

**AP<sup>®</sup> BIOLOGY**  
**2008 SCORING GUIDELINES (Form B)**

**Question 4**

4. Scientists use the concept of homology in identifying evolutionary relationships among organisms. Features shared by two groups of organisms are said to be homologous if the similarities reflect shared ancestry. Homology is found in comparisons of structural, molecular, biochemical, developmental, physiological, and behavioral characteristics of organisms. Select **THREE** of the following hypotheses and explain **TWO** examples of homology that support each hypothesis.

**First 3 only (4 points maximum each)**

- (a) Chloroplasts are related to photosynthetic prokaryotes.

**(Identify two: 1 point identification, 1 point explanation for each)**

- DNA circular/nonhistonal
- Photosynthesis process the same
- Ribosomes/size and organization
- Endosymbiotic origin of chloroplasts
- Chlorophyll
- Binary fission for reproduction

- (b) Spiders and insects are closely related.

**(Identify two: 1 point identification, 1 point explanation for each)**

- Exoskeleton
- Jointed appendages
- Tracheal tubes
- Chitin
- Open circulation
- Simple eyes (ommatidia)
- Segmented body
- Ventral NS—paired nerve cord and segmental ganglia
- Malpighian tubules—excretory

- (c) Echinoderms (sea stars and their relatives) are closely related to the chordates (the phylum that includes vertebrates).

**(Identify two: 1 point identification, 1 point explanation for each)**

- Deuterostome difference (blastopore forms anus)
- Cleavage pattern (radial) and gastrula structures similar
- DNA sequencing
- Coelomates—body cavity
- Bilateral larvae
- Indeterminant development

- (d) Reptiles and birds are closely related.

**(Identify two: 1 point identification, 1 point explanation for each)**

- Embryology
- Amniotic/cleidoic egg (not just “egg”)
- Dinosaur/ skeletal structure
- Scales or scales → feathers
- Similar brain structures
- Uric acid

- (e) Humans and chimpanzees are closely related primates.

**(Identify two: 1 point identification, 1 point explanation for each)**

- DNA sequencing
- Thumbs (not just “hands”)
- Brain structure
- Tool making/culture—other specific behaviors
- Chromosome banding pattern
- Protein structural similarity/ conservation—e.g., cytochrome c
- Skeletal similarities—e.g., no external tail, stereoscopic vision

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- (a) Chloroplasts are related to photosynthetic prokaryotes.
  - (b) Spiders and insects are closely related.
  - (c) Echinoderms (sea stars and their relatives) are closely related to the chordates (the phylum that includes vertebrates).
  - (d) Reptiles and birds are closely related.
  - (e) Humans and chimpanzees are closely related primates.

c) Echinoderms and chordates, which are both deuterostomes, share deuterostome characteristics which are ~~the~~ developmental characteristics. The embryos of both Echinoderms and chordates exhibit radial symmetry during ~~the~~ cleavage after fertilization, which is an embryonic homology which is a shared derived characteristic of deuterostomes. Also, the embryos of the two are indeterminate during early stages of development, meaning a splitting of the embryo can result in two organisms that are genetically identical.

d) Reptiles and birds show both developmental and physiological homologies which give evidence to the fact that reptiles are ancestors of birds. As amniotes, both reptiles and birds lay amniotic egg which prevent desiccation of embryos and allow development outside the female's body. The amniotic egg allows gas exchange, storage of waste, and supplying of

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nutrients to the embryo. Also, as tetrapods, birds and reptiles both have four limbs with homologous bone structure. The fact that the bones in limbs of birds and reptiles are homologous suggest that the two have had similar ancestors.

e) Humans and chimpanzees are very closely related, which is shown by both physiological and molecular homologies. Both primates have extremely dexterous fingers and opposable thumbs, a physiological homologies which shows their closeness in evolutionary relationship. The DNA of the two primates exhibit over 98% similarity, molecular evidence that speciation of the two primates occurred relatively recently and have very close ~~ancestors~~ ancestors.

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  - Humans and chimpanzees are closely related primates.

B) As you go down in classifications spiders and insects are closely related in terms of structure and physiology. Structure ~~was~~ wise, they both share the segmented body (although the spider can produce its web) and jointed legs. ~~Physiologically~~ ~~the~~ ~~Behaviorally~~ ~~they act~~ ~~the~~ ~~same~~ although spiders don't build

E) Humans are the most closely related to primates and the most compelling evidence is found in the DNA. If we look at our DNA combinations, they are extremely close giving evidence that there is something that might of caused a mutation and it brought us great minds such as ~~the~~ Sir Issac Newton. ~~same~~ This has been debated on so many times though. Structurally speaking, we all share the same systems. Lymphatic, respiratory, cardiac, all of them and this is due to the ~~the~~ information on the DNA. Both function in the same way (homologous structures).

A) Both being <sup>homologous</sup> ~~analogous~~ structures, they absorb light to perform photosynthesis to attain energy. The chloroplast

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(a) Chloroplasts are related to photosynthetic prokaryotes.

According to endosymbiotic theory, the chloroplast and mitochondria are believed to be separate photosynthetic prokaryotes that were engulfed. As the evidence of this hypothesis, chloroplasts have their own DNA that is different from that of plants. Also, chloroplasts replicate on their own, not by the ~~the~~ leaves' replication.

(d) Reptiles and birds are closely related. When seen in the structural model, both reptiles and birds have similar circulatory systems. Also, both reptiles and birds lay eggs as a way of reproducing. These similarities show that reptiles and birds are closely related.

(e) Humans and chimpanzees are closely related primates. When seen in the genetic level, the chromosome of human and chimpanzee only differ by few chromosomes. Also, the human beings and chimpanzees both have warm-blooded traits; two ventricles and two atria in heart, and bear babies. These similarities show how closely related primates human being and chimpanzees are.

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**AP<sup>®</sup> BIOLOGY**  
**2008 SCORING COMMENTARY (Form B)**

**Question 4**

**Sample: 4A**

**Score: 10**

In part (c), the echinoderm to chordate comparison, the student correctly identifies that both groups are deuterostomes (1 point) and explains the associated type of cleavage (1 point). The student further identifies that embryo development in both groups is “indeterminate” (1 point) and that the “splitting of the embryo can result in two organisms that are genetically identical” (1 point).

In part (d), the reptile to bird comparison, the student identifies that “both . . . lay amniotic egg[s]” (1 point) and provides an explanation of the role of the amniotic egg in the prevention of “desiccation of [the] embryo” (1 point). While the discussion of reptiles and birds as tetrapods is correct, this homology is not unique and is not included in the scoring guidelines.

In part (e), the human to chimpanzee comparison, the student identifies that both have opposable thumbs (1 point) and as a result are “extremely dexterous” (1 point). The student further identifies that the DNA has a “98% similarity” (1 point) and explains that the high percent shows that “speciation of the two primates occurred relatively recently” (1 point).

**Sample: 4B**

**Score: 5**

In part (b), the comparison between spiders and insects, the student identifies that “both share the segmented body” (1 point) and “jointed legs” (1 point). No explanation is offered for either identification, so no additional points were earned.

In part (e), the human to chimpanzee comparison, the student identifies that the “DNA combinations” between the two “are extremely close” (1 point) and speculates that mutation might have produced human minds such as Sir Isaac Newton (1 point).

In part (a), the chloroplast to photosynthetic prokaryote comparison, the student identifies that both “absorb light to perform photosynthesis” (1 point). The student mentions that the “chloroplast . . . is thought to have been a prokaryotic cell,” but no explanation as to why is given nor is the term endosymbiotic theory mentioned or explained, so no further points were earned.

**Sample: 4C**

**Score: 2**

In part (a), the chloroplast to photosynthetic prokaryote comparison, the student earns 2 identification points. The first is for referencing the endosymbiotic theory and the second is for stating that chloroplasts have their own DNA.

In part (d), the reptile to bird comparison, the student mentions that both “lay eggs.” However, the type of egg (e.g., amniotic) is not indicated, and so no point was earned. In order to earn this point, the student had to clearly identify that the egg was different from that of other animals such as amphibians.

In part (e), the human to chimpanzee comparison, is not unique enough, so no points were earned.