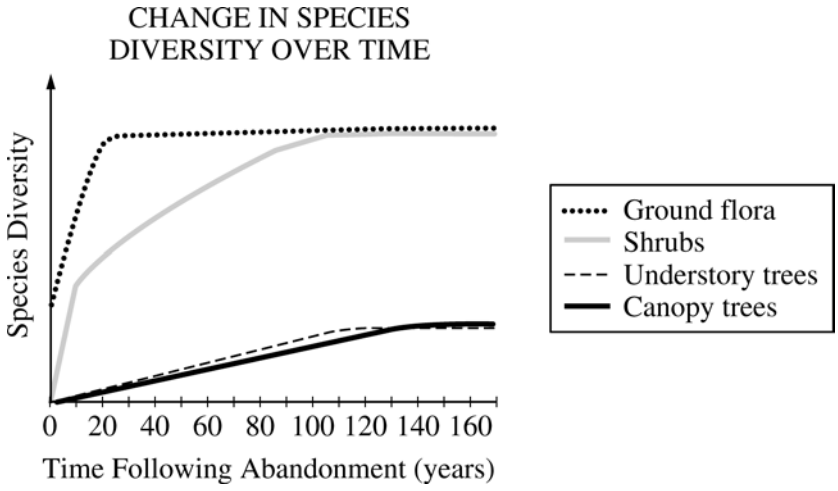
Correct discussion of the consequences of abnormal cell cycle regulation (1 point maximum)

- Uncontrolled cell proliferation, as in cancer
- Apoptosis
- Non-disjunction/aneuploidy/broken chromosomes from abnormal spindle events

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 2

Ecological succession describes the pattern of changes in communities over time. The graph below shows changes in plant diversity following the abandonment of an agricultural field in a temperate biome.



(a) **Discuss** the differences in plant diversity shown in the graph and **explain** how the changes affect the animal species composition between years 0 and 120.
(*4 points maximum*)

Discussion of differences in diversity shown in the graph (2 points maximum)

- Differences in the amount of diversity
  - More diversity in ground flora and shrubs
  - Less diversity in understory and canopy
- Differences in the rate of change in diversity
  - Rapid change in ground flora and shrubs
  - Slow change in understory and canopy
- Differences in the rate to community stabilization
  - Faster for ground flora
  - Slower for understory and canopy

Explanation of effect on animal species composition (2 points maximum)

- Pioneer community consists of small herbivores, insects, and other small, ground-dwelling animals.
- Climax community consists of insects, birds, and mammals and is multilayered.

(b) **Identify** TWO biotic and TWO abiotic factors and **discuss** how each could influence the pattern of ecological succession.
(*4 points maximum*)

Examples of biotic factors (1 point for each identification and 1 point for each appropriate discussion of its influence on succession; 2 points maximum)

- Competition
- Predation
- Herbivory

Question 2 (continued)

- Disease
- Parasitism
- Seed dispersal
- Nitrogen fixation
- Reproductive strategy
- Human impact

Examples of abiotic factors (1 point for each identification and 1 point for each appropriate discussion of its influence on succession; 2 points maximum)

- Climate
- Rainfall
- Light
- Wind
- Temperature
- Soil composition
- Fire
- Drought
- Altitude
- Geographic location

(c) **Design** a controlled experiment to determine how the diversity of plant species in a newly abandoned field would be affected by large herbivores.
(*4 points maximum*)

Experiment design (1 point each)

- Identify the independent variable and how it is manipulated.
- Identify the dependent variable and how it is measured (e.g., "count number of species"; not "observe diversity").
- Discuss variables to be held constant (at least three; one can be "divide the field in half").
- Identify the control (e.g., no herbivores).
- Verification and replication (e.g., large plot or many plots).
- Hypothesis or testable prediction related to species diversity.

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 3

Invasive species, such as red fire ants, introduced into an ecosystem often threaten native plants and animals.

(a) **Describe** THREE different factors that contribute to the success of invasive species in an ecosystem. *(3 points maximum)*

Factors that contribute to the success of invasive species (1 point each)

- No natural predators, parasites, pathogens.
- Effective aggressive mechanism of invasive organism.
- No limitation on resources.
- No environmental inhibitors (e.g., pollutants).
- R-selected species; increased season for reproduction; large or logarithmic populations.
- Variation in phenotype of large population.
- Available niche not occupied by any other species, hence no successful competitors.
- Prey lack effective defense mechanism against introduced species.
- Appropriate environmental conditions (e.g., rainfall, temperature).

(b) **Discuss** THREE ways that an invasive species can affect its new ecosystem. (*3 points maximum*)

Ways that an invasive species can affect its new ecosystem (1 point each)

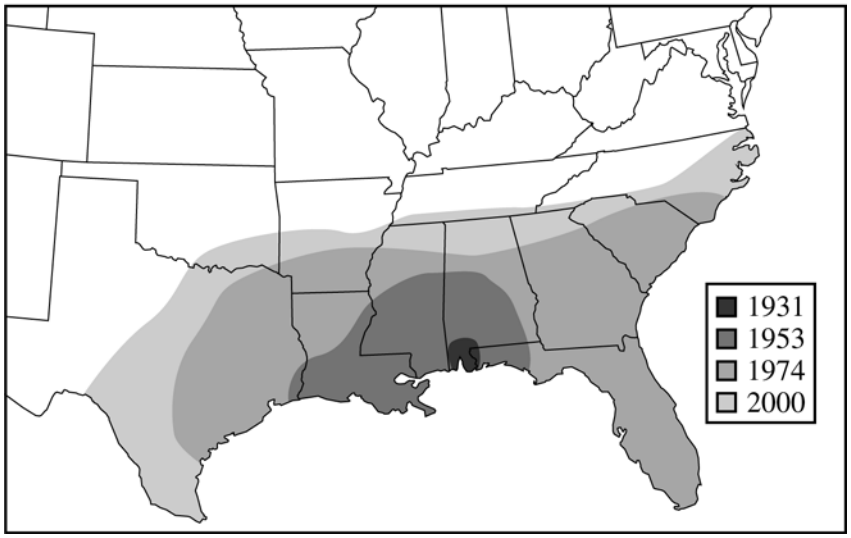
- Eliminates or decreases competitive species, thus decreasing biodiversity.
- Gause's Law of Competitive Exclusion.
- Decreases resources available for other species (food, shelter, reproductive space).
- Changes habitat (adds toxins; overpopulation).
- Addition of invasive species to unoccupied niche, thus increasing biodiversity.
- Introduction of parasitic microorganism living in the invasive species into native population.
- Resource partitioning.

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 3 (continued)

(c) The map indicates the spread of the red fire ant after its initial entrance into the United States at the port of Mobile, Alabama, in the 1930s. **Discuss** TWO environmental factors that might have determined the pattern of fire ant invasion.
(2 points maximum)

FIRST REPORTED OCCURRENCE OF RED IMPORTED FIRE ANT, *SOLENOPSIS INVICTA*



Environmental factors that might have determined the pattern of fire ant invasion (1 point each)

- Temperature: Warm temperatures (lack of freezing), as found in southeastern United States.
- Rainfall/humidity: Adequate moisture, as found in southeastern United States.
- Appropriate soil composition for nest building.
- Available space and unlimited resources.
- Habitat limitation: Salt water on southern and eastern coasts.

(d) **Discuss** TWO possible methods of eradicating or slowing the spread of these ants, including the environmental consequences of each method.
(2 points maximum)

Response must include both methods and consequences.

Methods (1 point)	**AND Consequences (1 point)**
Introduce sterile males or females	May lead to increase in population size of other species; opening of new niche.
Pesticide	Toxic to other organisms or the environment; pesticide-resistant strain increases.
Introduce predator	Long-term effects (positive or negative) on other species when fire ant population decreases.
Introduce infectious agent	Effects of infectious agent on other species.
Eliminate food source or preferred habitat	Effects on other species.

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 4

Phylogeny reflects the evolutionary history of organisms.

(a) **Discuss** TWO mechanisms of speciation that lead to the development of separate species from a common ancestor.
(2 points maximum)

Mechanisms that lead to the development of separate species from a common ancestor (1 point each)

- Geographic isolation (or allopatric speciation) takes place when a population of one species becomes physically separated by some geographic barrier such as a river, mountain range, etc. Long-term isolation of two populations eventually leads to reproductive isolation.
- Sympatric speciation happens when new species arise as a result of reproductive isolation within the population range — for example, because of polyploidy or switching mating behaviors (fruit flies going from hawthorn to apple to lay eggs). Eventually the two populations are unable to interbreed.
- Reproductive isolation by prezygotic barriers, such as habitat, temporal, behavioral, mechanical, or gametic incompatibility.
- Reproductive isolation by postzygotic barriers (e.g., reduced hybrid viability or fertility) leads to speciation.

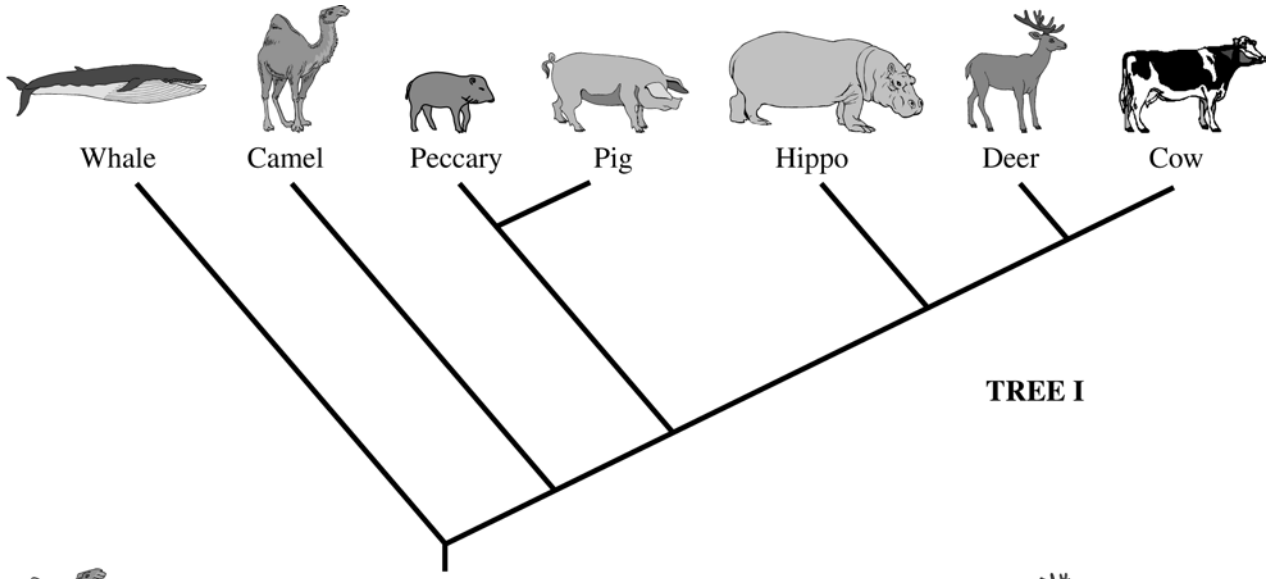
(b) **Explain** THREE methods that have been used to investigate the phylogeny of organisms. **Describe** a strength or weakness of each method.
(6 points maximum)

Response earns 1 point for each method explained and 1 point for either a strength *OR* a weakness.

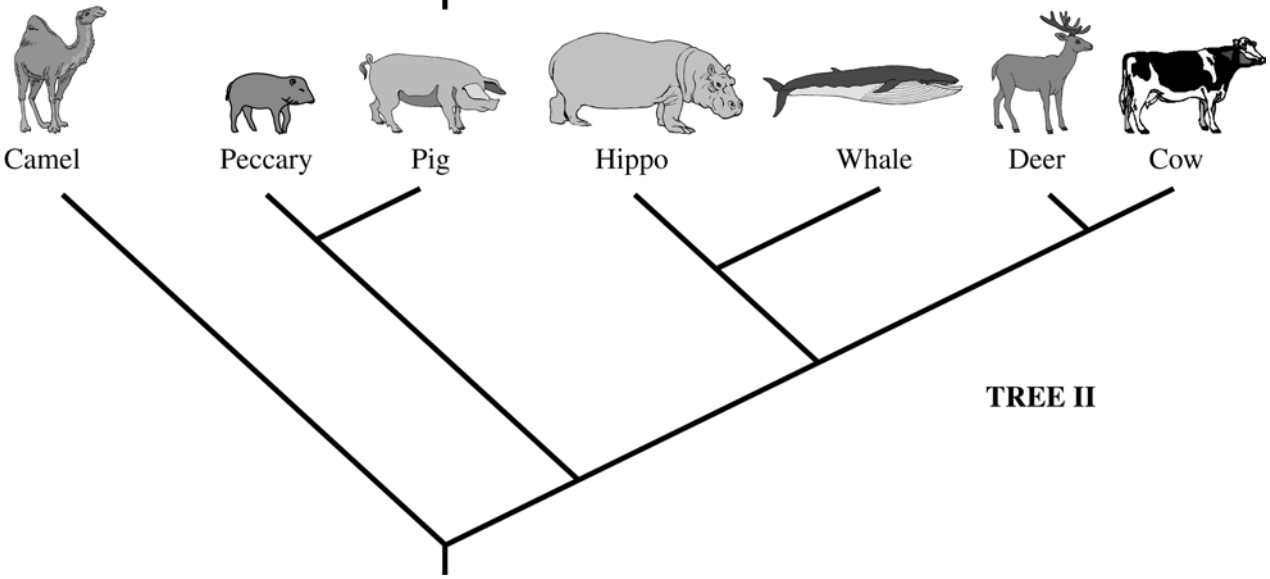
Methods (1 point)	**AND Strengths (1 point)**	**OR Weaknesses (1 point)**
Fossils (paleontology)	Determine time; reveal extinct species.	Not all species leave fossils. Fossil record is incomplete.
Anatomy/morphology	Homologous structures indicate evolutionary relationships.	Analogous structures. Some taxa have little diversity (e.g., bacteria). Some morphology reflects environment or diet.
Embryology/development	Reveals similarities in structures and patterns of development that are not evident in adults.	Similarities between species may be lost in later development.
Molecular traits (amino acid sequence in proteins or base sequence in DNA)	Large numbers of traits. Allow study of evolution between closely related species. Most accurate.	No (or little) data for extinct species. Variation within species blurs differences between species.
Behavioral traits	Some behaviors are genetic (e.g., frog calls).	Behavior maybe culturally transmitted or learned (e.g., bird calls).

Question 4 (continued)

(c) The two phylogenetic trees represent the relationship of whales to six other mammals. All of the organisms shown have a pulley-shaped astragalus bone in the ankle except for the whale.



TREE I



TREE II

AP® BIOLOGY
2011 SCORING GUIDELINES (Form B)

Question 4 (continued)

DATA ON PRESENCE OF SPECIFIC DNA SEQUENCES

+ sequence present
– sequence absent
? undetermined

Locus	1	2	3	4	5	6	7	8	9	10	11	12	13
Cow	–	–	–	–	–	+	+	+	+	+	+	+	–
Deer	–	–	–	–	–	+	?	+	+	+	+	+	–
Whale	+	+	+	+	+	–	?	+	+	–	?	+	–
Hippo	?	–	+	+	+	–	+	+	+	–	?	+	–
Pig	–	–	?	–	–	–	?	–	?	–	–	+	+
Peccary	?	?	?	?	?	?	?	?	?	?	?	?	+
Camel	–	–	–	–	–	–	–	–	–	–	–	–	–

- For each tree, **describe** a monophyletic group, the closest relative to the whale, and the point at which the pulley astragalus was lost or gained.
  (3 points maximum)

  - Correctly identifying a monophyletic group in *BOTH* Tree I and II (a number of correct possibilities) or correctly defining a monophyletic group as a species and all of its descendants. **(1 point)**
  - Correctly identifying the camel as the closest relative to the whale in Tree I *AND* the hippo in Tree II. **(1 point)**
  - Stating that the gain of the pulley astragalus bone in Tree I occurs between the whale and the camel, *OR* that the loss of the bone occurs on the line to whales, *AND* that the loss of the pulley astragalus bone in Tree II occurs between the common ancestor of the hippo and the whale. **(1 point)**

- Based on the principle of parsimony (the simplest explanation is the best) and the genomic information in the table shown, **identify** which tree is the best representation of the evolutionary relationship of these animals, and **justify** your answer.
  (1 point maximum)

Identification of correct tree	**Justifications include but are not limited to**
Tree II	• The camel is the out-group, with none of the 13 sequences. • The peccary and pig have the fewest sequences, but they are similar. • The deer and cow share the same half of the 13 sequences. • The whale and hippo have a similar pattern of DNA sequences.

Note: No point is earned for using the pulley astragalus bone to justify Tree II, nor for discussing common environments, body shapes, or feeding habits.