



Natural Selection, Speciation and Classification

Name: _____

Class: _____

1. A leaf insect found in a country park near Tai Po is described as having wings present, a body with three main regions, and antennae that are clubbed. Use the key below.

- 1a. Wings absent ... Species W
- 1b. Wings present ... Go to 2
- 2a. Body with two main regions ... Species X
- 2b. Body with three main regions ... Go to 3
- 3a. Antennae thread-like ... Species Y
- 3b. Antennae clubbed ... Species Z

Which species is it?

- A. Species W
- B. Species X
- C. Species Y
- D. Species Z

2. Which feature is most important when constructing a reliable dichotomous key for rocky-shore molluscs collected near Sai Kung?

- A. Each step offers exactly two clear opposite choices based on observable traits
- B. Each step lists every possible species name at once
- C. Species are ordered by how attractive their shells look
- D. Only soft internal organs seen after full dissection are used

3. A student uses this key on four local stream crabs from the New Territories:

1a. Carapace longer than wide ... Crab J

1b. Carapace wider than long ... Go to 2

2a. Claws of equal size ... Crab K

2b. Claws of unequal size ... Go to 3

3a. Walking legs with dense hairs ... Crab L

3b. Walking legs without dense hairs ... Crab M

Which crab has a carapace wider than long, unequal claws, and walking legs with dense hairs?

A. Crab J

B. Crab K

C. Crab L

D. Crab M

4. The table shows the number of nucleotide differences in a mitochondrial gene between bird species H and four other species.

Species	Nucleotide differences from H
P	14
Q	3
R	21
S	8

Which species shared a common ancestor with species H most recently?

A. Species P

B. Species Q

C. Species R

D. Species S

5. Which of the following would provide the LEAST reliable evidence for determining the phylogenetic relationship between two species of local freshwater fish?

A. Comparison of DNA base sequences

B. Comparison of amino acid sequences of a respiratory protein

C. Comparison of their feeding habits and body colour patterns

D. Comparison of their internal skeletal anatomy

6. The table shows the number of amino acid differences in the protein cytochrome c between species M and four other organisms.

Organism	Amino acid differences
Organism J	1
Organism K	9
Organism L	28
Organism N	4

Which conclusion is most valid from this molecular evidence?

- A. Organism L is the most closely related to species M
- B. Organism K shares a more recent common ancestor with M than organism L does
- C. Organism J is more distantly related to M than organism L is
- D. Species M evolved directly from organism J

7. The scientific names of two local mangroves are *Kandelia obovata* and *Kandelia candel*. What can correctly be concluded?

- A. They belong to different genera but the same species
- B. They belong to the same genus but different species
- C. They must be able to produce fertile hybrid offspring
- D. They are identical organisms given two alternative names

8. In the three-domain system, which statement correctly compares domain Bacteria and domain Eukarya?

- A. Bacteria are always larger than all eukaryotes
- B. Bacteria lack a true nucleus; eukaryotes have a true nucleus
- C. Bacteria always have mitochondria; eukaryotes never do
- D. Bacteria never have cell walls; eukaryotes always do

9. A deep ravine permanently splits a population of snakes on Lantau into two groups that cannot cross. After many thousands of years the groups cannot produce fertile offspring when reunited. Which combination of processes best explains formation of the new species?

- (1) geographic isolation
- (2) accumulation of genetic differences
- (3) natural selection under different local conditions

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

10. On a rocky shore near Shek O, limpets with thicker shells become more common after years of heavy crab predation. According to natural selection, which explanation is most accurate?

- A. Individual limpets grew thicker shells during their lives to escape crabs
- B. Crabs deliberately spared thick-shelled limpets so the population would improve
- C. Limpets with thicker shells already present survived better and passed on their genes
- D. Predation caused every limpet to mutate a thicker shell at the same time

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Answers

1 D

A dichotomous key is followed one couplet at a time using only the stated observable traits.

Wings are present → choose 1b and go to 2.

Body has three main regions → choose 2b and go to 3.

Antennae are clubbed → choose 3b → Species Z.

2 A

A dichotomous key must give exactly two contrasting, mutually exclusive choices at each step, based on features that can be observed on the specimen without destruction.

This single correct path allows reliable identification in the field. Listing many names at once, ranking by colour preference, or relying only on soft internal organs after dissection makes the key impractical or unreliable.

3 C

Carapace wider than long → choose 1b and go to 2.

Unequal claws → choose 2b and go to 3.

Walking legs with dense hairs → choose 3a → Crab L.

Follow each couplet in order; mixing opposite traits or skipping a step gives the wrong name.

4 B

Molecular evidence relies on the idea that mutations accumulate over time. Species that shared a common ancestor more recently have had less time to accumulate differences.

Q has only 3 differences – the smallest number – so Q is most closely related to H and shared a common ancestor most recently. Larger counts (S, P, R) indicate more distant relationships.

5 C

Phylogenetic relationships are best inferred from evidence that reflects shared genetic history.

DNA sequences, amino acid sequences of conserved proteins, and homologous internal structures all track common ancestry well.

Feeding habits and surface colour patterns are least reliable because unrelated species can evolve similar habits or colours when they occupy similar ecological niches (convergent evolution), and related species can diverge quickly in these traits.

6 B

Fewer amino acid differences mean a closer phylogenetic relationship and a more recent common ancestor.

J (1 difference) is closer to M than K (9) or L (28). N (4) is closer to M than K. Therefore organism K shares a more recent common ancestor with M than organism L does, because 9 is much smaller than 28.

Molecular similarity does not mean one organism evolved directly from another living species listed in the table.

7 B

m

In binomial nomenclature the first word is the genus and the second is the species epithet.

Both names begin with *Kandelia*, so the plants belong to the same genus but are different species because the second words differ. Sharing a genus does not mean they are the same species or that they must produce fertile hybrids.

8 B

Members of domain Bacteria are prokaryotes: they lack a true nucleus and membrane-bound organelles.

Members of domain Eukarya have a true nucleus and organelles such as mitochondria. Absolute claims about size, walls always present or absent, or mitochondria in all bacteria are incorrect.

9 D

Geographic isolation stops gene flow between the groups.

Mutation and recombination create genetic variation; different habitats then favour different traits by natural selection.

Over time genetic differences become great enough for reproductive isolation. All three processes are involved in this allopatric speciation.

10 C

Natural selection acts on existing heritable variation. Some limpets already had thicker shells.

Crabs act as the selective agent: thin-shelled limpets are eaten more often, so thick-shelled limpets survive and reproduce more. Their offspring inherit the tendency for thicker shells. Individuals do not thicken their shells by will, and predation does not force every limpet to mutate at once.