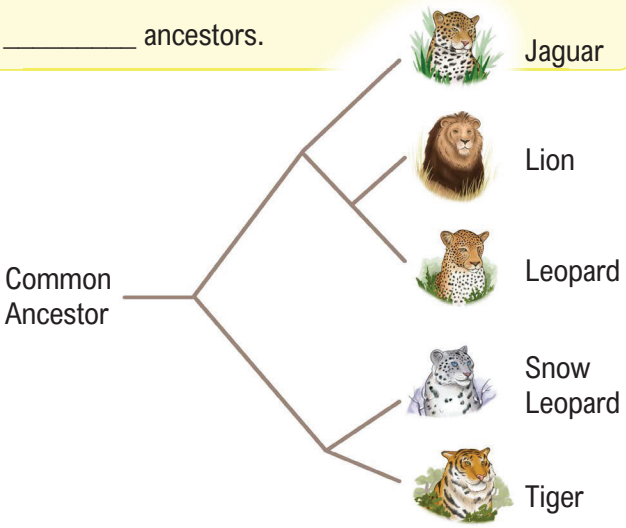
## TOPIC: INTRODUCTION TO EVOLUTION AND NATURAL SELECTION

### Evolution and Natural Selection

**Evolution:** gradual change of a _____ through time.

*"Descent with modification"*

- **Common Descent:** species alive today share _____ ancestors.




**Natural Selection:** _____ of how & why populations *evolve*.

- Traits that help individuals survive & _____ become more common.

  *"Survival of the _____"*

- **Fitness:** likelihood that an individual contributes _____ to next generation.

◆ Natural selection leads to _____.

- **Adaptation:** a _____ that makes an organism well-suited to its environment.

## EXAMPLE

Evolution and natural selection are related concepts and can be difficult to separate completely. Read the following statements and decide whether the statement is more directly related to the concept of evolution or the concept of natural selection. For concepts relating to natural selection, write "NS"; for those relating to evolution, write an "E".

____ A caterpillar that is camouflaged is more likely to reproduce because it is less likely to be eaten by a bird.

____ The closest living relatives of birds are alligators and crocodiles. Therefore, we expect birds to share many traits with reptiles.

____ Fossil data indicates that the early ancestors of modern horses were less than ½ a meter tall, and a trend in horse evolution is that horse ancestors got larger over time.

____ When thinking of fitness, attracting mates can be just as important as surviving.

____ Dandelion seeds are able to travel great distances in the wind. The dandelions whose seeds travel the farthest have the best chance of spreading their offspring widely.

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### PRACTICE

Explain the relationship between natural selection and evolution.

a) Evolution is an explanation for how natural selection happens.

b) Evolution and natural selection explain the same phenomena but use different timescales.

c) Evolution explains how life begins, while natural selection explains how life changes.

d) Natural selection is an explanation for how evolution happens.

### PRACTICE

Which organism will have the highest fitness?

a) Organism A lives for 1 year, is relatively large, and produces 1 offspring.

b) Organism B lives for 5 years, is relatively small, and produces 1 offspring.

c) Organism C lives for 1 year, is relatively small, and produces 3 offspring.

d) Organism D lives for 3 years, is medium-sized, and produces 2 offspring.

### PRACTICE

Which statement would be supported by the concept of common descent?

a) Adaptations allow species to survive well in the environments in which they live.

b) Many similarities between species exist because they were inherited from the same ancestor.

c) Organisms that reproduce the most are considered to be the most fit in an evolutionary context.

d) Species change over time in response to environmental pressures.

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### Typological vs. Population Thinking

**Typological:** one _____ to which we compare (from_____).

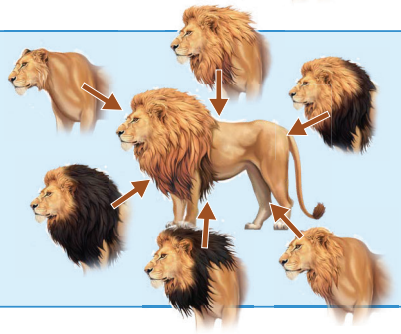
- Variation is _____ from the ideal.
- A species' description:

  A) is _____ over time & B) does not include its diversity.

**Population:** _____ from all individuals is important.

- What is average/typical depends on the _____.
- A species' description:

  A) will change over time & B) includes its _____.



◆ To understand evolution and natural selection, use _____ thinking.

**EXAMPLE**

Modern biologists agree that species are not fixed entities, but sometimes typological ways of speaking and describing organisms are used. Of the following statements, mark those that you think are more aligned with typological thinking with a "T". Mark those that you think are more aligned with population thinking with a "P".

___ Normal height for a human female is 5 ft 5 in.

___ Mature white oak trees often live for more than 200 years with rare examples living more than 400 years.

___ The eastern gray squirrel is a rodent with uniform gray fur weighing between 400 and 600 g.

___ A jaguar or leopard with abnormally dark coloration is called a "black panther".

___ The mean length of a birch tree leaf is 7± 2.5 cm.

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### PRACTICE

What is one reason population thinking is so important in biology?

a) Population thinking requires scientists to consider the full variation that is present in nature.
b) Population thinking allows for fast and accurate species identification.
c) Population thinking makes identifying abnormalities and diseases more straightforward.
d) Population thinking simplifies making comparisons between different species.

### PRACTICE

Dog breeds are defined by denoting breed standards, a list of agreed-upon traits that individuals of that breed should possess (such as size, coat, coloring, temperament, etc.). Dog shows rank dogs based on their adherence to these breed standards. Based on this information, which statement about dog breeds below is correct?

a) Breed standards describe many different traits; because many traits are considered, this reflects population thinking.
b) Because there are many breeds of dogs, dog breeds reflect population thinking.
c) Dog breeds reflect typological thinking because through breeding, humans control what traits a dog inherits.
d) Breed standards use an idealized form to which dogs are compared; this reflects typological thinking.

## TOPIC: INTRODUCTION TO EVOLUTION AND NATURAL SELECTION

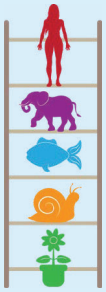
### Ladder vs. Tree Thinking

◆ Historically: hierarchy of _____. Today: evolutionary _____.

**Ladder Thinking:** _____ of species.

◆ Aristotle: species were _____ and had different levels of _____.

- Created *Scala Naturae* (Great Chain of Being): ordered species from low complexity (_____) to high complexity (_____).

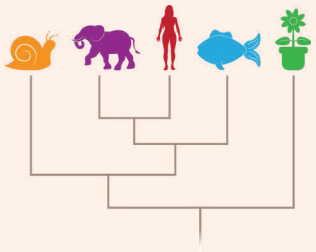


**Tree Thinking:** species _____ through common descent.

◆ Focus is on species _____.

◆ All populations have been evolving for the same amount of _____.

◆ _____ evolutionary histories explain species' variation.



**EXAMPLE**

Match the statements on the left with the type of thinking that they best represent on the right. Some statements may match to more than one type of thinking.

a) Species are unchanging.

b) Humans are the most complex organism.

c) Species can change over time.

d) Common ancestry can explain similarities between organisms.

e) Species descriptions should include their variation.

f) Variation is seen as imperfection.

Ladder-based thinking _____

Population thinking _____

Tree-based thinking _____

Typological thinking _____

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### PRACTICE

True or False: if false, choose the answer that best corrects the statement.

In tree thinking, species are organized from low complexity to high complexity.

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a) True.

b) False; in tree thinking, species are thought of as unchanging.

c) False; in tree thinking, species are organized from high complexity to low complexity.

d) False; in tree thinking, species are organized based on evolutionary relationships.

### PRACTICE

The Latin term *Scala Naturae* reflects which argument?

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a) Darwin's argument for descent with modification.

b) Aristotle's argument that organisms can be arranged hierarchically by complexity.

c) Plato's argument that all individuals deviate from a divine ideal form.

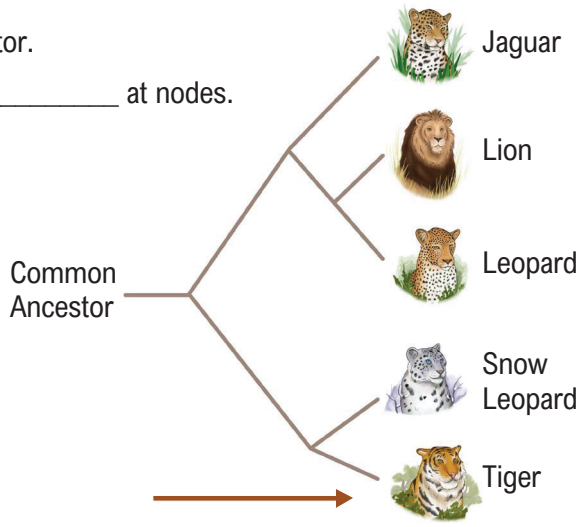
d) The modern biological argument that organisms should be organized by evolutionary relationships.

## TOPIC: INTRODUCTION TO EVOLUTION AND NATURAL SELECTION

### Reading Trees

◆ Phylogenetic Trees: a way to understand species' _____ based on common descent.

- Branches: represent a _____ over time.
- Nodes: represent a _____ ancestor.
- To read a tree, focus on how branches _____ at nodes.




◆ Relatedness = how _____ in the tree is a common node (ancestor).

**EXAMPLE**

Answer the following questions using the tree below:

a) Which organism is most closely related to the Emu?

_____

b) Is a Tinamou more closely related to a Kiwi or a Rhea?

_____

c) Which bird or birds is the ostrich most closely related to?

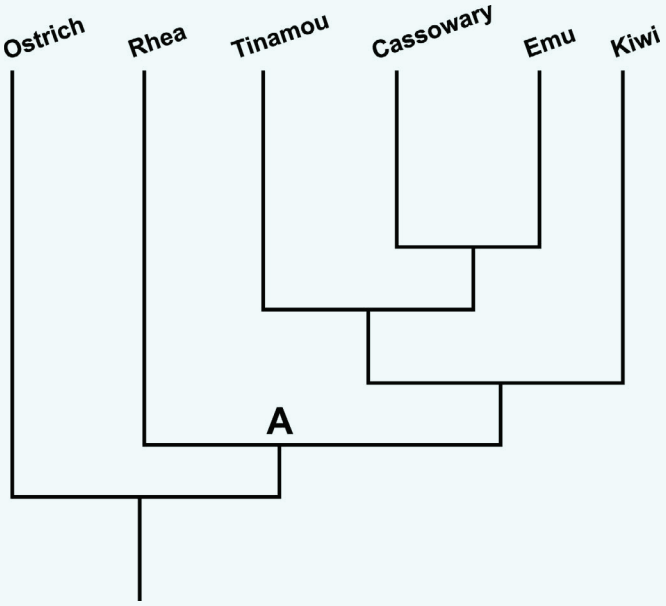
_____

d) Which bird or birds would you expect to share the most traits with the tinamou?

_____

e) Circle all the descendants of the bird that lived at node A.

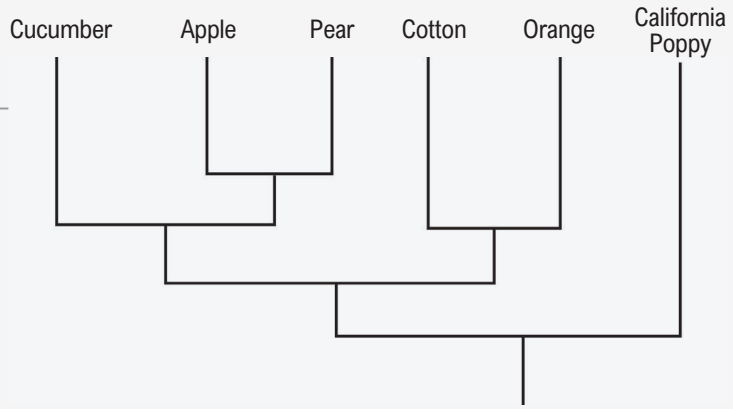
f) Put a star on the node of the tree that represents the most recent common ancestor of the Cassowary and the Kiwi.



## TOPIC: INTRODUCTION TO EVOLUTION AND NATURAL SELECTION

### PRACTICE

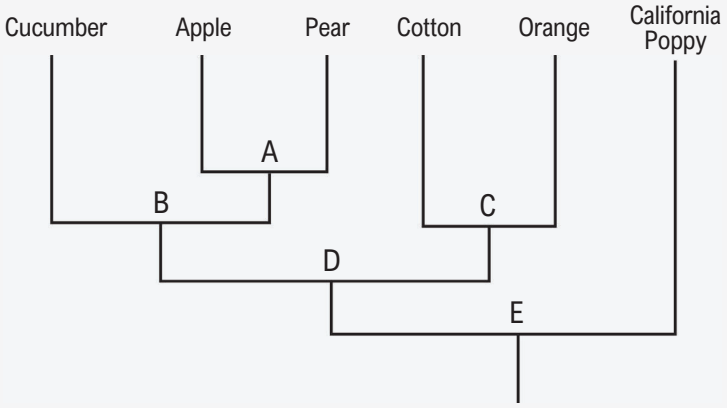
Based on the following simplified tree, which of the following is more closely related to the pear?




a) Cucumber.
b) Cotton.
c) Orange.
d) California Poppy.

### PRACTICE

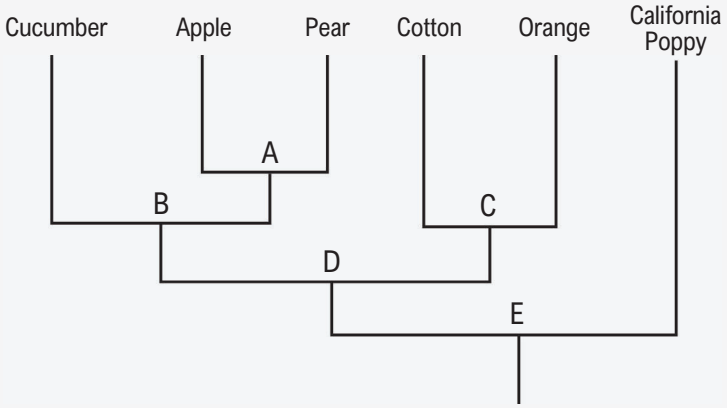
Based on the simplified tree below, identify which node represents the most recent common ancestor between pears and cucumbers.




a) Node A.
b) Node B.
c) Node C.
d) Node D.

### PRACTICE

Which of the following statements is FALSE based on the simplified phylogenetic tree shown?




a) The cucumber is equally related to the apple and the pear.
b) The cucumber and the California poppy share a common ancestor at node E.
c) The most recent common ancestor between the apple and the orange is also the most recent common ancestor of the apple and the California poppy.
d) The pear and the cucumber are more closely related than the pear and the orange.