CollegeBoard
Advanced Placement Program

AP® Biology
2004 Scoring Guidelines

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Question 1

(a) **Explain** how the reduction and rearrangement are accomplished in meiosis.
(5 points maximum)

REDUCTION
1 point: **(homologous) chromosomes pair, then separate** and move to opposite poles during 1st meiotic division
1 point: **chromatids separate** during 2nd meiotic division

1 point: two rounds of cell (nuclear) division but only one replication of the chromosomes
OR

REARRANGEMENT
1 point: **crossing over** (in proper context)
1 point: **random alignment (independent assortment)** of tetrads
1 point: **elaboration (e.g.: correct mechanism/description or consequences** of one of the above) *

*NOTE: Diagrams that are clearly labeled and are described in the essay portion are acceptable and may receive a point

(b) Several human disorders occur as a result of defects in the meiotic process. **Identify** ONE such chromosomal abnormality; what effects does it have on the phenotype of people with the disorder? **Describe** how this abnormality could result from a defect in meiosis.
(4 points maximum)

CHROMOSOMAL ABNORMALITY
1 point: **Identify** one condition by name or description (e.g.: Down or trisomy 21; Turner or XO; fragile X; cri-du-chat or 5p-; etc.)
1 point: **Phenotype** of the example given above

DESCRIBE
1 point: **Name or identify the meiotic event** (e.g.: nondisjunction, unequal crossing over, inversion, mispairing)
1 point: **Description** of the meiotic event *

(c) Production of offspring by parthenogenesis or cloning bypasses the typical meiotic process. **Describe** either parthenogenesis or cloning and **compare** the genomes of the offspring with those of the parents.
(3 points maximum)

CLONING OR PARTHENOGENESIS
1 point: **Definition**
- **Parthenogenesis**: development of an unfertilized egg into an adult; often the adult is haploid

OR

- **Cloning**: using a somatic cell or cells from a multicellular organism to make one or more genetically identical individuals (or inducing a diploid body cell of an organism to revert to its embryonic state and then develop into a complete adult organism without fertilization)

1 point: **Description** of an example or the process in a plant or animal (parthenogenesis is rare in plants)
1 point: **Comparison** of the genomes of offspring and parents (e.g. identical for cloning)

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Question 2

(a) For EACH of the four contributions listed below, **discuss** one example of supporting evidence.
(2 points each; 8 points maximum)

Contributions	*Possible Examples of Evidence (1 point)*	*Explanation/Understanding of Phrase (1 point)*
The nonconstancy of species	♦ Must demonstrate variation ◊ Finches, horses, dogs, whales, peppered moths, etc.…	♦ Individual variation within a species/population (can be phenotypic or genotypic) ♦ Change within species over time (not change in an individual) ♦ Change in number of species over time
Branching evolution, which implies the common descent of all species	♦ Must demonstrate common ancestry ◊ Homology (embryological, structural, molecular, processes) ◊ Vestigial structure from common ancestor ◊ Hominoids, finches, etc…	♦ Shared or common ancestor ♦ Adaptive radiation concept (divergent evolution, one species becomes 2 or more)
Occurrence of gradual changes in species	♦ Must demonstrate change over time (generations) ◊ Vestigial structures (pelvic bones, appendix) ◊ Fossil sequence ◊ Coat color changes ◊ Giraffes' necks ◊ Antibiotic/pesticide resistance	♦ Small changes over time / slow rate of change/incremental ♦ Genes mutate → selection occurs → populations evolve ♦ Accumulation of genetic/phenotypic changes
Natural selection as the mechanism for evolution	♦ Must demonstrate an appropriate natural selection effect ◊ Antibiotics/pesticide resistance ◊ Finches, moths, etc… ◊ Predator/prey relationships	♦ Differential reproductive success ♦ Survivors pass genes to next generation ♦ No Lamarckian language (want, need…) ♦ No "survival of fittest" alone

Note:
Examples in context may earn 2 points.
Possible examples are not limited to the listings above.
An example alone, without the context of the phrase = no points.

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Question 2 (cont'd.)

(b) **Discuss** how TWO of the following have modified biologists' interpretation of Darwin's original contributions.
(3 points each; 6 points maximum)

	Definition/Explanation of the Idea (1 point)	*Description of How It Has Enhanced/Modified Interpretation of Evolution (1 point)* * Direct mention of Darwin's view is not necessary for points.	*Depth of Discussion /Expansion Point (1 point)* ♦ Discuss evidence ♦ Deeper description of the theory ♦ Describe applicable technology
Hardy-Weinberg Equilibrium	♦ Allele (gene) frequency remains constant over time ♦ Under certain conditions no evolution occurs	♦ D - Ongoing gradual change HW - Constant allele ratio (must refer to alleles or genes) *Hardy-Weinberg equation without explanation of variables within equation = no points	Examples: ♦ Five conditions of Hardy-Weinberg Equilibrium cited correctly (*need all 5*) o Very large population size - no drift o No movement in or out of a population o No net mutations o Random mating - no sexual selection o No natural selection Hardy-Weinberg as a null hypothesis for determining cause of change
Punctuated Equilibrium	♦ Sudden changes in tempo ♦ Long period of stasis then sudden change	♦ D - Gradual change PE - Possible rapid change	Examples: ♦ A graph of punctuated evolution vs. Darwinian evolution ♦ Discussion of fossil record reflecting a punctuated equilibrium pattern
Genetic Engineering	♦ Manipulation and/or alteration of genes/DNA ♦ Others related to biotechnology	♦ D - Natural gene transfer GE - human directed gene transfer ♦ D-Gradual change GE - rapid change ♦ DNA analysis allows genomic comparisons	Examples: ♦ Cloning process expressed ♦ RFLP analysis explained ♦ Universality of genetic code

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Question 3

(a) On the axes provided, **construct** and **label** a graph showing the results for the three samples.
(1point each; 3-point maximum)

- Orientation of axes is correct: x-axis is time/minutes, y-axis is light transmittance/%
- Data are plotted correctly (one misplaced data point is permissible)
- Graph is accurate: must include proper scaling and correct labels and units of measurement and key

(b) Identify and explain the control or controls for this experiment.
(1 point each; 3-point maximum)

- Sample 1 is the control
- Sample 1 is in the light and has permissive temperature/functional structures (membranes, proteins, enzymes, etc.)
- Control is the basis for comparison to treatment effects (can award even if wrong sample was identified as the experimental control)
- Reliability of data/design: identical procedures, reagents, measurements, adequate sample size (must identify at least two)

(b) **Discuss** how electrons are generated in photosynthesis and why the three samples gave different transmittance results.
(1 point each; 6-point maximum)

- Chlorophyll (photosystem, reaction- or photo- center; "chloroplast" alone is not sufficient) is the link between light (photons) and the generation of electrons
- Water is the source of electrons (photolysis, oxidation, splitting)
- Electron generation, not simply photosynthesis, is proportional to DPIP reduction light transmittance
- Decreasing light availability decreases the quantity of electrons that will be generated, and/or vice versa
- Boiling disrupts functional structures (membranes, denaturation of proteins/enzymes, etc.; "chloroplast" alone is not sufficient)

Elaboration (1 point only)
photosystem II and/or I/Z-scheme
data analysis

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Question 4

(a) **Identify** the participants involved in the symbiosis and describe the symbiotic relationship, and

(b) **Discuss** the specific benefit or detriment, if any, that each participant receives from the relationship.

1 point maximum is awarded for a correct pair of participants involved in each example given.
Participants must be organisms.
1 point maximum is awarded for describing a correct symbiotic relationship to each example.
1 point maximum is awarded for discussing how **each** participant is involved in a specific benefit or detriment from the relationship.
Wrong participants: NO points for participants, relationship, or discussion.
Nonspecific participants: 2 points maximum for relationship and discussion.
1 point maximum for elaborating on any **one** of the four choices used. 10 points awarded only if 4 choices attempted.

Example of Symbiotic Relationship	***Participants Involved***	***Relationship Involved***	***Discussion on Each Participant***
Plant root nodules	Plants/legumes + *Rhizobium*/bacteria	Mutualism/both organisms benefit	Plants receive nitrogen (not N_2) while bacteria receive CHO's and other nutrients/water and shelter/hospitable environment
Digestion of cellulose	Termites/ruminants + microorganisms (bacteria, protozoa, fungi) Plants + pathogenic bacteria/fungi	Mutualism/both organisms benefit Parasitism/one member is harmed, the other benefits	Host is able to use cellulose as a nutrient (energy source) while symbiont gains food/shelter/hospitable environment Host is infected, bacteria/fungi receives nutrients
Epiphytic plants	Large trees (plants) + epiphyte/bromeliads/ orchids/some mosses/ ferns Epiphyte + ants/frogs/small animals Dodder/mistletoe + plant	Commensalism/one member benefits, the others are not harmed Mutualism/both organisms benefit Parasitism/one member is harmed, the other benefits	Host is not affected or given any benefit. Symbiont has a substrate for anchoring/access to sunlight & pollinators Bromeliads provide water, shelter free of predation to many insect larva, frogs, etc…/a source of nitrogen is given to plant Host has nutrients removed while epiphyte receives nutrients
AIDS	Human + Virus/HIV/retrovirus	Parasitic/one member is harmed, the other benefits	HIV uses host to replicate while host/immune system is harmed or killed
Anthrax	Human/ruminant/ horse/pig + *Bacillus anthracis*/bacteria/spores	Parasitic/one member is harmed, the other benefits	Illness or death to host; bacteria receives nutrients, habitat

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