

# BIOL2107, Fall '23

## Lecture 5





# Carl Linnaeus



Swedish botanist

Carl Linnaeus, also known after his ennoblement as Carl von Linné, was a Swedish botanist, zoologist, and physician who formalised binomial nomenclature, the modern system of naming organisms. He is known as the "father of modern taxonomy". [Wikipedia](#)

**Born:** May 23, 1707, [Råshult, Älmhult Municipality, Sweden](#)

**Died:** January 10, 1778, [The Linnaeus Museum, Uppsala, Sweden](#)

**Known for:** Binomial nomenclature; Scientific classification; Taxonomy

# John Ray



John Ray

<b>Born</b>	29 November 1627 <a href="#">Black Notley</a> , near <a href="#">Braintree</a>
<b>Died</b>	17 January 1705 (aged 77) Black Notley
<b>Nationality</b>	<a href="#">English</a>



**K P C O F G S**

Grizzly bear 	Black bear 	Giant panda 	Red fox 	Abert squirrel 	Coral snake 	Sea star 
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**KINGDOM Animalia**

					
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**PHYLUM Chordata**

				
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**CLASS Mammalia**

			
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**ORDER Carnivora**

		
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**FAMILY Ursidae**

	
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**GENUS Ursus**


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**SPECIES *Ursus arctos***

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Grizzly bear	Black bear	Giant panda	Red fox	Abert squirrel	Coral snake	Sea star
						

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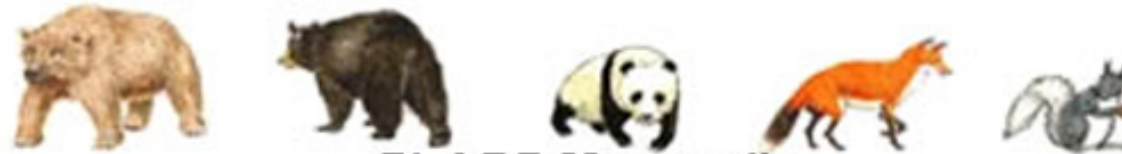
**KINGDOM Animalia**

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**PHYLUM Chordata**

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**CLASS Mammalia**

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**ORDER Carnivora**

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**FAMILY Ursidae**

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**GENUS Ursus**

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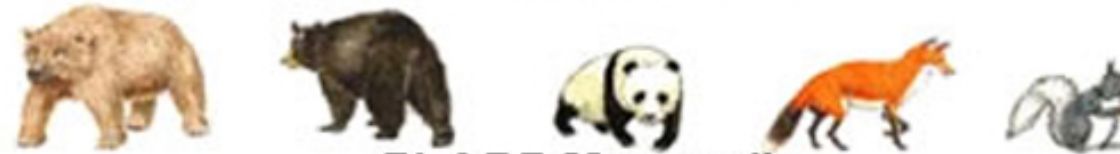
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**PHYLUM Chordata**

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**CLASS Mammalia**

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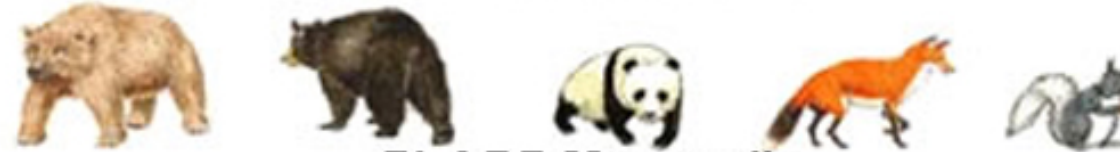
**KINGDOM Animalia**

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**PHYLUM Chordata**

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**CLASS Mammalia**

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**ORDER Carnivora**

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**GENUS Ursus**

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**CLASS Mammalia**

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**ORDER Carnivora**

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**CLASS Mammalia**



**ORDER Carnivora**



**FAMILY Ursidae**



**GENUS Ursus**



**SPECIES *Ursus arctos***




*Ursus maritimus*



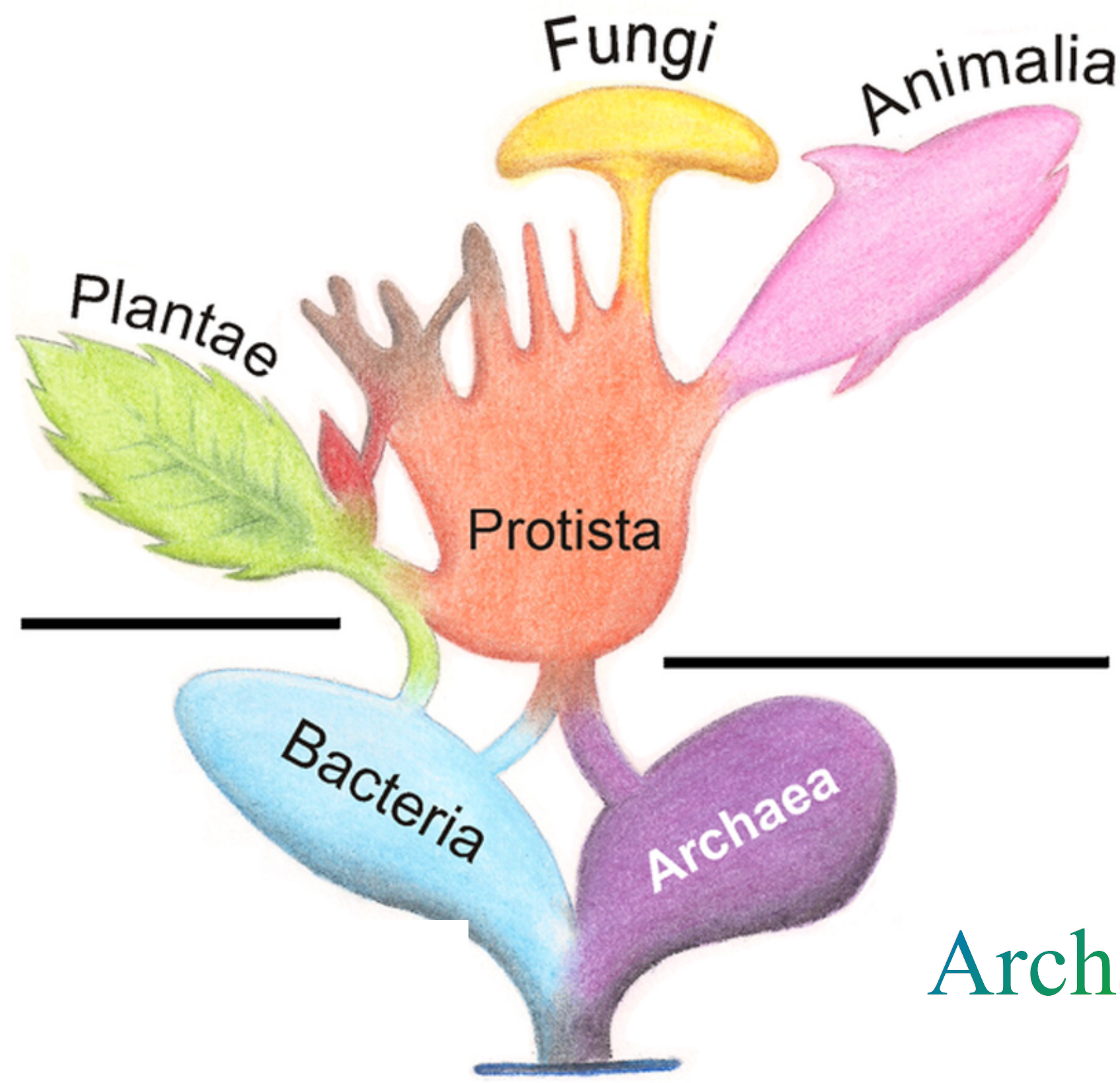
*Ursus arctos horribilis*

# KPCOFGS (redirected from *Kids Prefer Cheese Over Fried Green Spinach*)

Category filter:  

Acronym	Definition
KPCOFGS	Kingdom, Phylum, Class, Order, Family, Genus, Species ( <i>taxonomy order</i> )
KPCOFGS	Kings Play Chess on Funny Green Squares ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Keep Ponds Clean or Frogs Get Sick ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kinky People Come Over for Group Sex ( <i>taxonomy order</i> )
KPCOFGS	King Prawn Curry or Fat Greasy Sausages ( <i>taxonomy mnemonic</i> )
KPCOFGS	Kings Play Cricket on Flat Green Surfaces ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Ken Poured Coffee on Fran's Good Shirt ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Playing Cards on Freeways Get Smashed ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kingdom Phylum Class Order Family Genus Species King Philip Can Only Find Green Socks ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Pick Candy over Fancy Green Salads ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Playing Chess on Freeways Get Smashed ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Keep Paying Casey Off For Gun Sales ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	King Paul Cried Out for Good Soup ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )



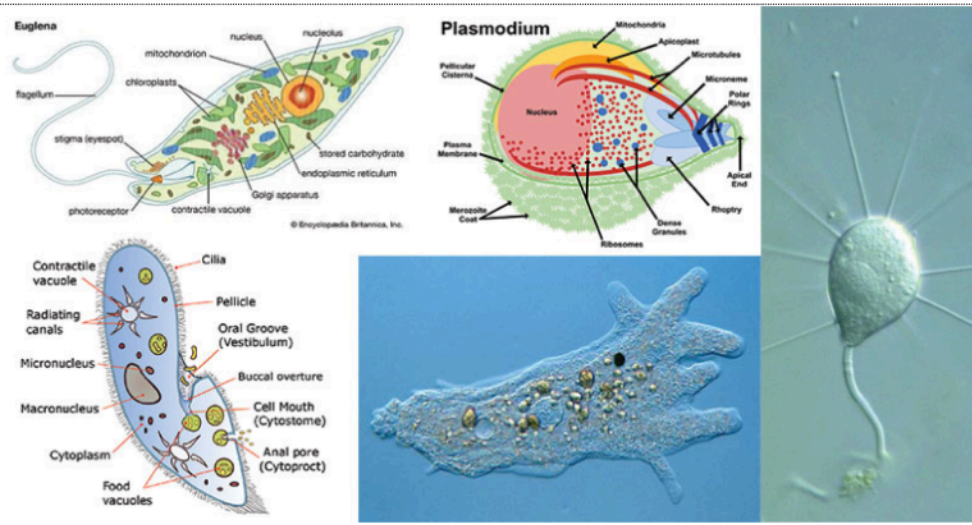


Archaea

**Do Kids Prefer Cheese Over Fried Green Spinach ??**

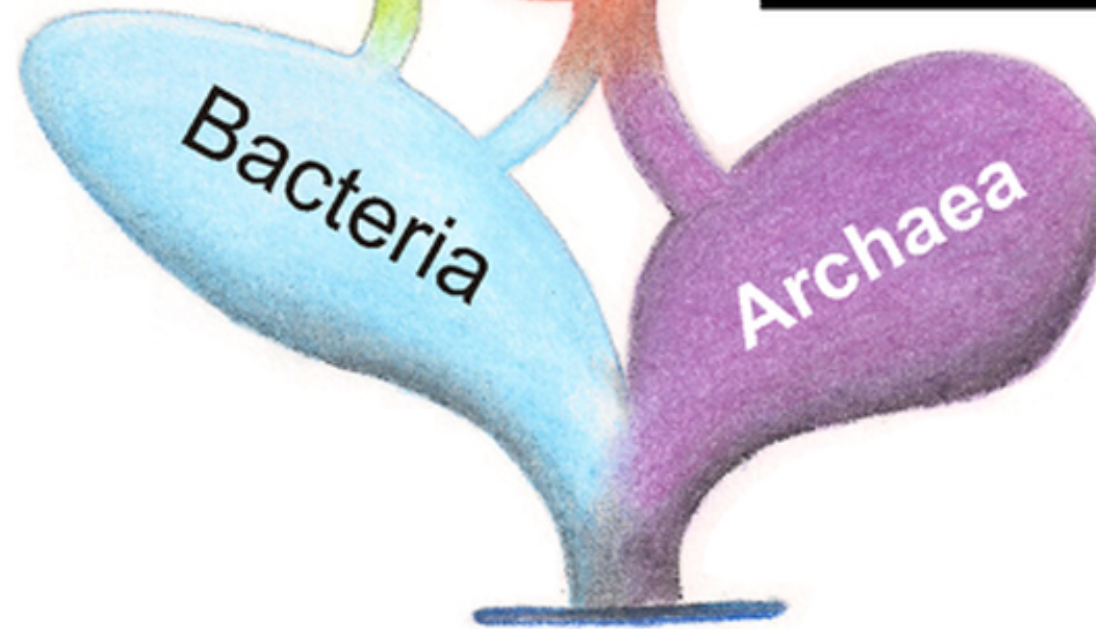


**Protozoa** may be defined as "microscopic acellular animalcules existing singly or in colonies, without tissue and organs, having one or more nuclei".



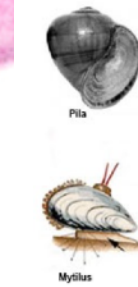
**Some of the characteristics are:**

1. There are about 50,000 known species of Phylum Protozoa.
2. Protozoans exhibit mainly two forms of life; **free-living** (aquatic, freshwater, seawater) and **parasitic** (ectoparasites or endoparasites). They are also **commensal** in habitat.
3. They are **small**, usually **microscopic**, not visualize without a **microscope**.
4. They are the **simplest** and **primitive** of all animals.
5. They have a simple body organization. i.e. with a **protoplasmic grade** of organization.
6. The body is **unicellular** (without tissue and organs).
7. They have one or more **nuclei** which are monomorphic or dimorphic.



**Phylum Mollusca and classification**

December 13, 2017



**General features:**

- They are commonly called...
- They are mostly marine, f...
- It is the **second largest p...**



Insects or Insecta are pancrustacean hexapod invertebrates and the largest group within the arthropod phylum. Insects have a chitinous exoskeleton, a three-part body, three pairs of jointed legs, compound eyes and one pair of antennae.

[Wikipedia](#)

- Legs:** six legs [ny.gov](#)
- Class:** Insecta; Linnaeus, 1758
- Kingdom:** Animalia
- Phylum:** Arthropoda
- Clade:** [Pancrustacea](#)
- Subphylum:** [Hexapoda](#)

Do Kids Prefer Cheese Over Fried Green Spinach

# **Domains and Kingdoms of Life**

[https://www.youtube.com/watch?v=F38BmgPcZ\\_I](https://www.youtube.com/watch?v=F38BmgPcZ_I)





## Carl Linnaeus

Swedish botanist



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D K P C O F G S



Pidgeon Hole



After Darwin, however, this classification scheme **needed** significant refinement on precisely what was meant by each of the terms, (especially the term "**Species**")

"**Species** are groups of interbreeding (or potentially interbreeding) natural populations, which are reproductively isolated from other such groups."

Biological Species Concept [BSC]

## Ernst Mayr and the Evolutionary Synthesis

[Ernst Mayr](#) helped define the [modern synthesis](#) of evolutionary theory, proposing the "[Biological Species Concept](#)." In particular, his work on species and speciation helped scientists understand the progress and mechanisms of evolution from one species to another, and the importance of the species unit as "the keystone of evolution."

**Credits:** Courtesy of Ernst Mayr



Click for [larger image](#)

But, the arguments and difficulties that we have in defining "**Species**" reflect very accurately the arguments that scientists have had over the centuries.....

Yes, there are quite definitely constraints to evolutionary change(s)?

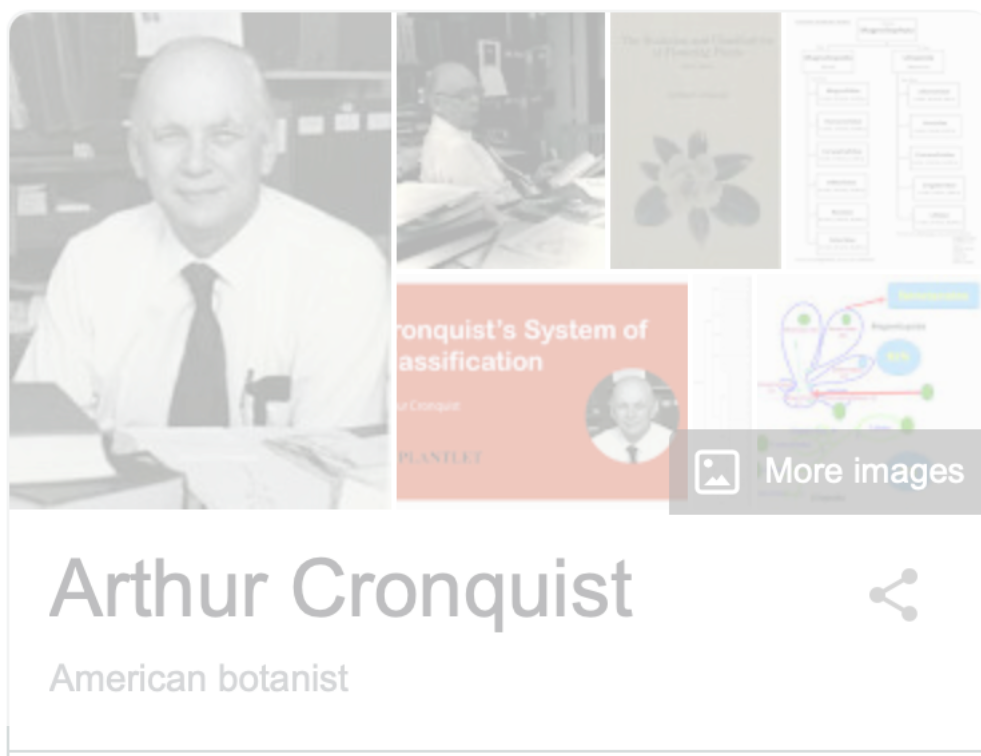
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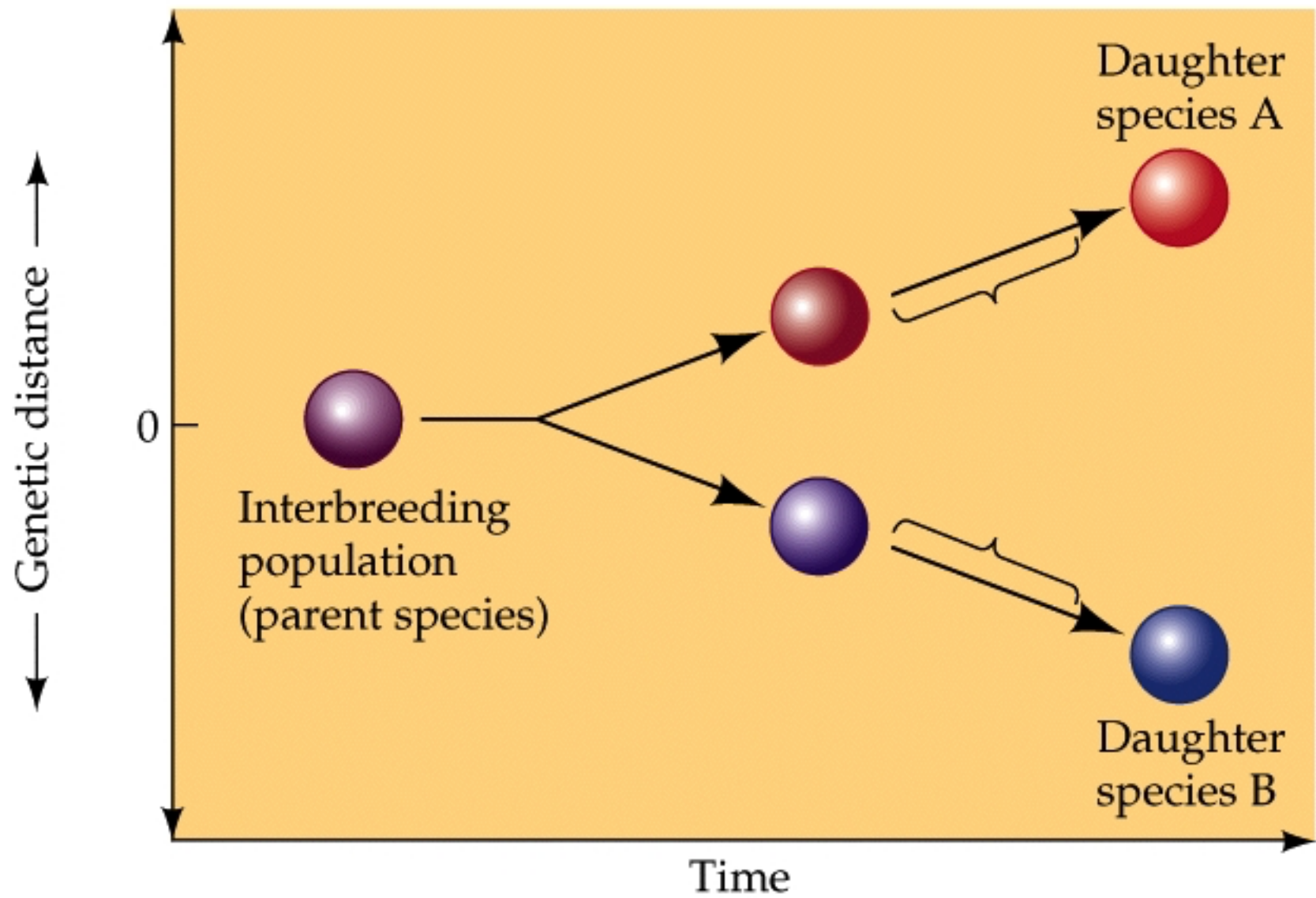
Genetic integration works on the premise that "if individuals within a population mate with one another, but not with individuals of other populations, this population can be considered to be an

**"independent evolutionary unit"**, and can safely be called a **Species**

"...the smallest groups that are consistently and persistently distinct and distinguishable by ordinary means."

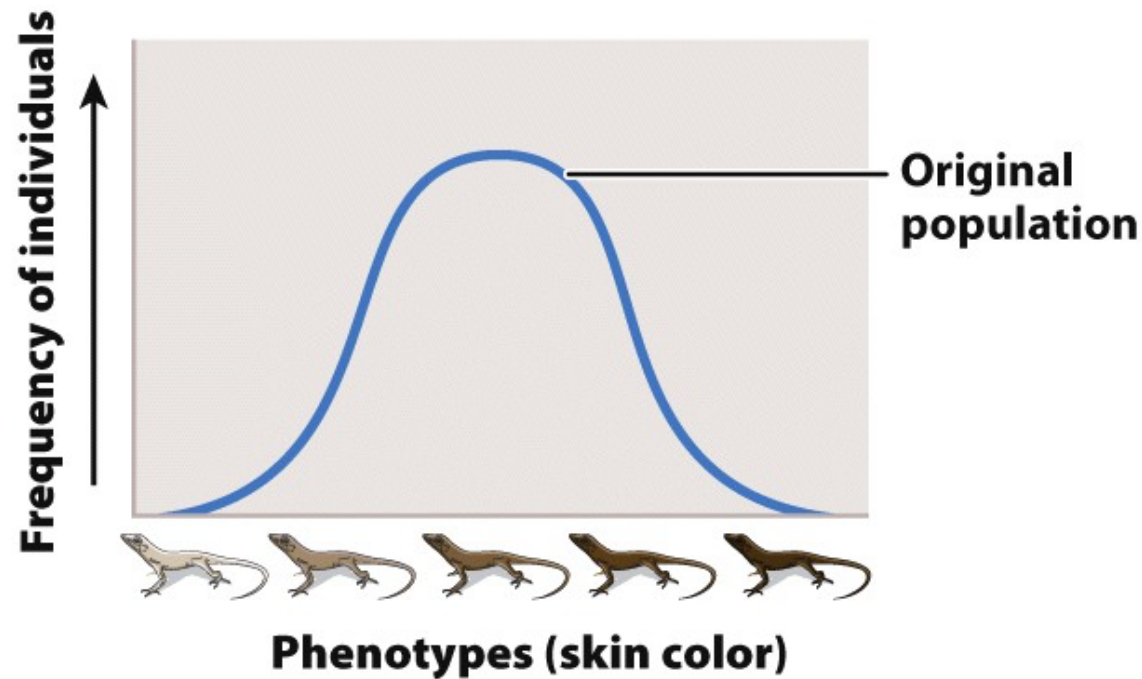
**Morphological Species Concept (MSC)**  
-Cronquist 1988





Speciation is the process by which one "species" splits into two.



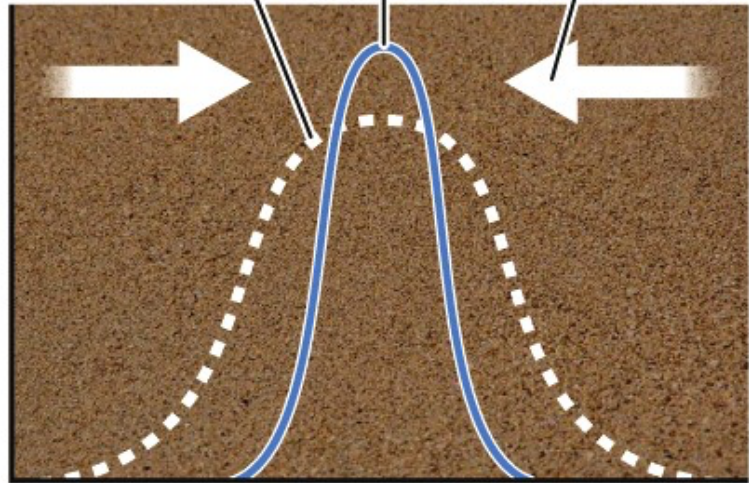


How does selection affect this distribution of phenotypes in three environments in which the background colors differ? In each case, lizards that are camouflaged against the background survive and reproduce whereas those that do not are eliminated by predators.

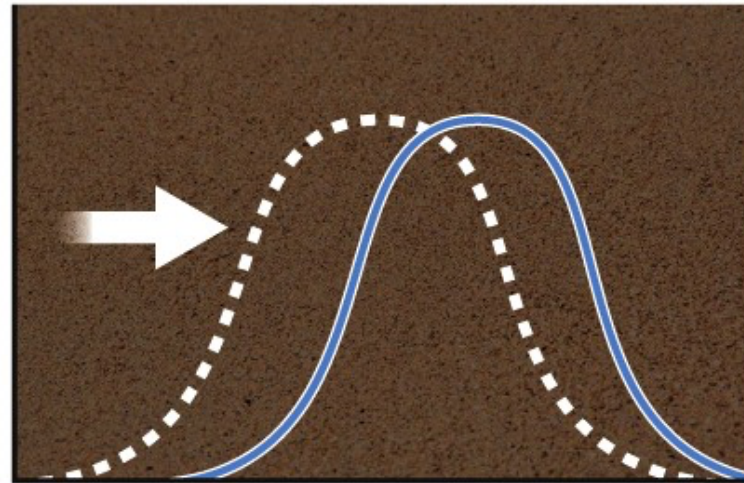
Original population

Population after selection

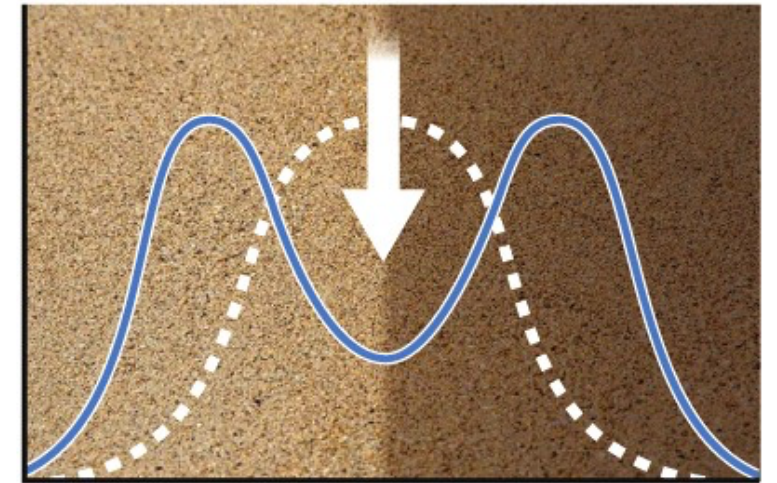
These individuals are selected against.



**Stabilizing selection selects against the extremes.**



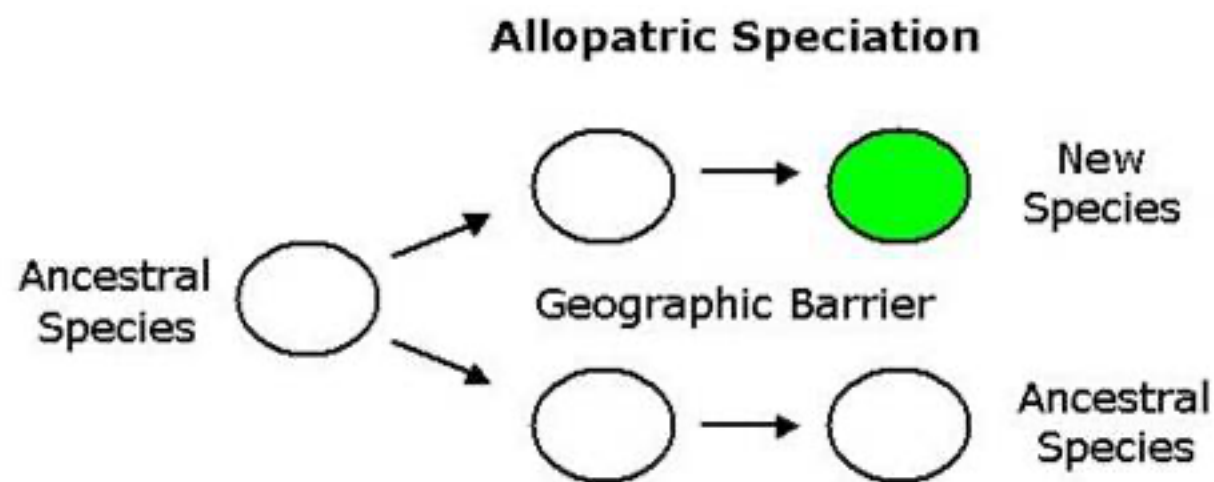
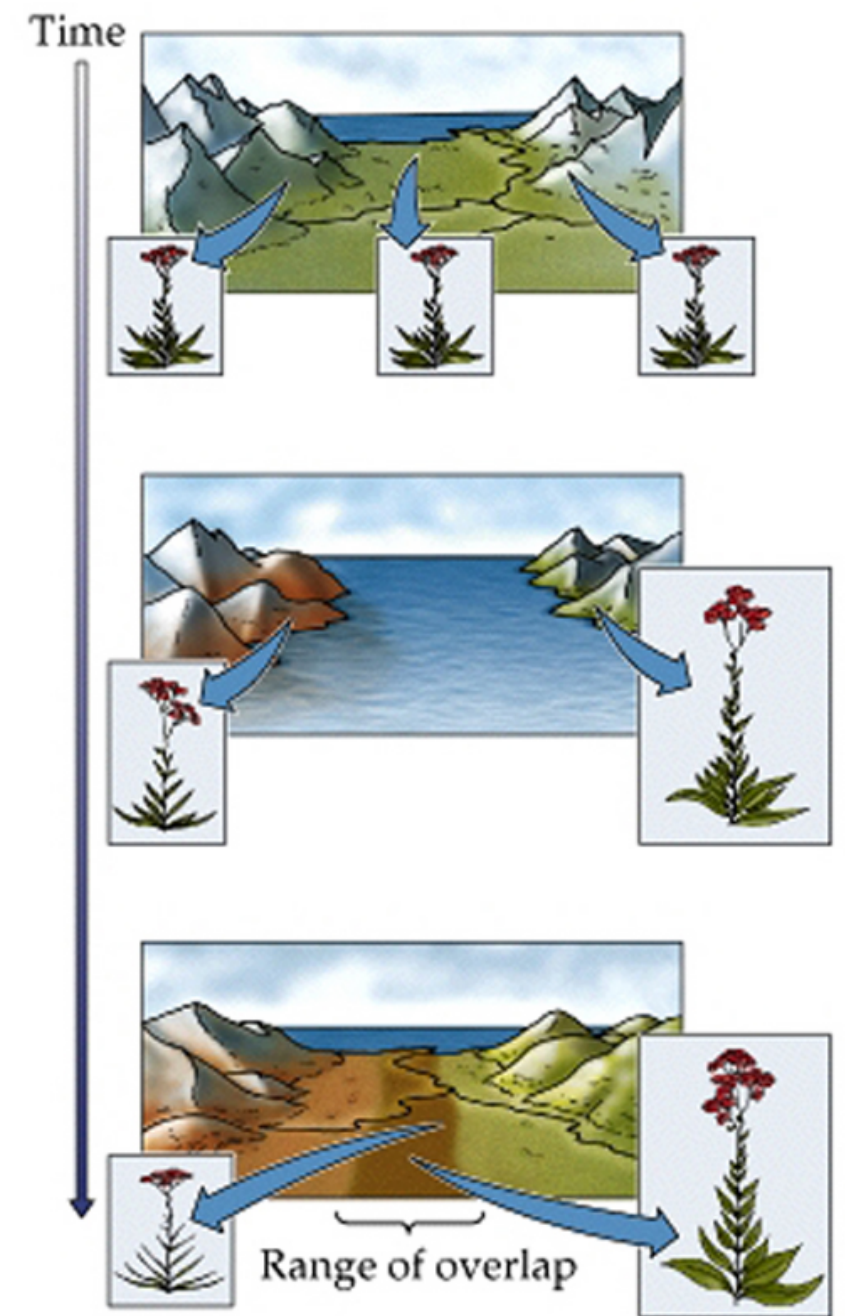
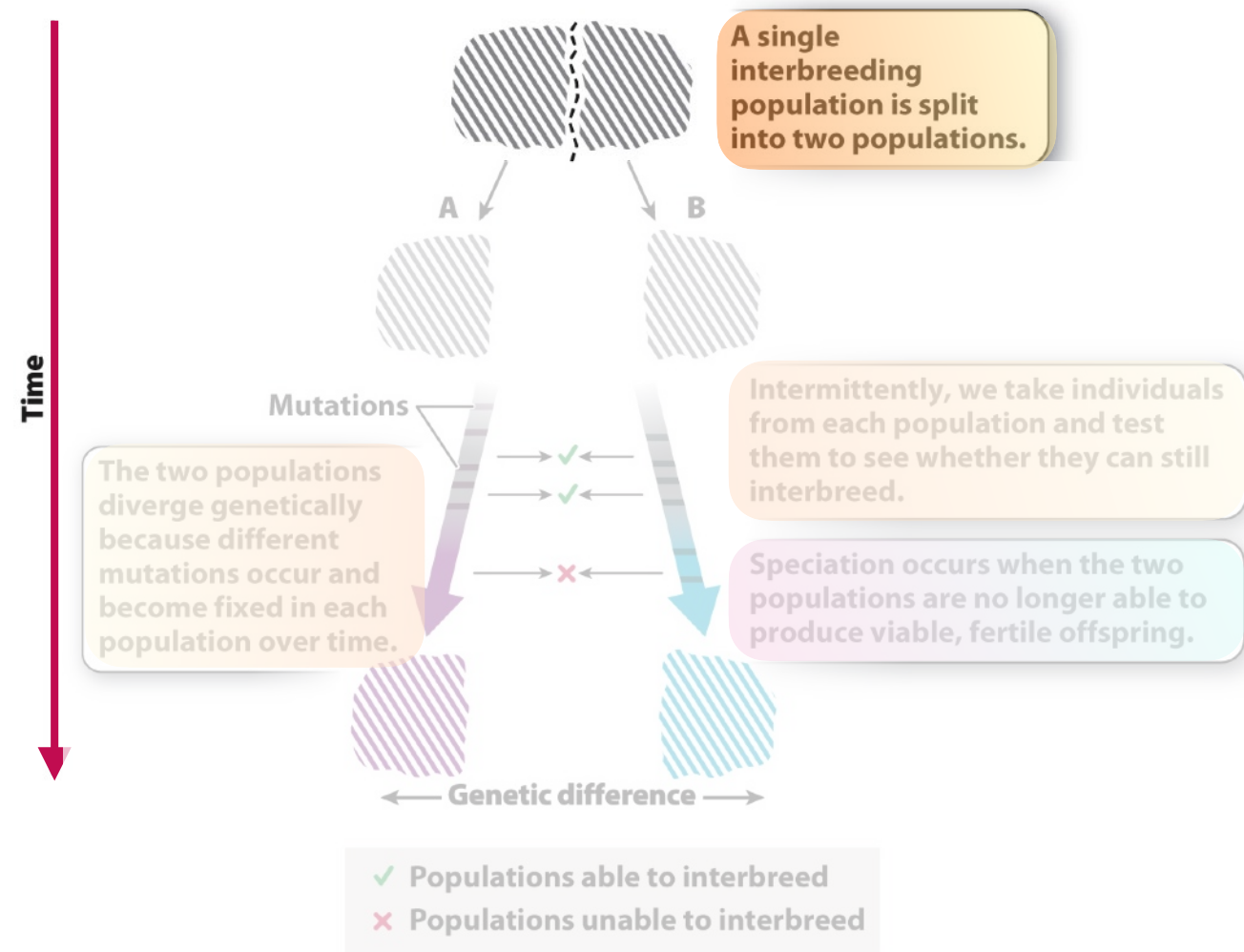
**Directional selection selects against one of the two extremes.**



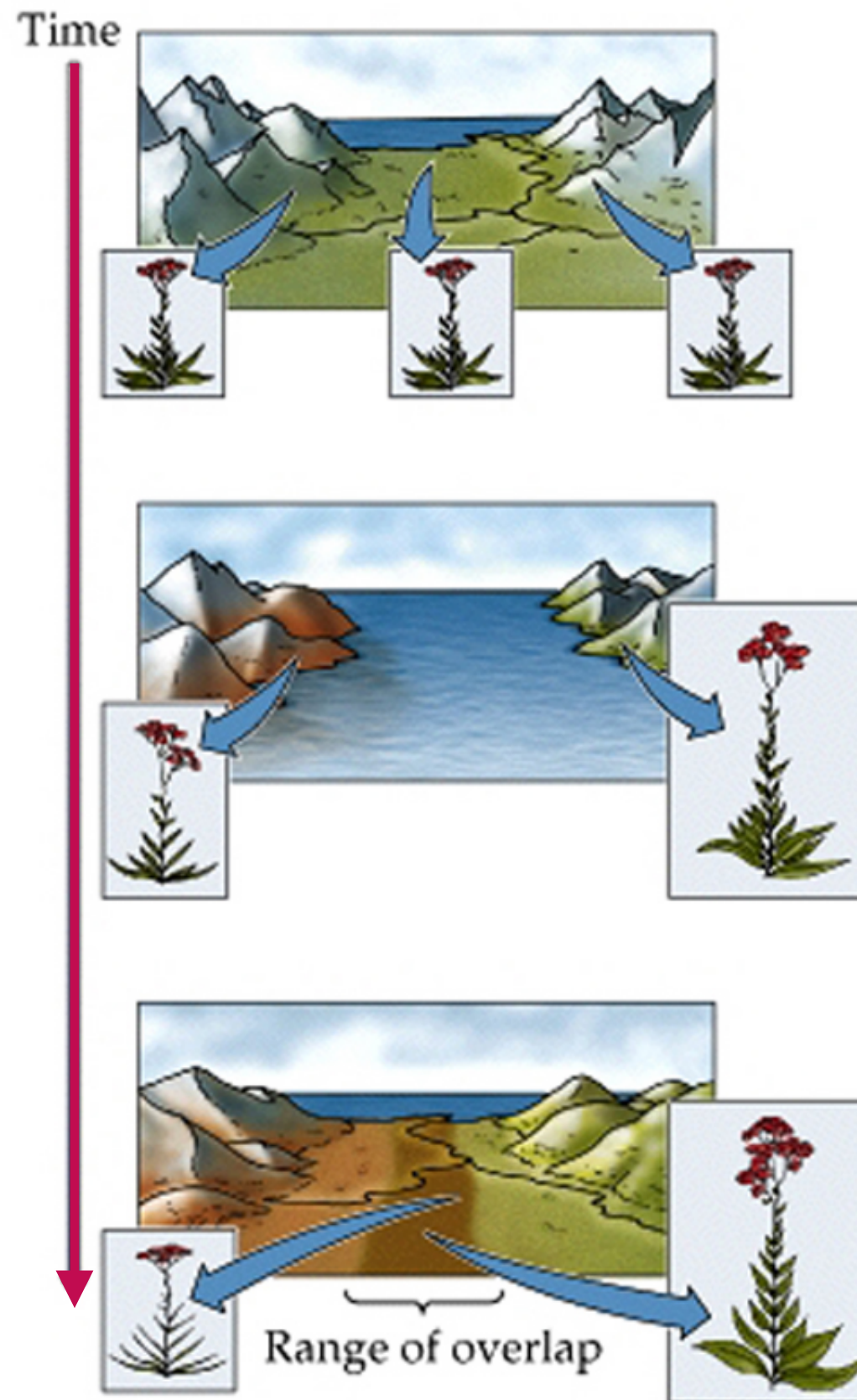
**Disruptive selection selects against the mean.**



**Allopatric speciation** requires total genetic "reproductive" isolation.....or, when two or more parts of a single population become divided by a geographic barrier, alternatively known as **geographic speciation**.



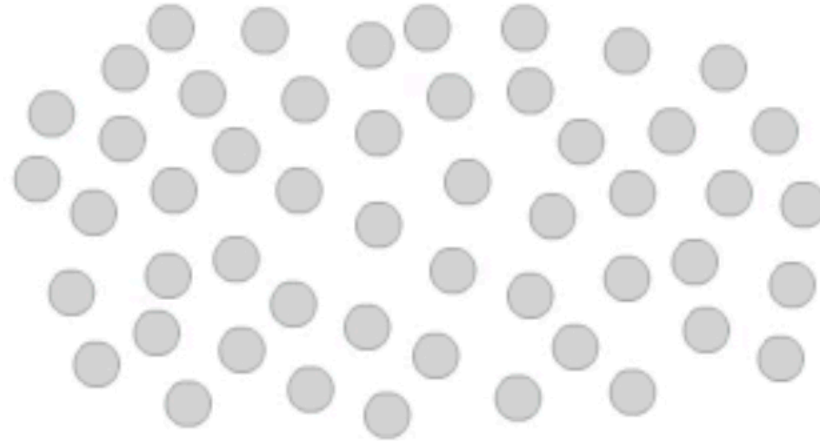
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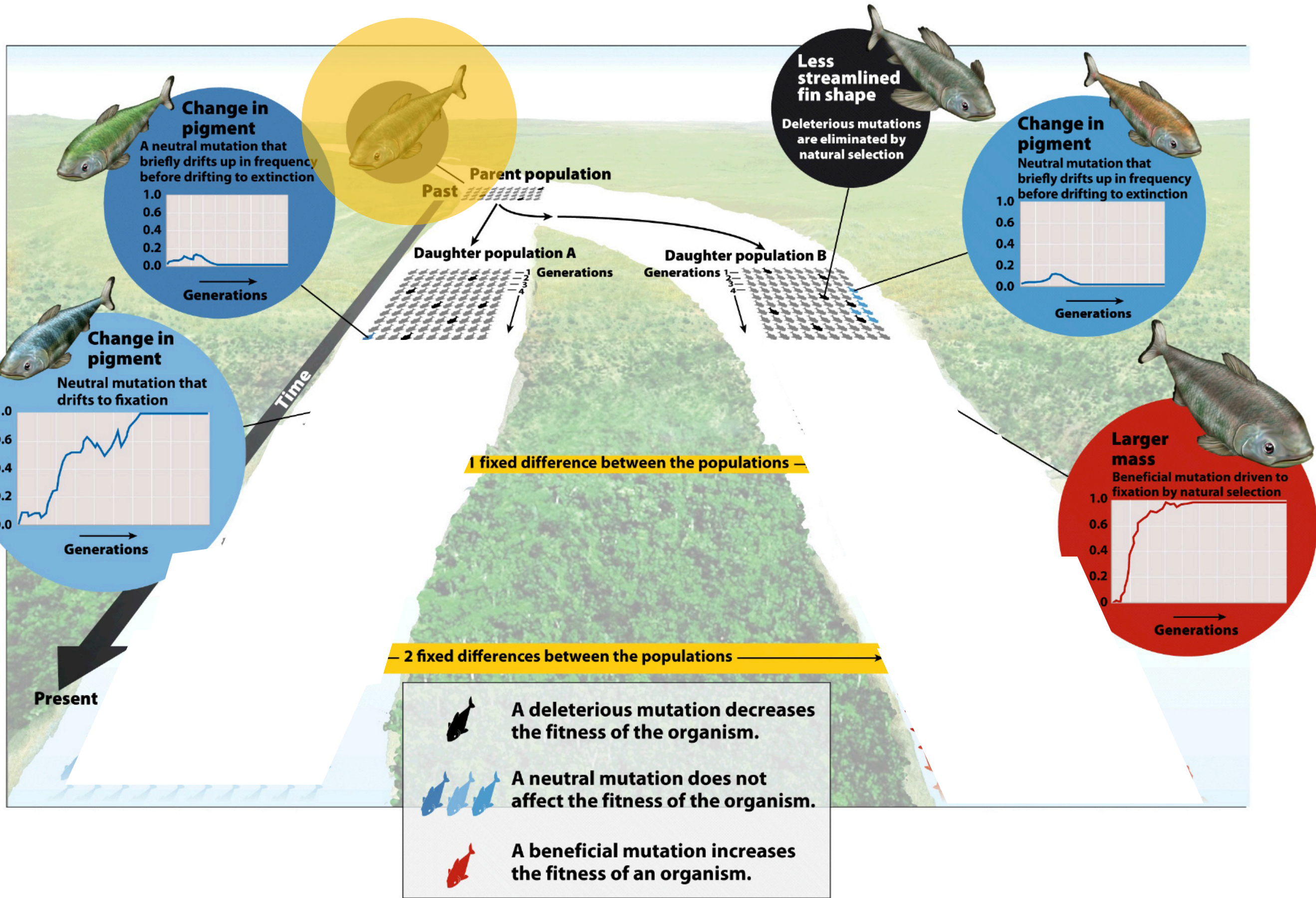
# Speciation

## Speciation

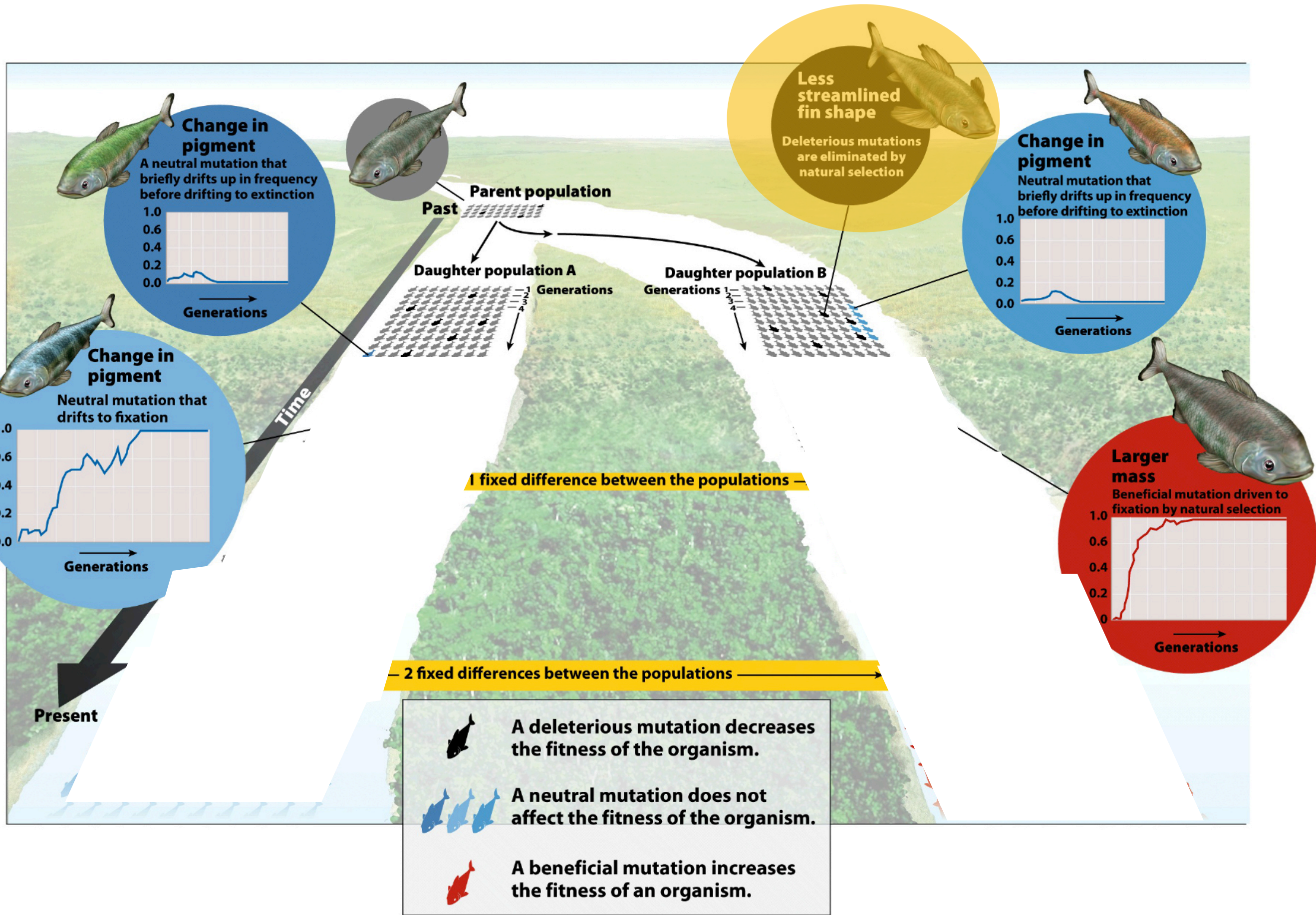


**1**  
Generation

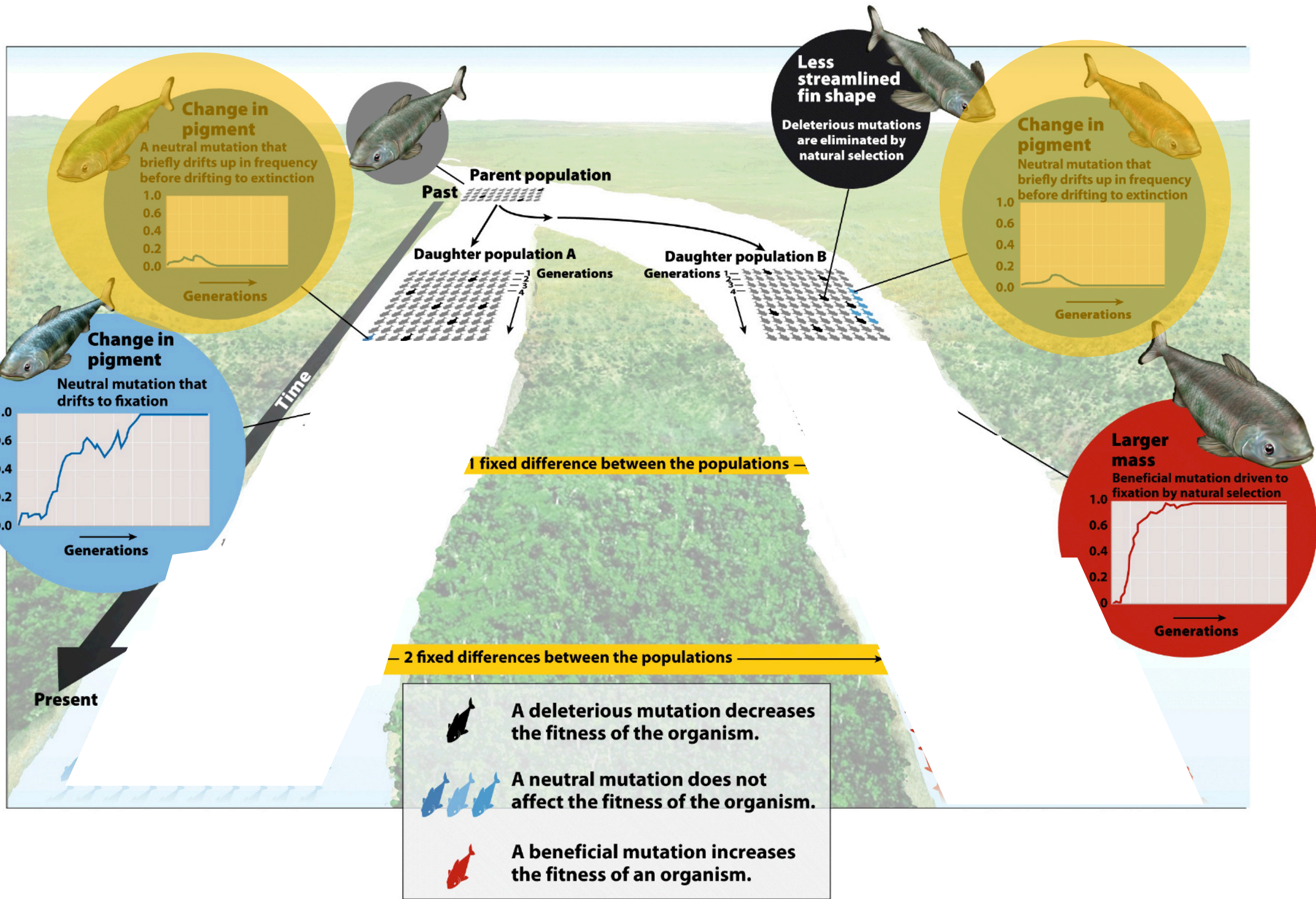
We will track the evolution of this population through time.



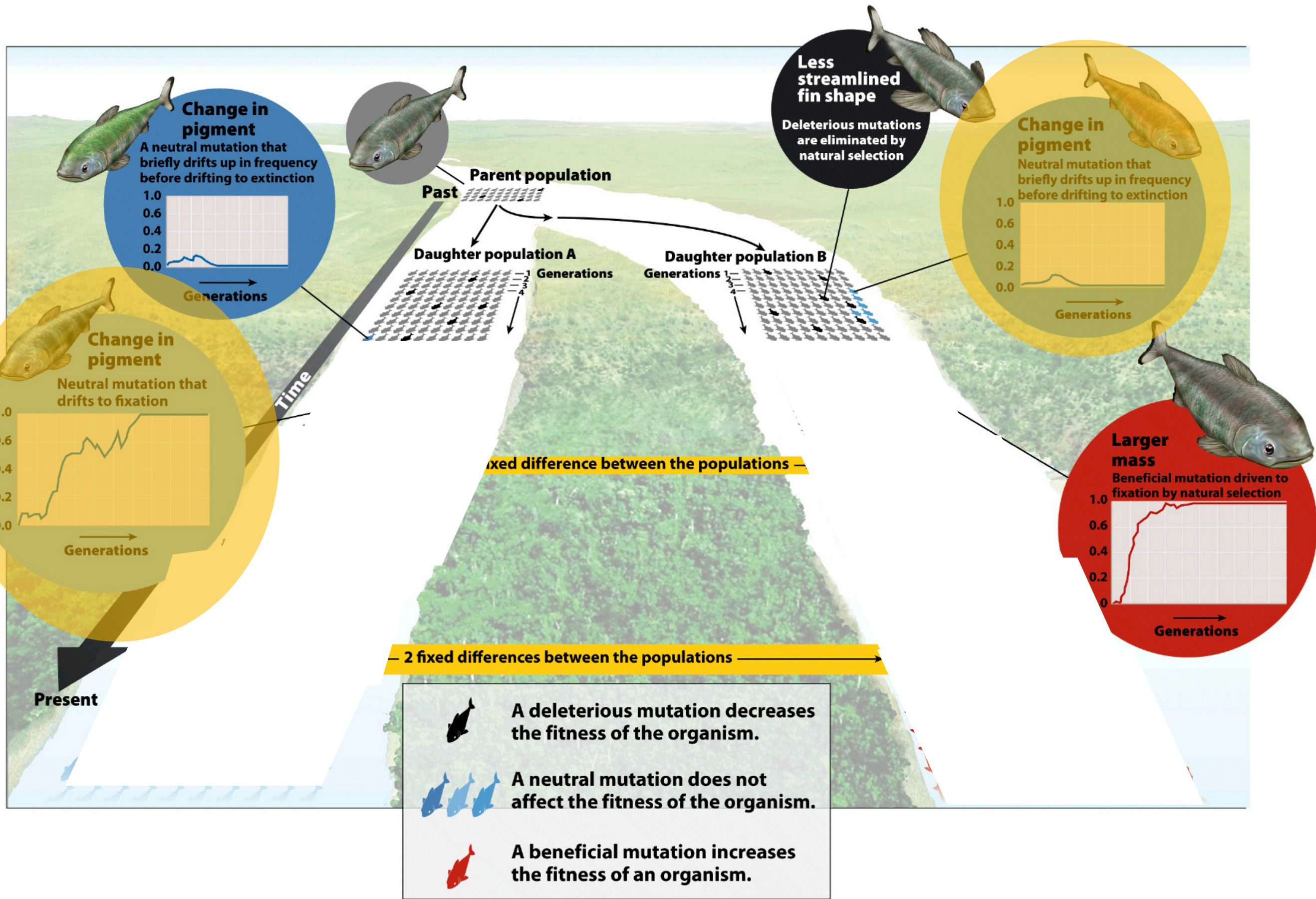




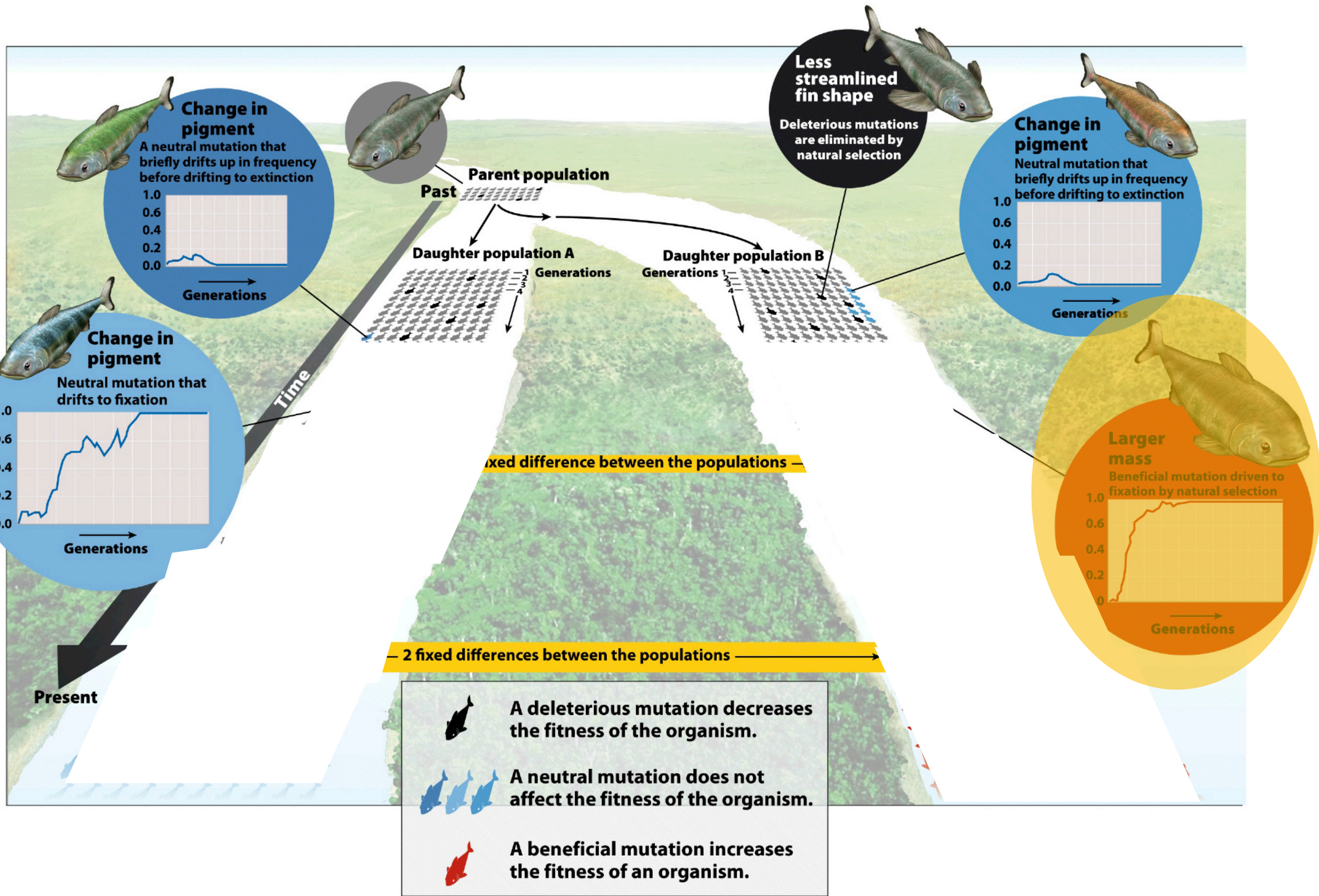




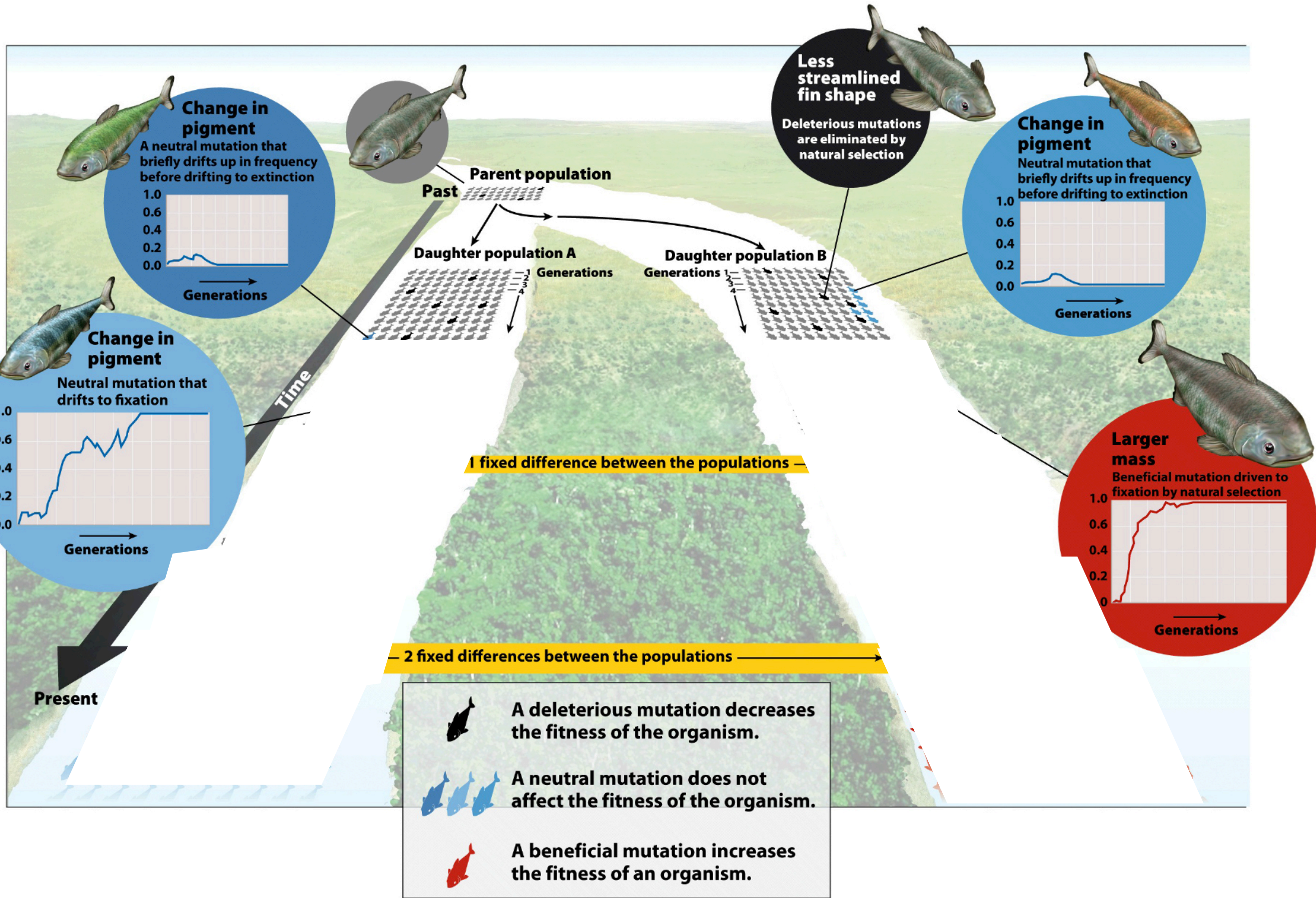














**Figure 19.6**

Three examples of beak variation in Galápagos finches.



**(a) Cactus-eater.** The long, sharp beak of the common cactus finch (*Geospiza scandens*) helps it tear and eat cactus flowers and pulp.



**(c) Insect-eater.** The green warbler finch (*Certhidea olivacea*) uses its narrow, pointed beak to grasp insects.

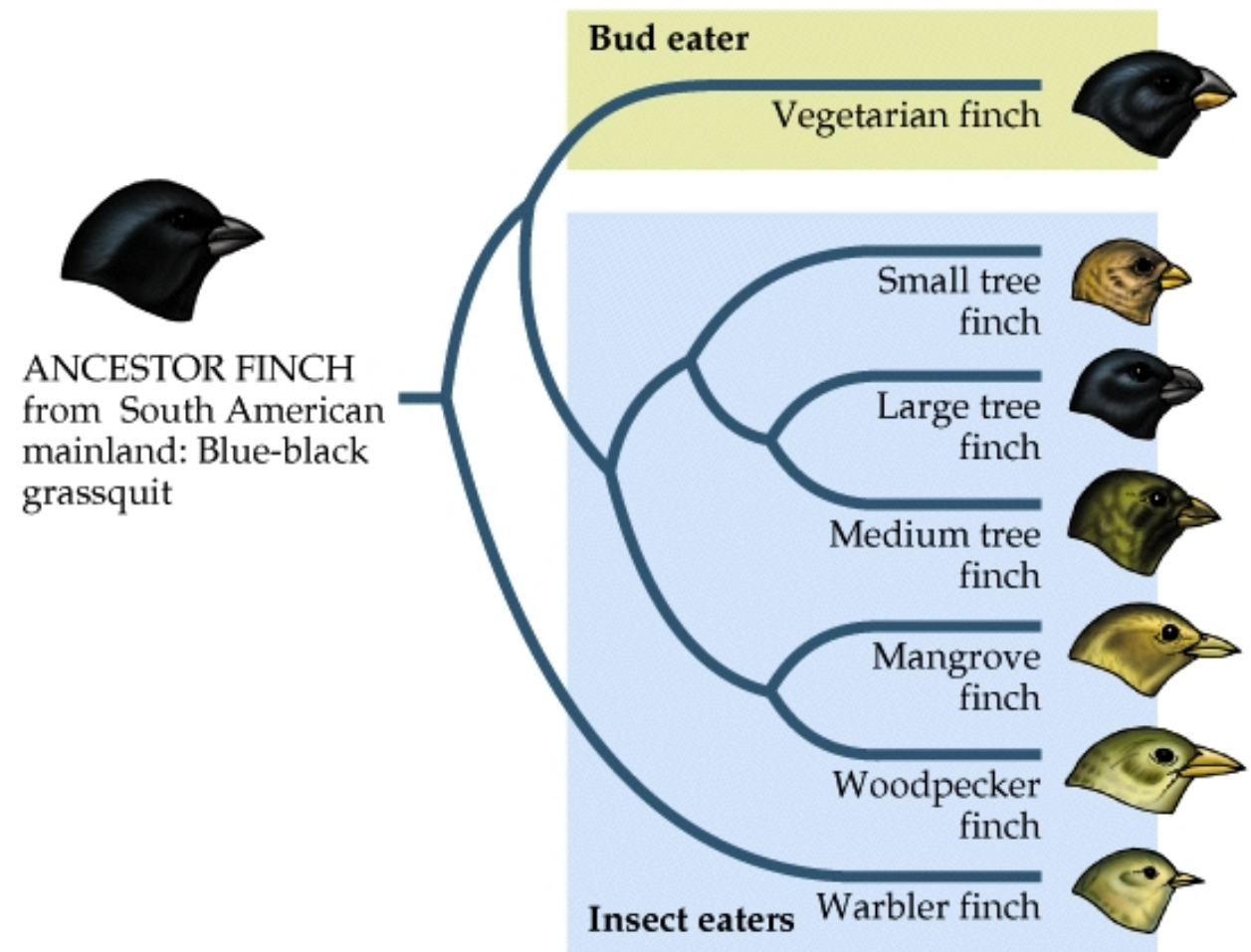
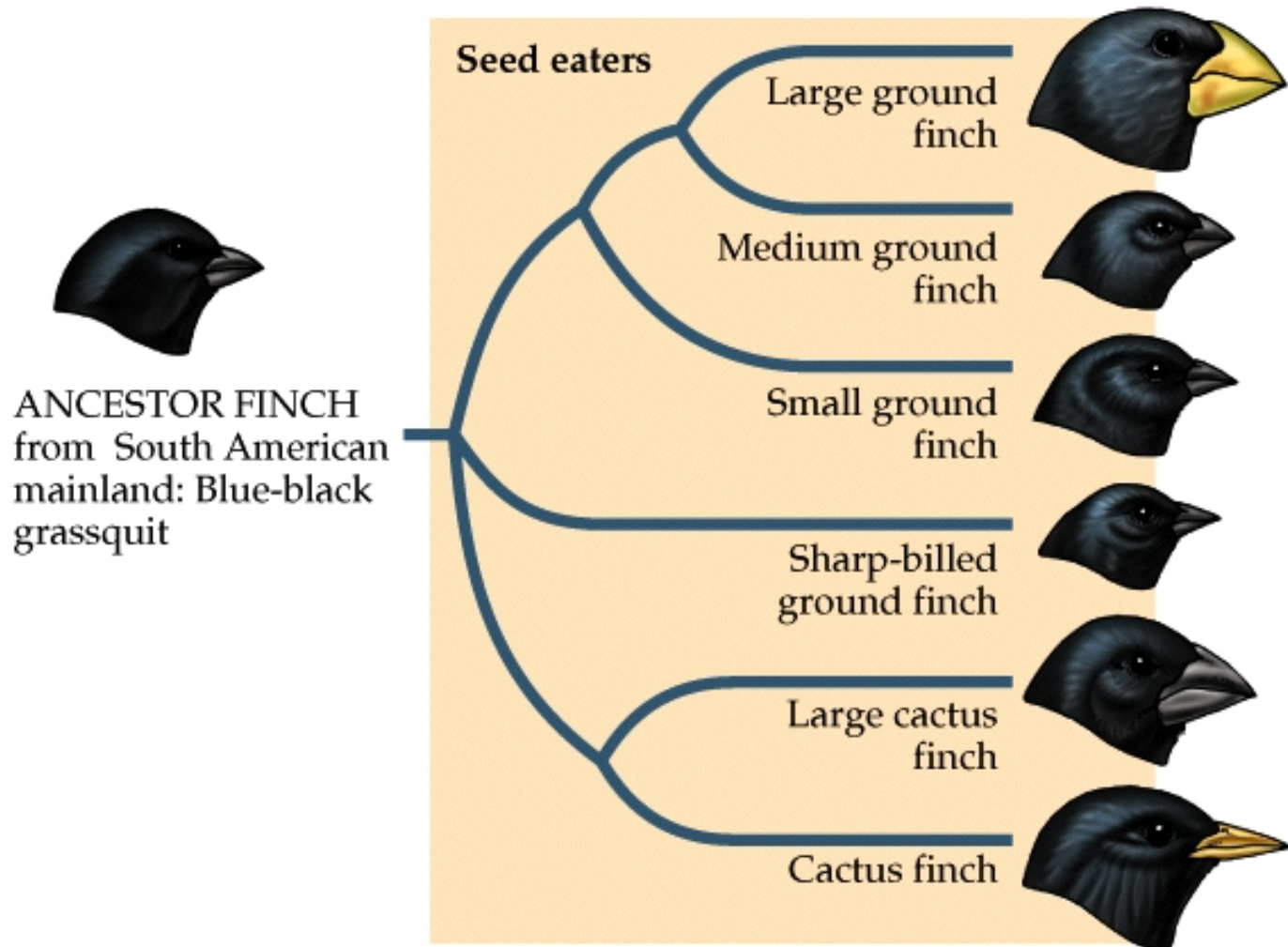


**(b) Seed-eater.** The large ground finch (*Geospiza magnirostris*) has a large beak adapted for cracking seeds on the ground.

The Galápagos Islands are home to more than a dozen species of closely related finches, some found only on a single island. A striking difference among them is their beaks, which are adapted for specific diets.







## Darwin's Galapagos Finches



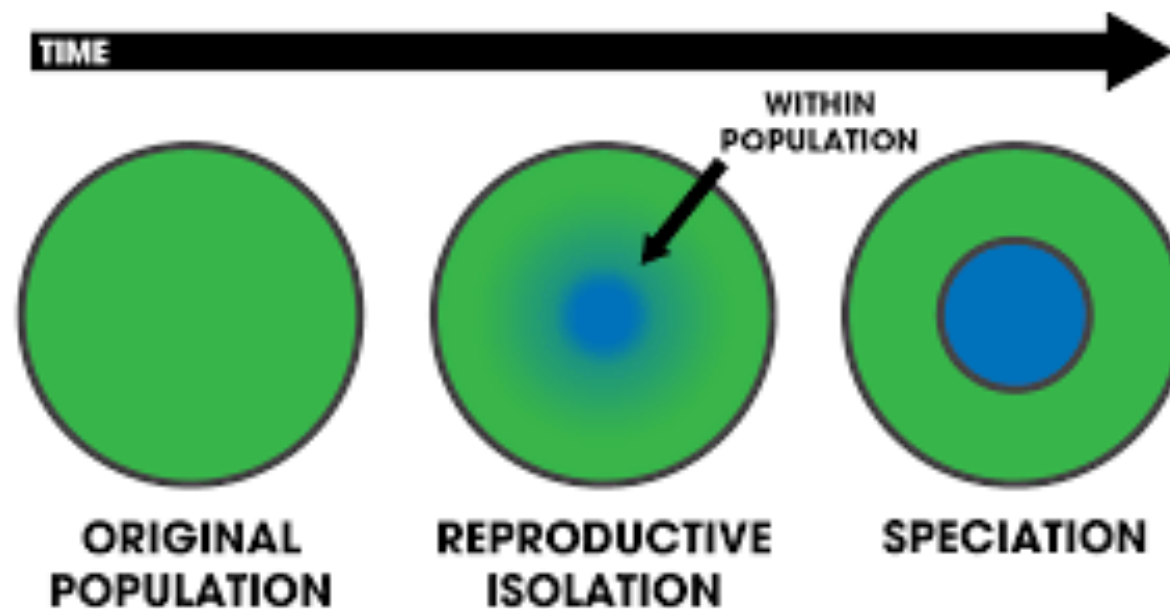


American and European Sycamores

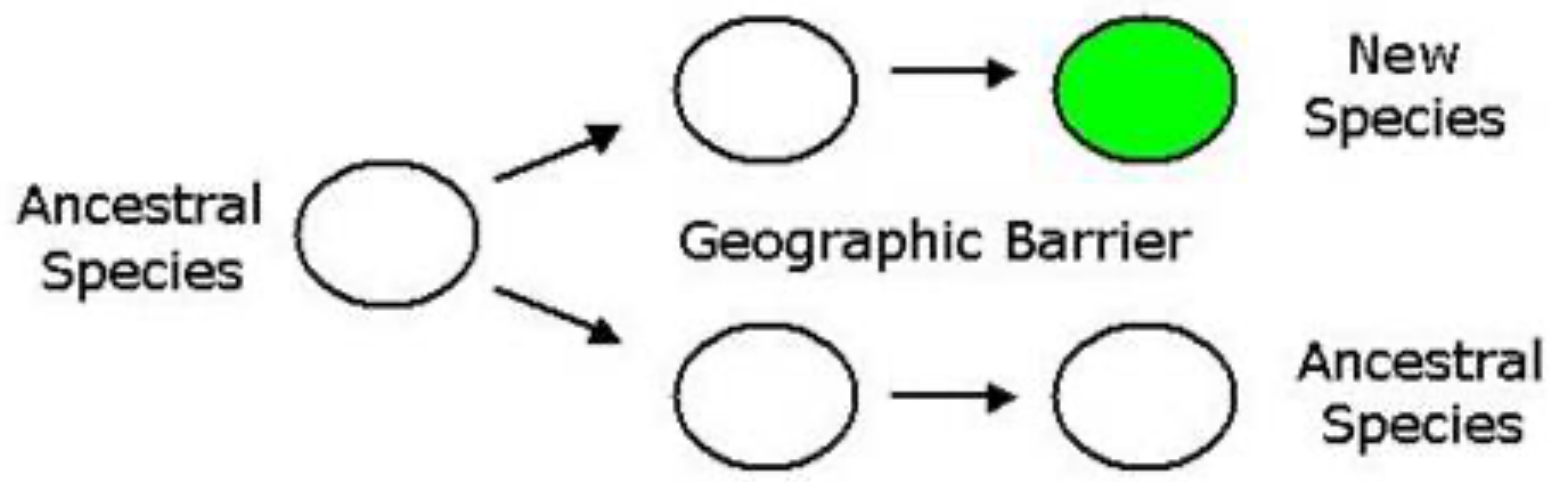
**Sympatric speciation** is the evolution of a new species from a surviving ancestral species while both continue to inhabit the **same geographic region**.

Fruit flies have speciated sympatrically in New York State for more than a hundred years. These fruit flies originally courted, mated, and deposited eggs only on **hawthorn fruits**.

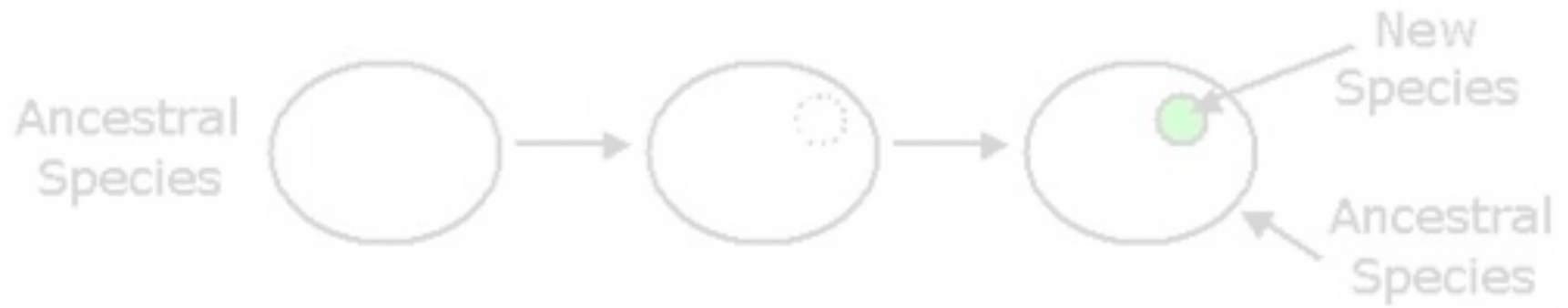
About 170 years ago, large commercial **apple orchards** were planted in New York. Some fruit flies began to lay their eggs on the apple trees, perhaps by mistake. Consequently, their offspring sought out apple trees as adults and, therefore, mated with other fruit flies of similar heritage.



### Allopatric Speciation



### Sympatric Speciation





**Sympatric speciation** is the evolution of a new species from a surviving ancestral species, while both continue to inhabit the **same geographic region**.

Any potential example of a possible future “sympatric speciation” spring to mind??

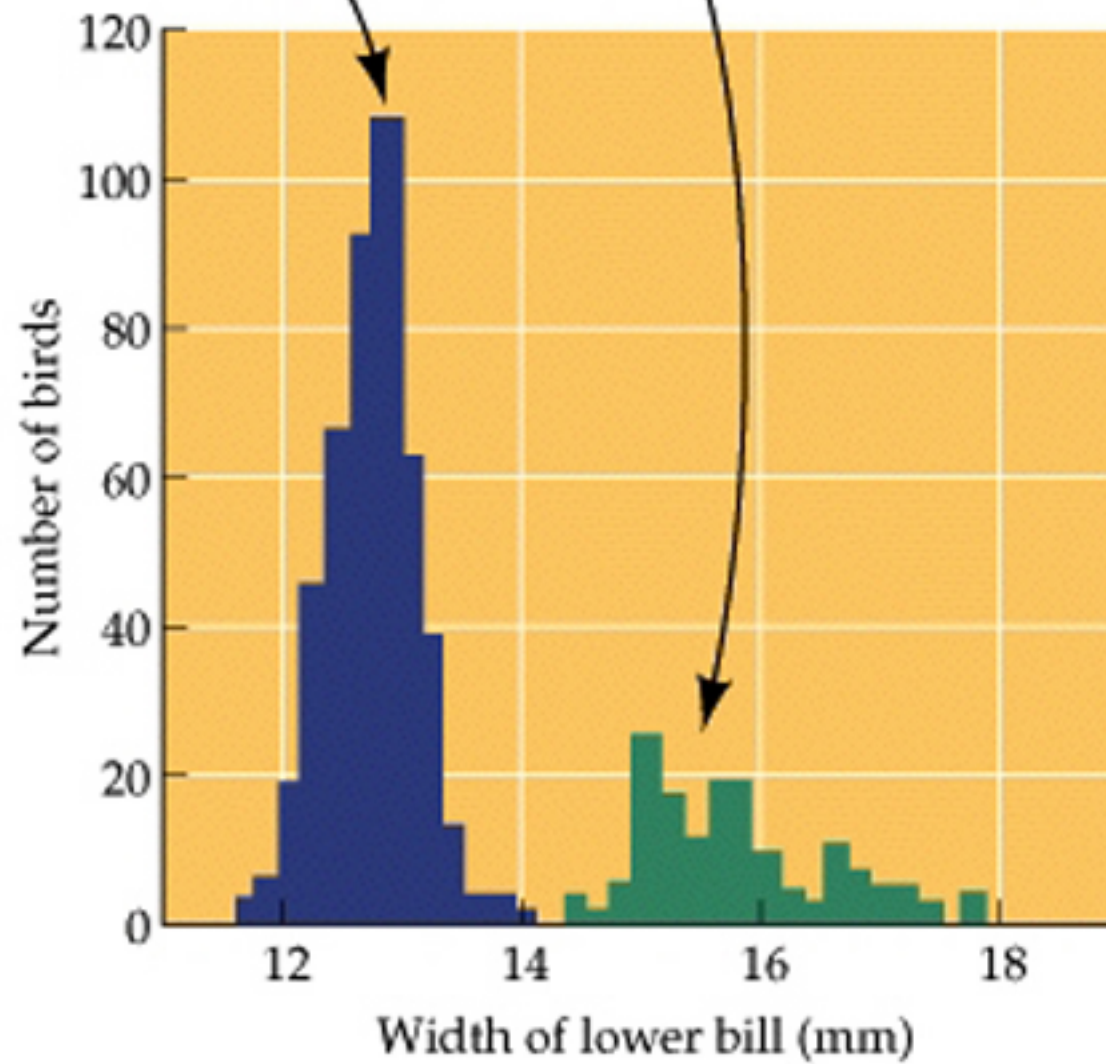
(A) American Sycamores

(B) West African Finches

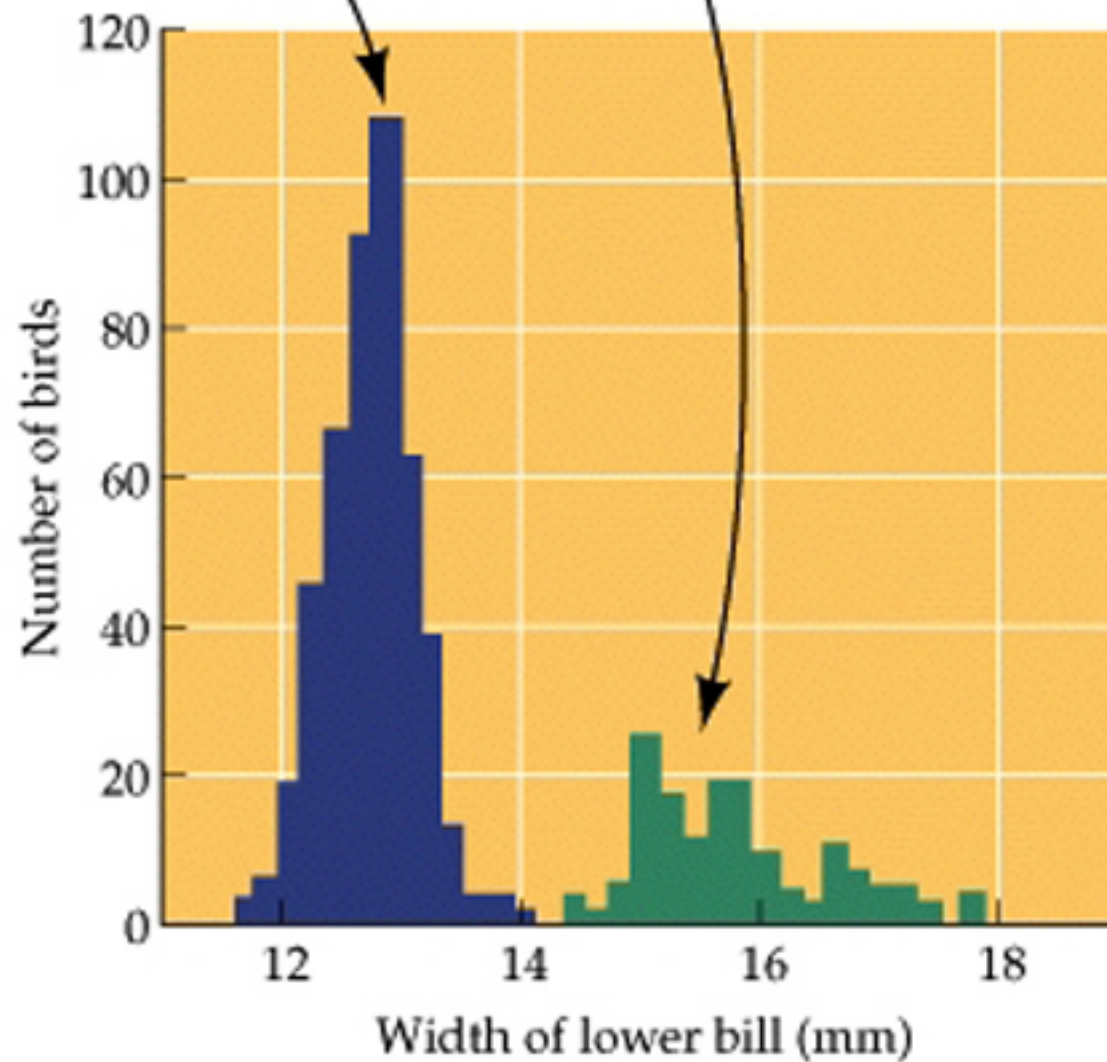
(C) Long necked Giant Tortoise in the Galapagos Islands

(D) Birds and Bats

(E) Red winged Blackbirds

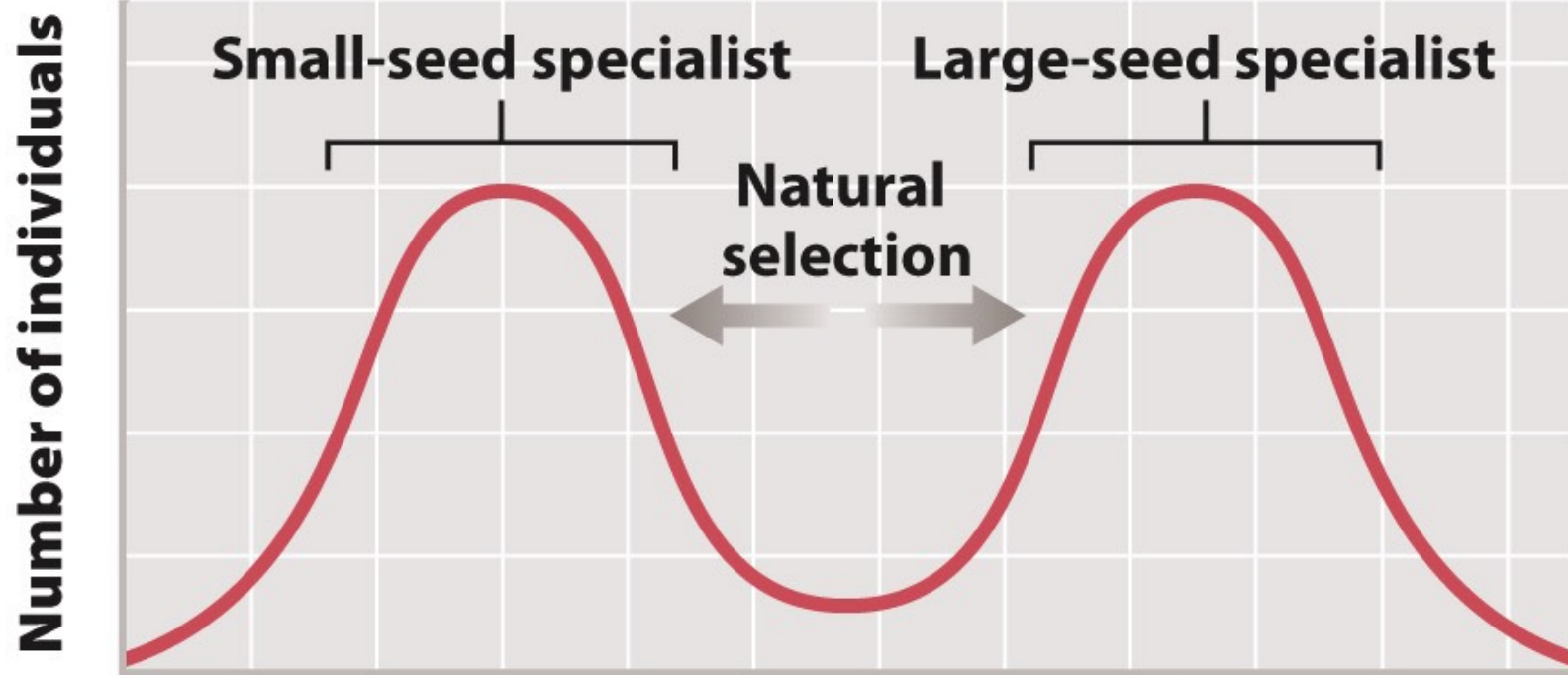




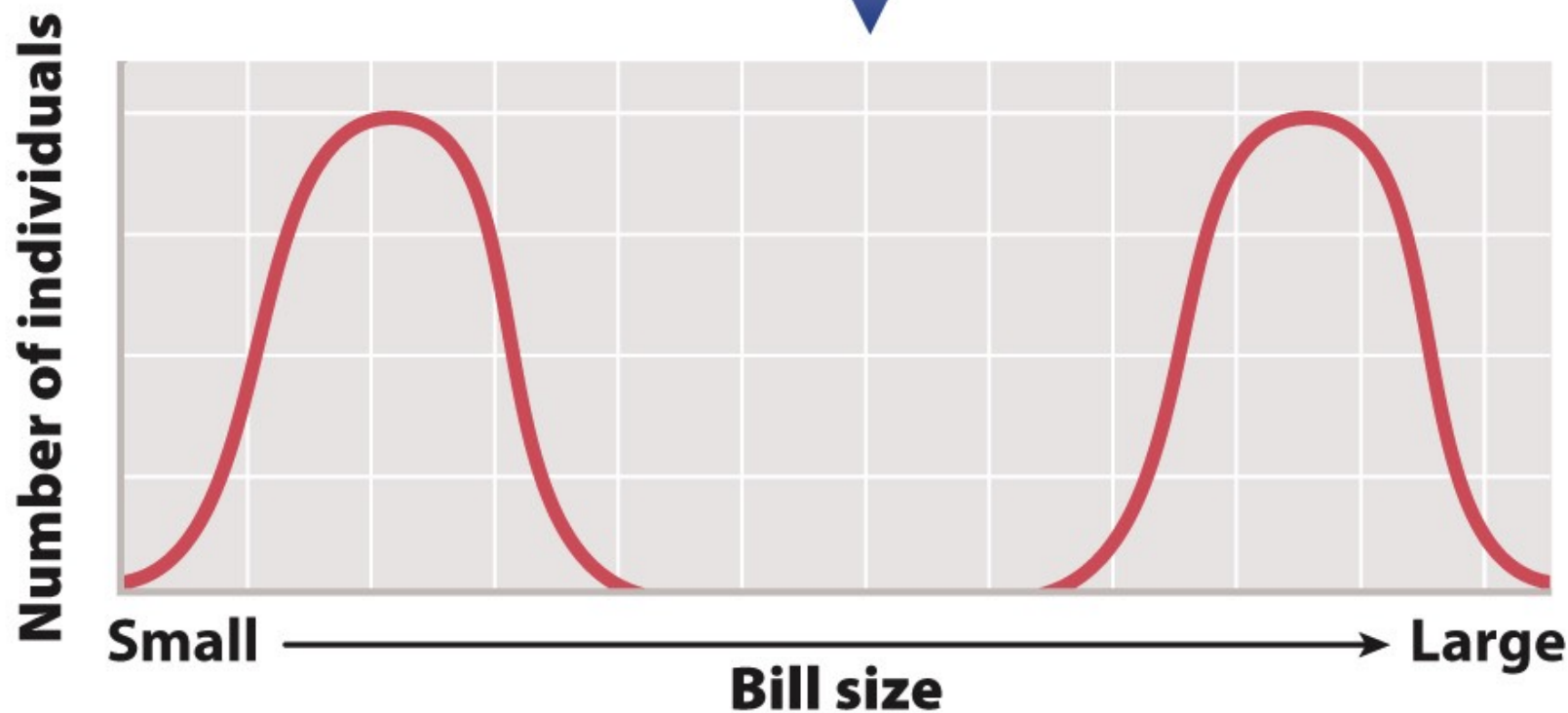


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Speciation DOES NOT  
HAVE TO  
HAPPEN!!!  
Remember, this is  
ONLY ONE  
trait!



Natural selection eliminates medium-billed birds in an environment with no medium-sized seeds, and favors small-billed birds and large-billed birds in response to the availability of small and large seeds.

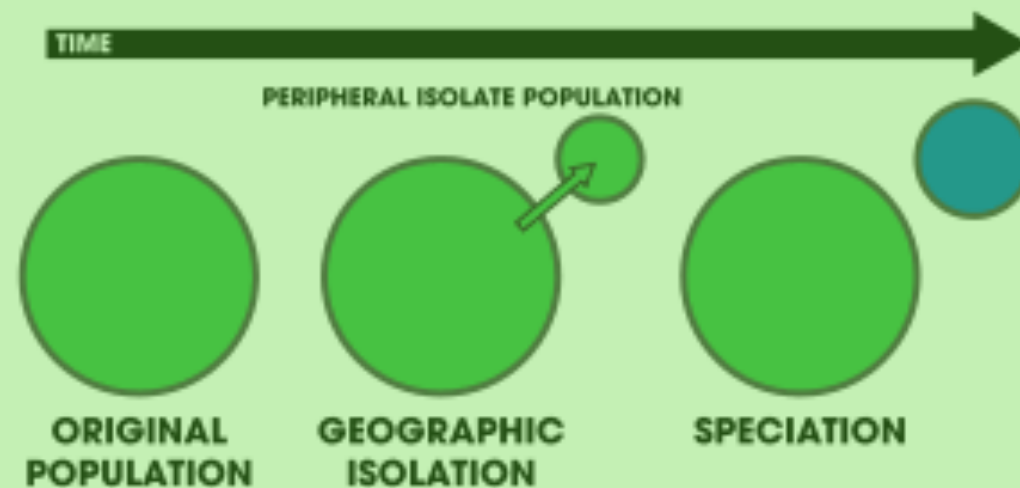


Disruptive selection, if strong enough and sustained enough, may eventually lead to sympatric speciation.

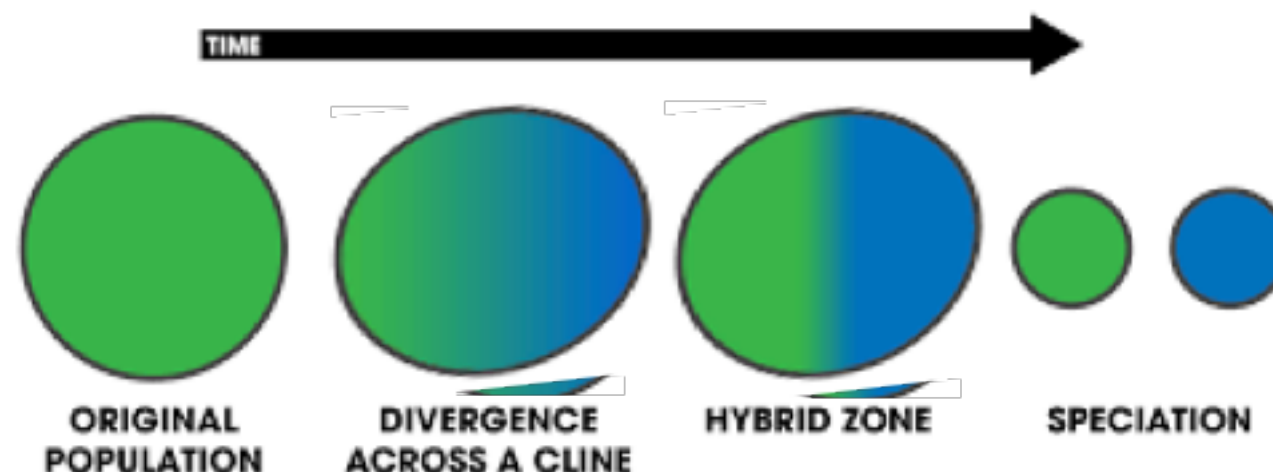
Figure 22.11  
*Biology: How Life Works, Second Edition*  
 © 2016 Macmillan Education



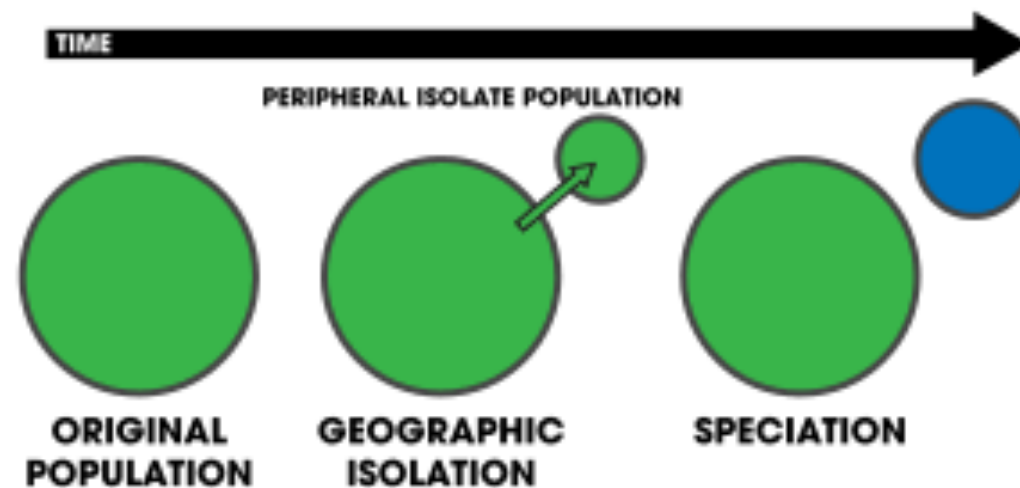
**Peripatric speciation** is a mode of speciation in which a new species is formed from an isolated peripheral population. Since **peripatric** speciation resembles allopatric speciation, in that populations are isolated and prevented from exchanging genes, it can often be difficult to distinguish between them, but does not require any “barriers”.



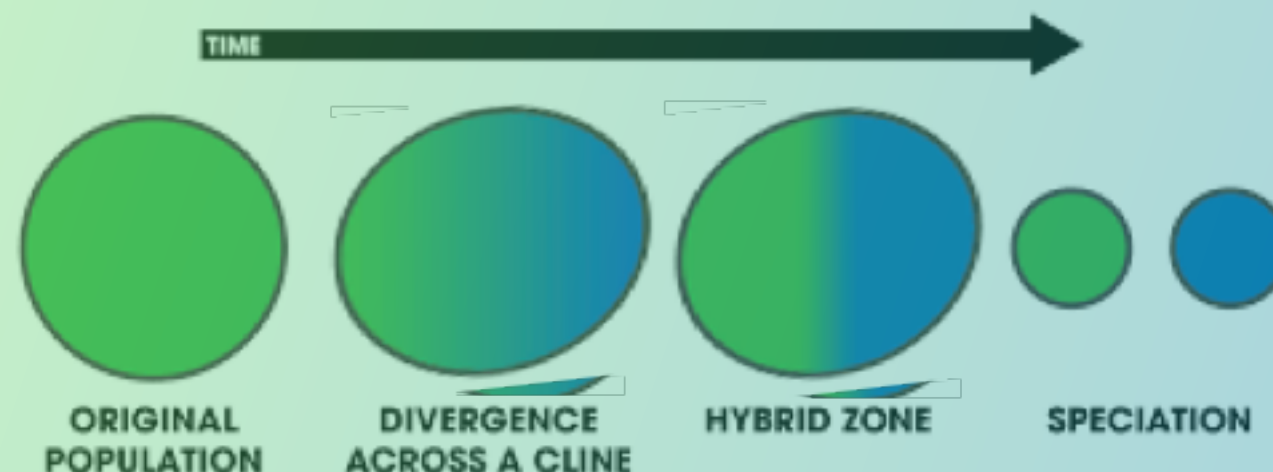
**Parapatric speciation** separates adjacent population, that may have initially separated as a consequence of reproductive isolation, coupled with some degree of migration, again -in the absence of any geographic barrier. **Parapatric** speciation is quite similar to sympatric speciation, but reflects some migration.



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**Allopatric: Speciation with no gene flow between diverging populations**

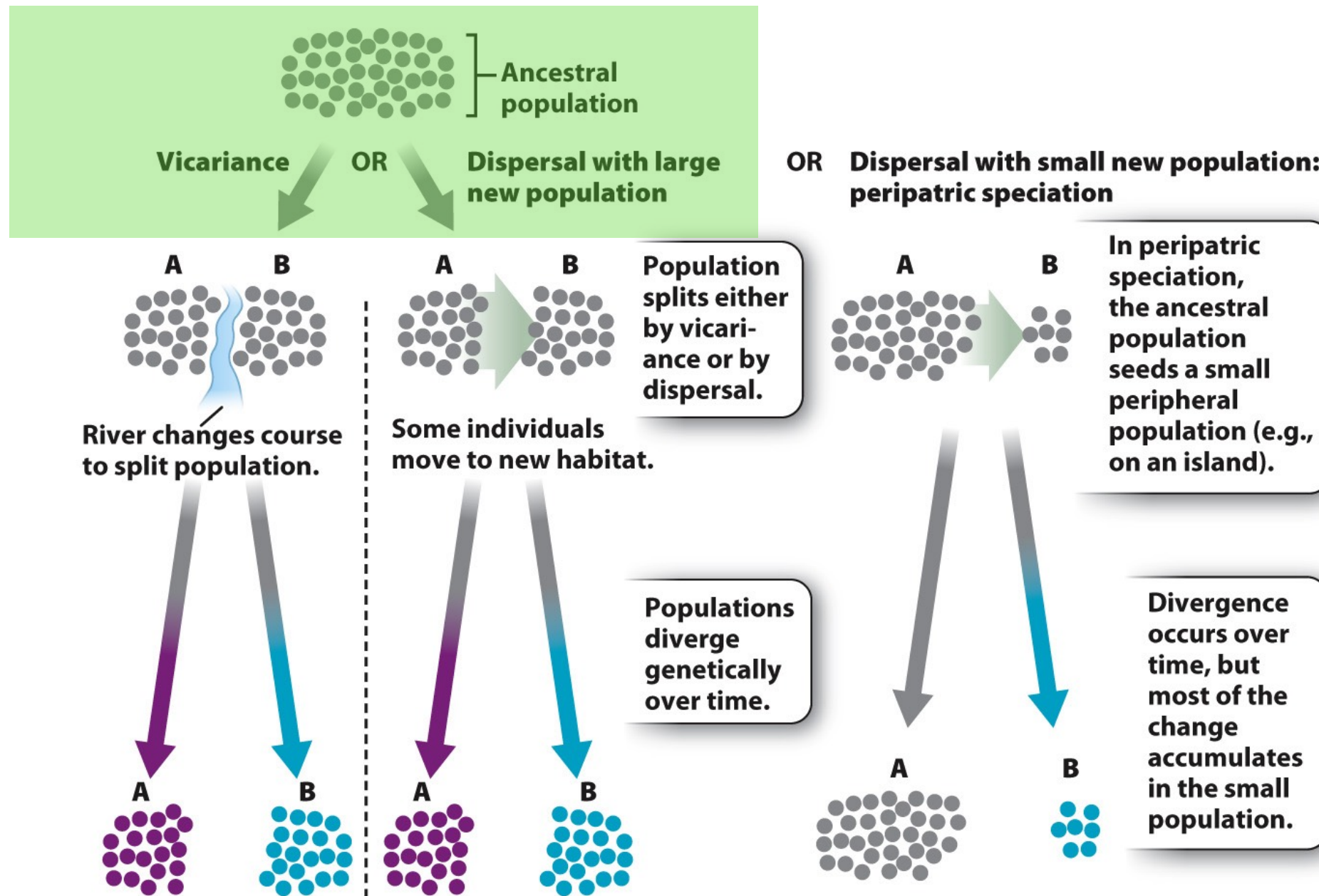
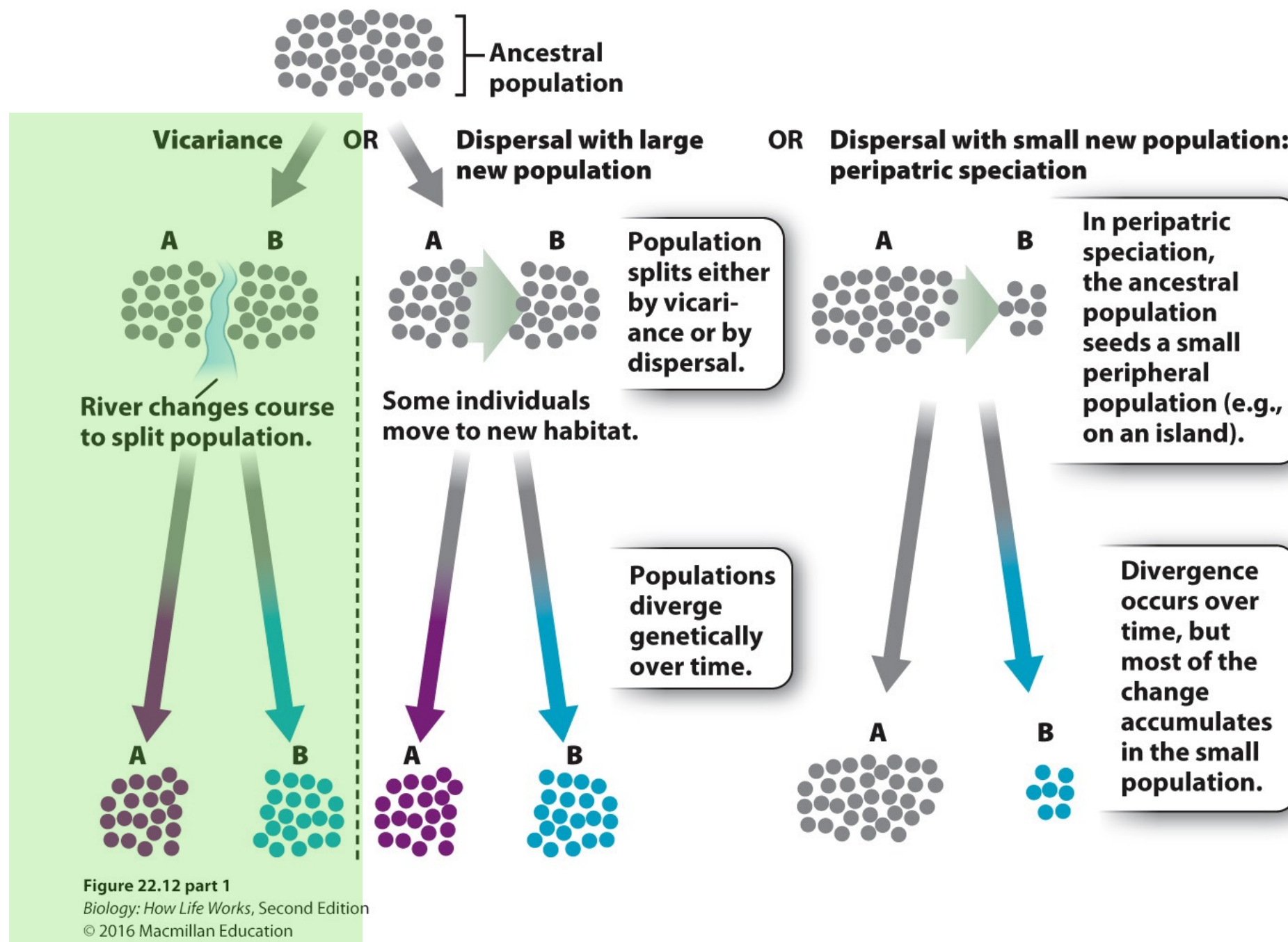


Figure 22.12 part 1  
 Biology: How Life Works, Second Edition  
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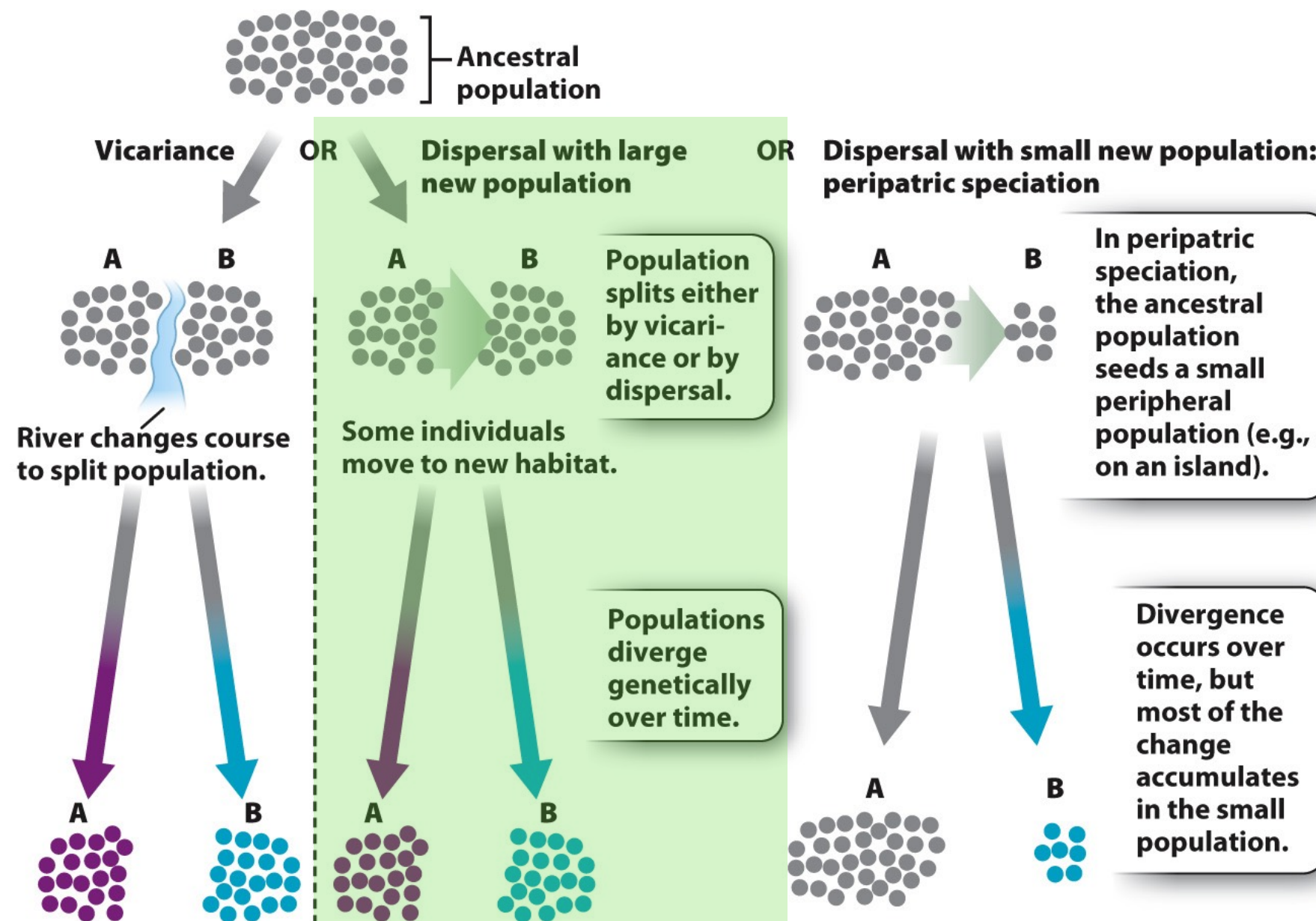


Figure 22.12 part 1  
 Biology: How Life Works, Second Edition  
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**Peripatric speciation** is a mode of speciation in which a new species is formed from an isolated peripheral population. Since **peripatric** speciation resembles allopatric speciation, in that populations are isolated and prevented from exchanging genes, it can often be difficult to distinguish between them, but does not require any “barriers”.

**Allopatric: Speciation with no gene flow between diverging populations**

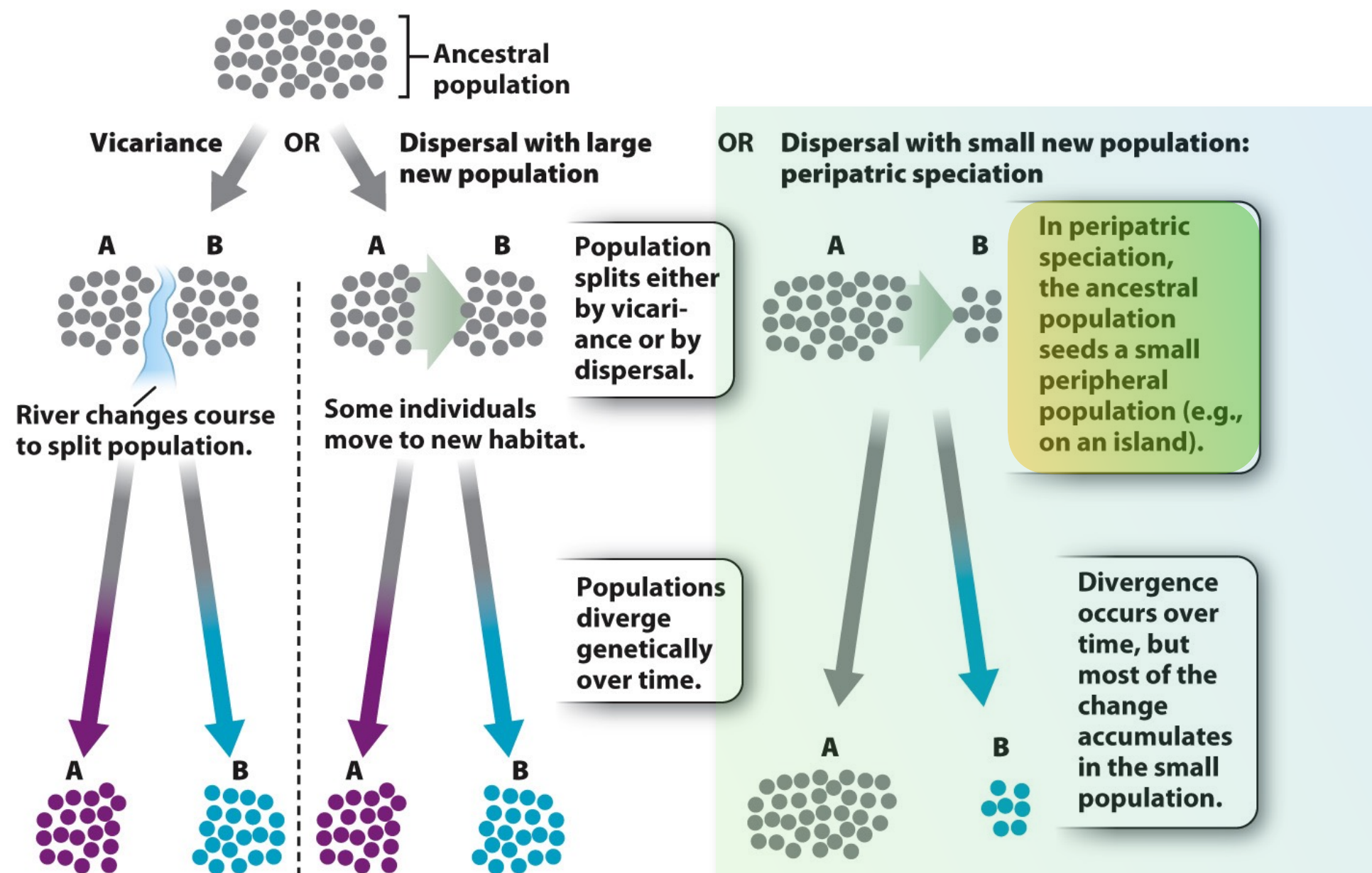
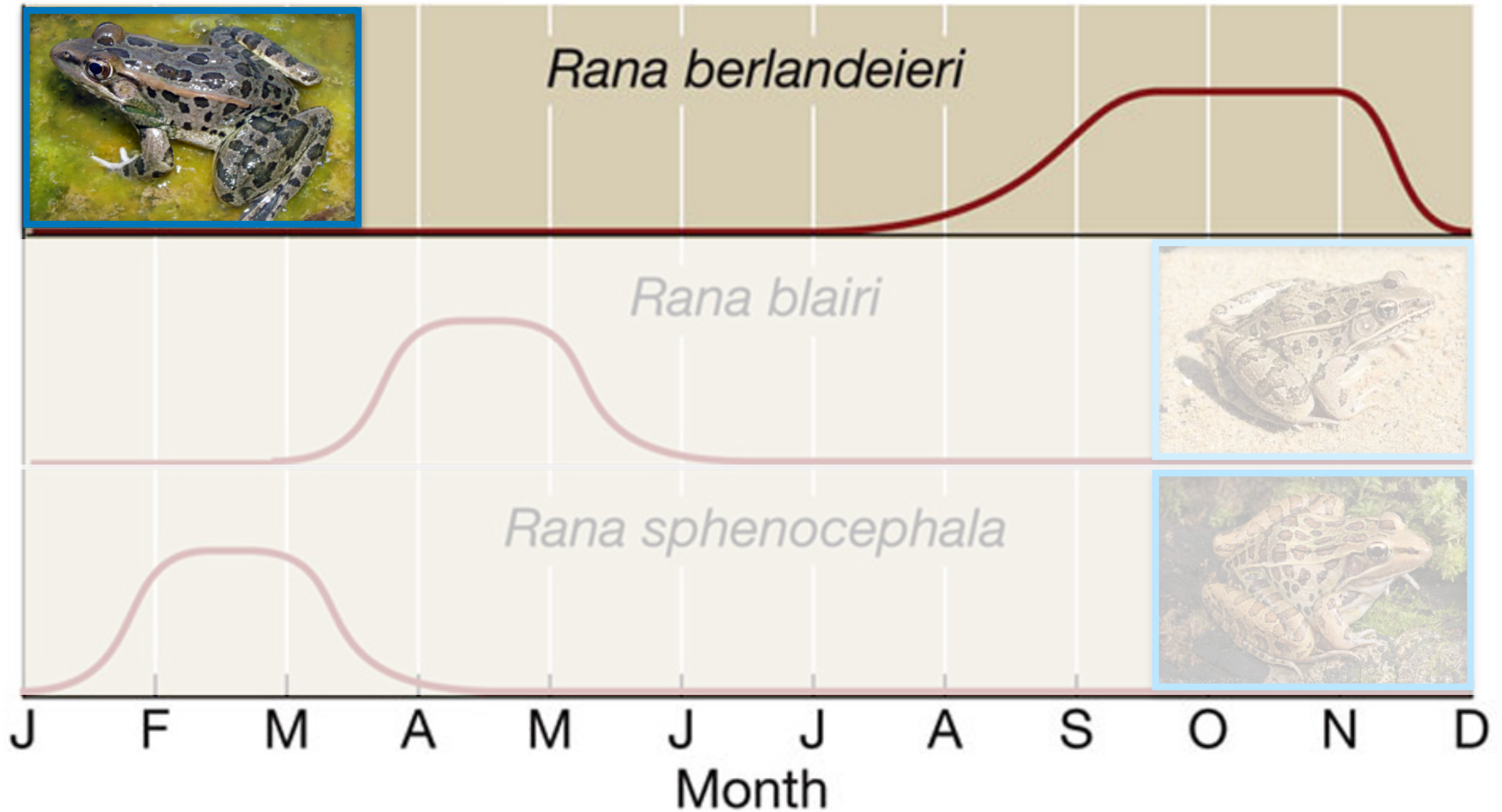


Figure 22.12 part 1  
 Biology: How Life Works, Second Edition  
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(B) Sympatry

Parasympatry, if it involves “migration”



LIFE 9e, Figure 23.9 (Part 2)

# Reproductive Isolating Mechanisms

**Prezygotic barriers** -operate before mating

Five **prezygotic** reproductive barriers have been described:

**Spatial isolation** -is the separation by location of inhabitation in the environment.

**Temporal isolation** -is the separation by differing mating seasons, or times of day.

**Mechanical isolation** -is the separation by differing shapes of reproductive organs.

**Gametic isolation** -is the separation by the inability of sperm from one species to fertilize the egg of another species.

**Behavioural isolation** -is the separation by behaviour, eg. lack of recognition of potential mates as mating partners.



# Reproductive Isolating Mechanisms

**Postzygotic barriers** -operate after mating.

If individuals of two different "species" still recognize one another and are able to mate, **postzygotic** reproductive barriers may prevent gene exchange.

There are three **postzygotic** reproductive barriers have been described, with the major two being:

**Low Hybrid viability** -the offspring just generally don't do so well.

**Hybrid zygote abnormality** -which is the failure of a hybrid zygote to develop in to a reproductively viable stage of life.

**Hybrid infertility** -the inability of a hybrid to reproduce. Hybrid offspring may survive less well than offspring resulting from matings within each species. All the offspring of one sex may be sterile, or all the offspring may be of only one sex. In nearly all cases of hybrid sterility and inviability, it is the sex that is heterozygous for the sex chromosomes that is absent or sterile.

**Mules / Hinnys** -derived from donkeys and horses- are one of the more readily known examples of this type of barrier, with a female mule only being born every once in a while.

## Reproductive Isolating Mechanisms

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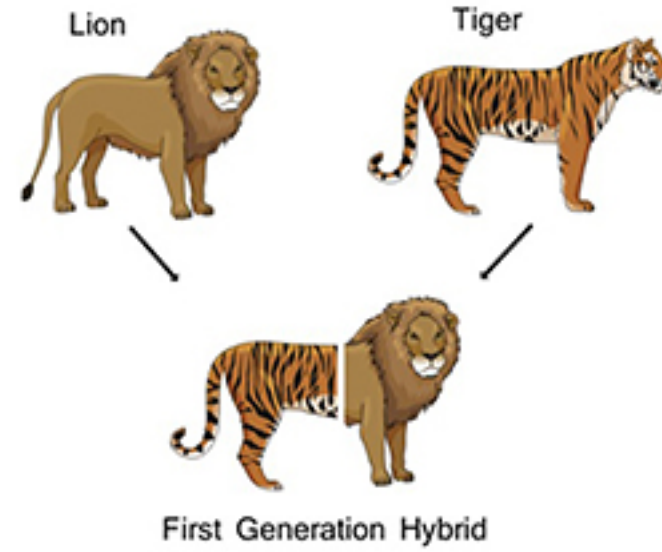
Ligers and Tigons



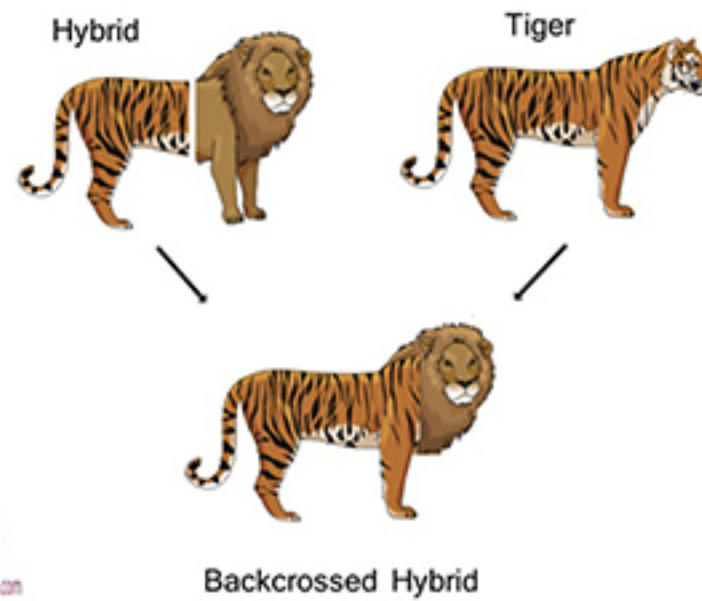
A)

Who's mating?

What genes does the offspring have?



■ Tiger ■ Lion



■ Tiger ■ Lion

WOTHE  
GRAPH.com

B)



Photo credit: Hkandy, WikimediaCommons

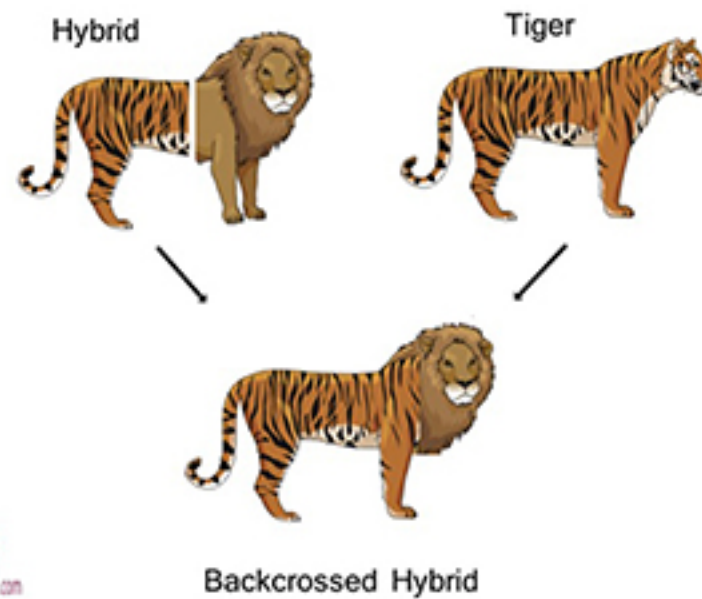
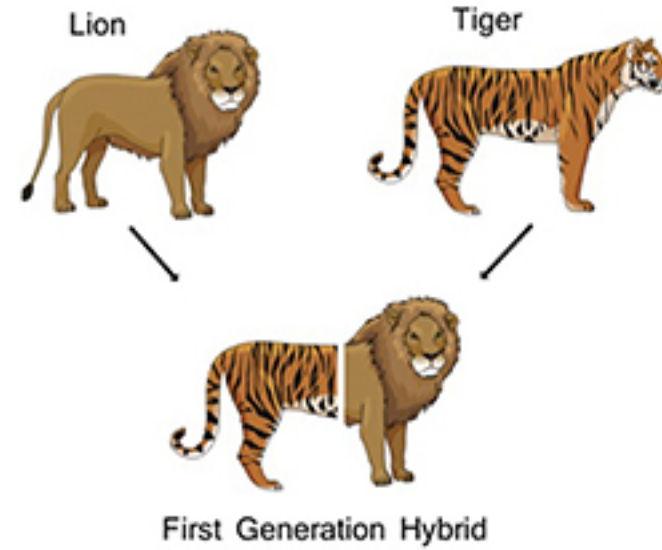




Ligers and Tigons



Who's mating?



What genes does the offspring have?



■ Tiger ■ Lion



■ Tiger ■ Lion

WOTHE  
GRAPH.com

Breaks ALL the rules from the **Biological Species Concept [BSC]** & the **Morphological Species Concept (MSC)**



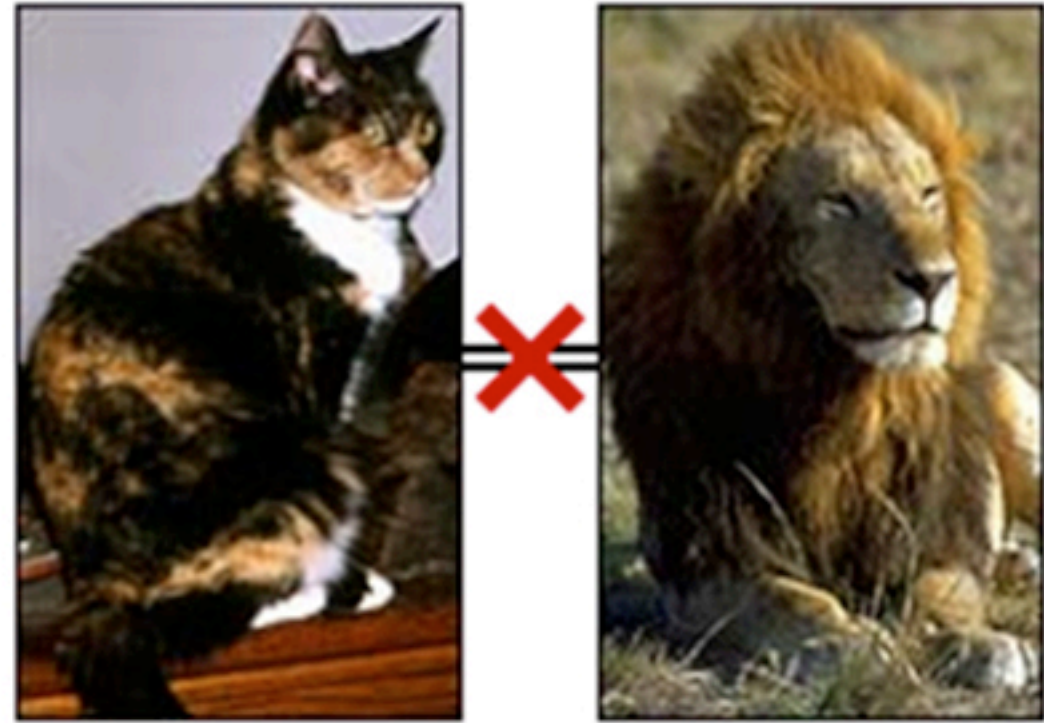
Orchids of these two different genera hybridize...



*Laelia*

*Cattleya*

...but cats of these two different genera do not.



*Felis*

*Panthera*

<http://evolution.berkeley.edu/evolibrary/>

Breaks ALL the rules from the  
**Biological Species Concept [BSC]** & the  
**Morphological Species Concept (MSC)**





**Figure 19.6**

Three examples of beak variation in Galápagos finches.



**(a) Cactus-eater.** The long, sharp beak of the common cactus finch (*Geospiza scandens*) helps it tear and eat cactus flowers and pulp.



**(c) Insect-eater.** The green warbler finch (*Certhidea olivacea*) uses its narrow, pointed beak to grasp insects.



**(b) Seed-eater.** The large ground finch (*Geospiza magnirostris*) has a large beak adapted for cracking seeds on the ground.

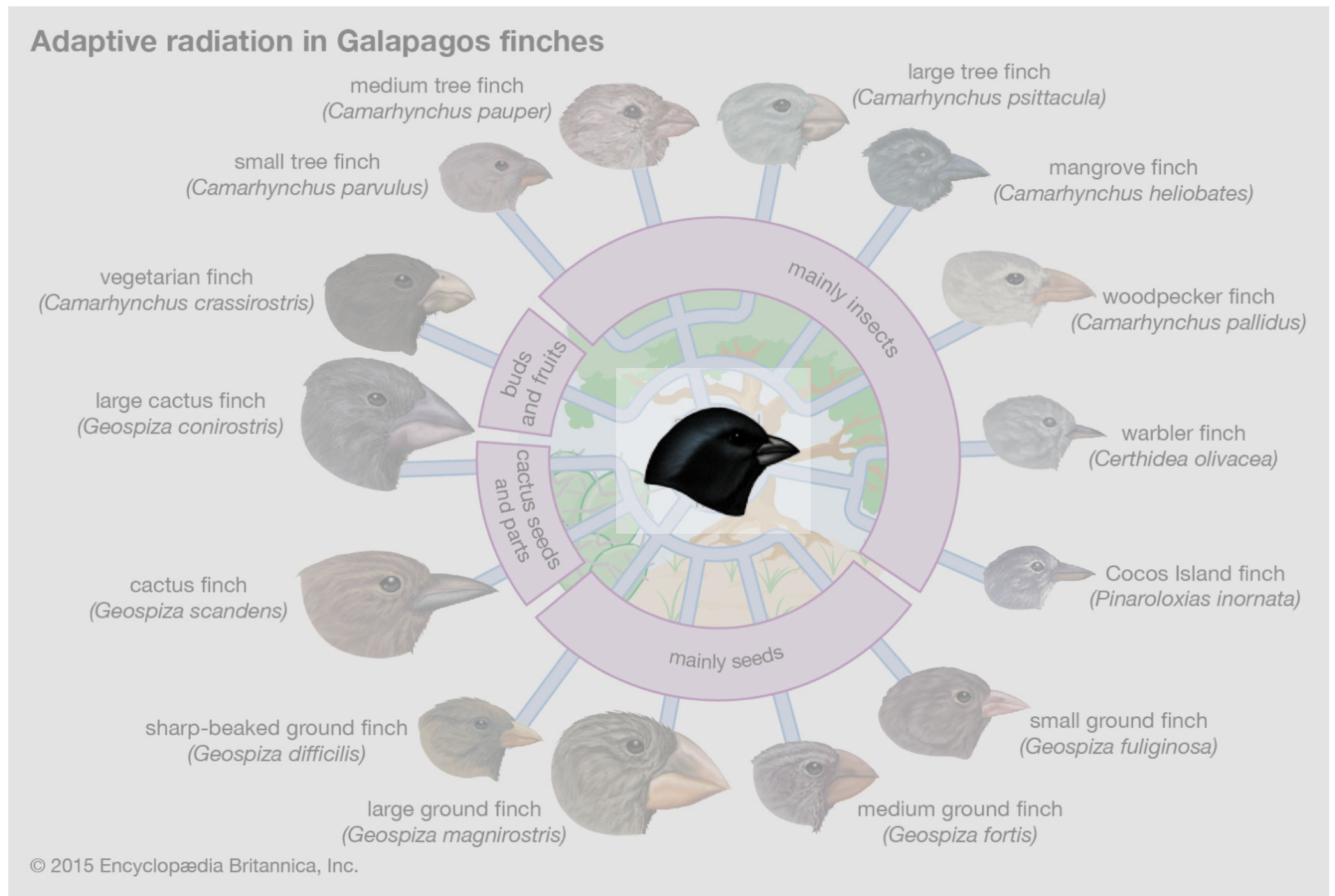
The Galápagos Islands are home to more than a dozen species of closely related finches, some found only on a single island. A striking difference among them is their beaks, which are adapted for specific diets.



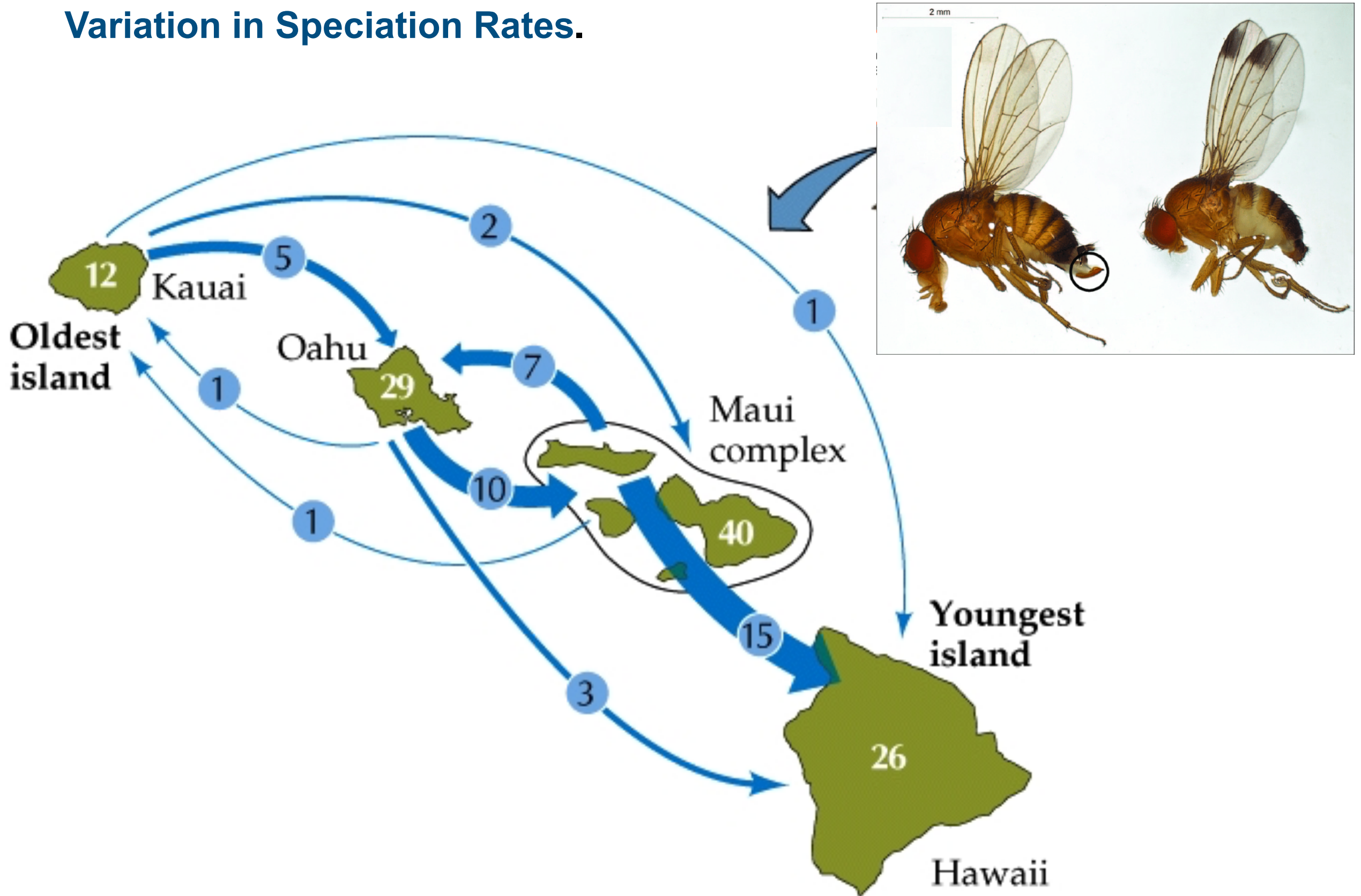


## Variation in Speciation Rates.

**Adaptive radiation** is a rapid increase in the number of species with a common ancestor, characterized by great ecological and morphological diversity. The driving force behind it is the adaptation of organisms to new ecological contexts.



# Variation in Speciation Rates.





## Variation in Speciation Rates.

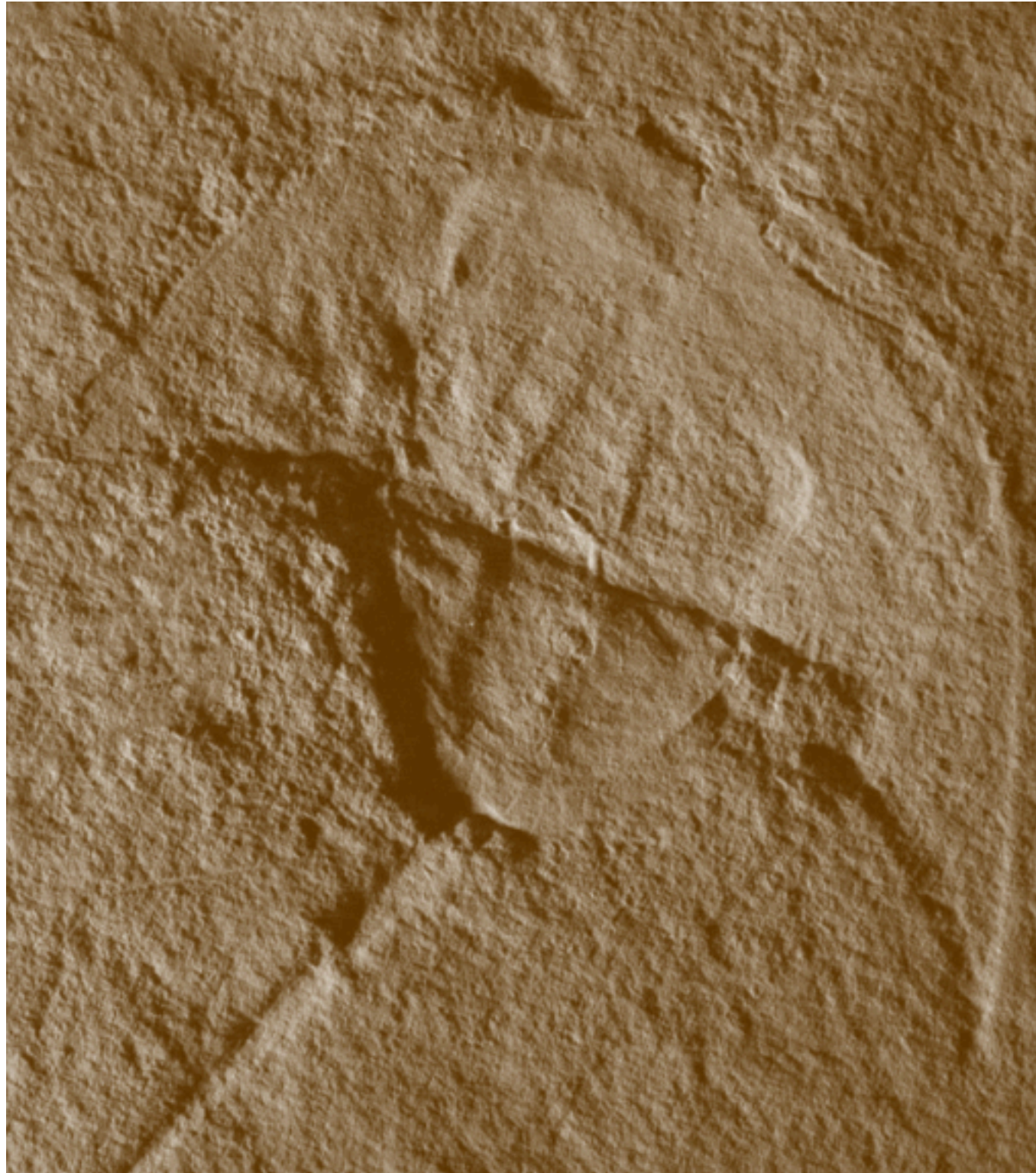
Species need not be very different and may differ in relatively few genes.



Hawaiian Fruit Flies



## Variation in Speciation Rates.



**“Darth Vader” Horse Shoe Crab... circa 145 million years ago**



# Variation in Speciation Rates.

## Behaviour may influence speciation rates

Populations of land snails may be separated by barriers as narrow as city streets, which -for the common garden snail- can be quite impressive barriers. Animals with complex behavior may speciate at a high rate because of choices of mates. Indeed, mate selection is probably a major contributor to rapid evolution as a consequence of reproductive isolation between species. Moreover, extremes of sexual selection: complex mating rituals, for example, may differentiate potential partners...parapatric speciation perhaps?

*Helix aspersa*



## Variation in Speciation Rates.

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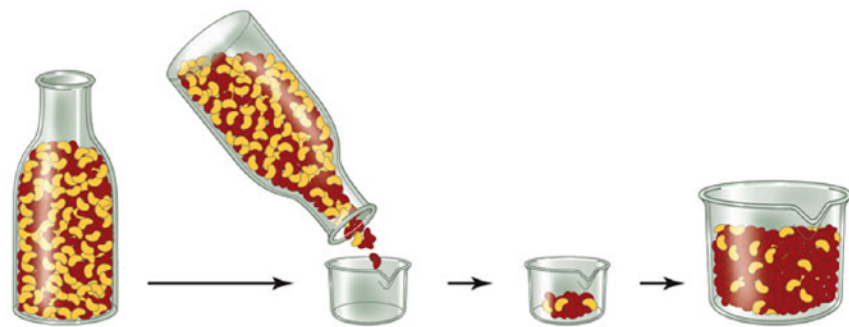


# Variation in Speciation Rates.

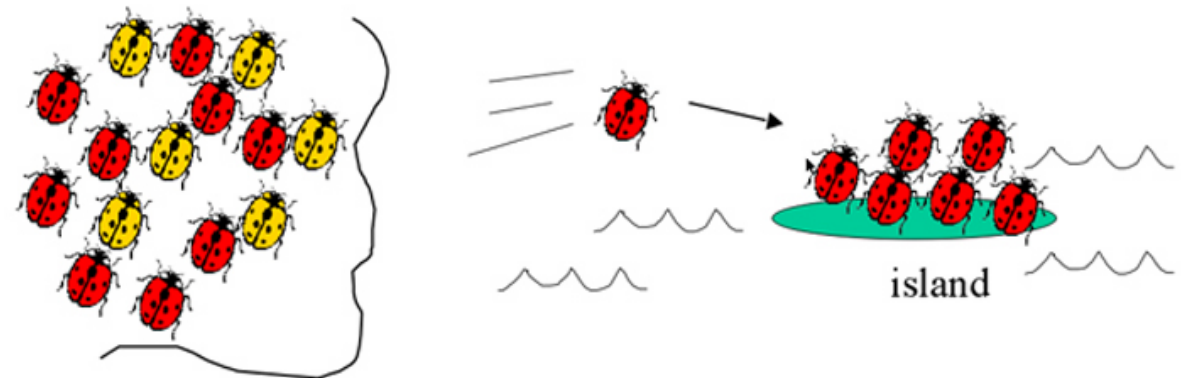
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**Population bottlenecks:** the significant alteration in the gene pool, resulting from a "**bottlenecks**" or "**founder-effects**" change, may result in new adaptive changes (within the population) that result in more rapid speciation.



- founder effect: a few individuals from a population start a new population with a different allele frequency than the original population



## Variation in Speciation Rates.

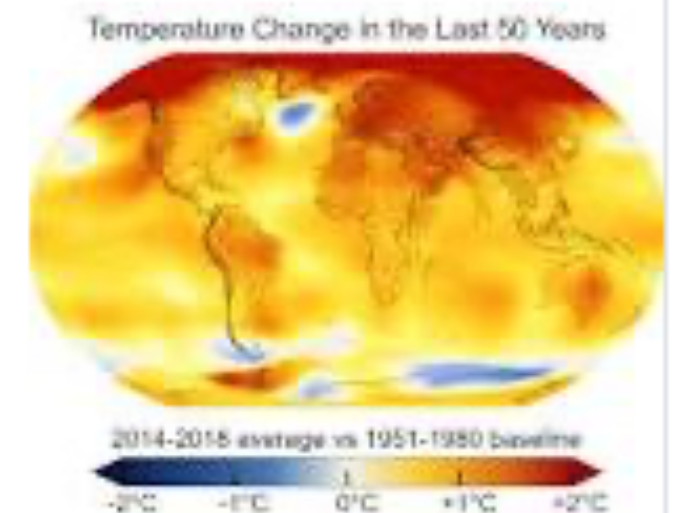
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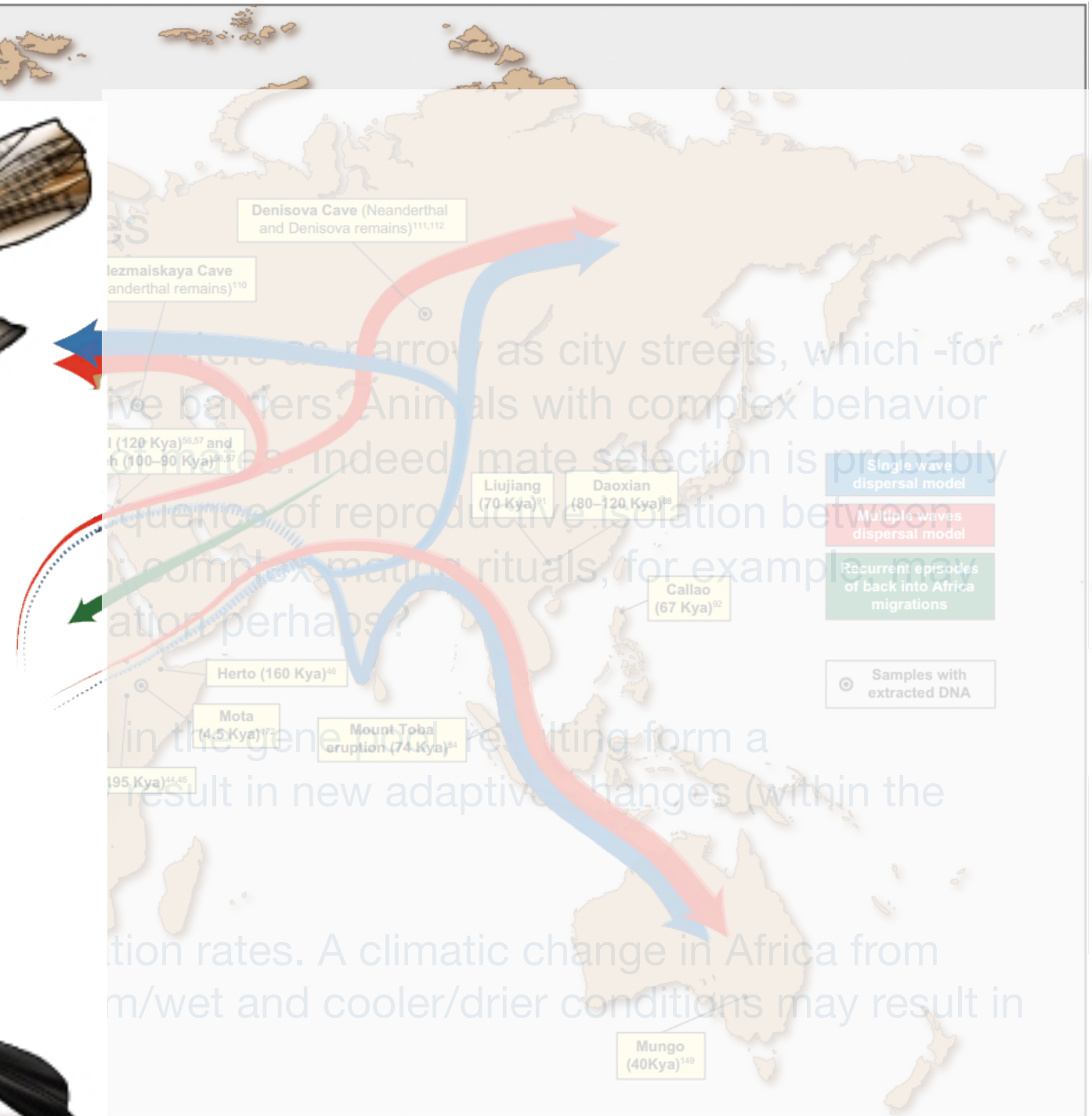
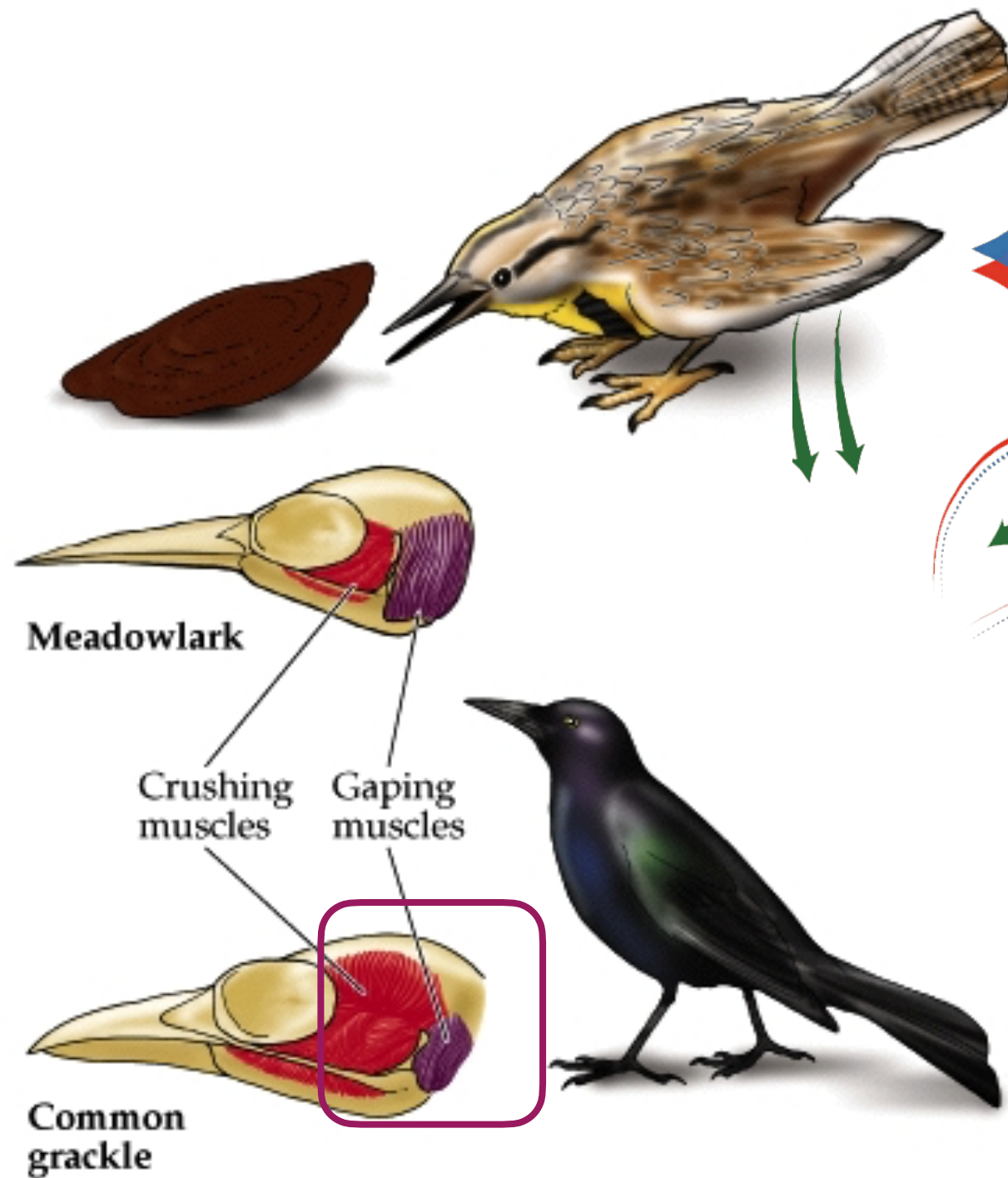
**Environmental changes:** may trigger high speciation rates. A climatic change in Africa from warm/wet to more rapid oscillations between warm/wet and cooler/drier conditions may result in a burst of changes.

# Global warming

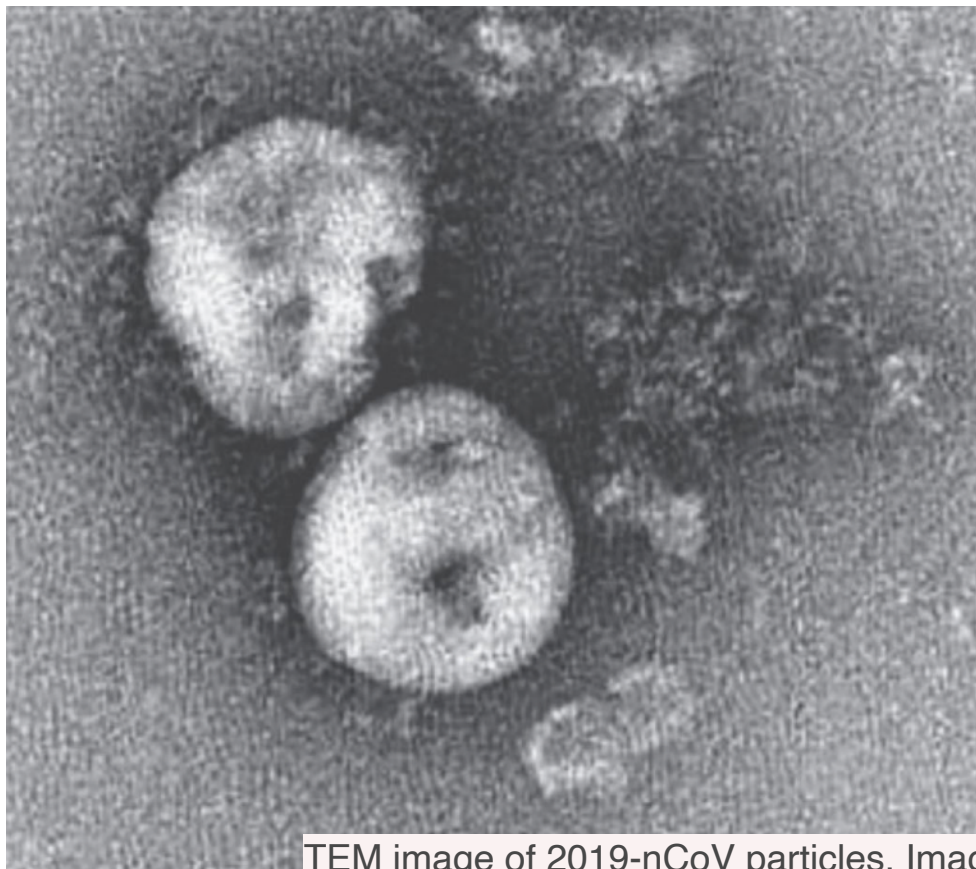




# Variation in Speciation Rates.



e.g. Stronger gaping muscles in some species of American blackbirds allow them to turn over objects on the ground where prey may be hiding. With the adaptation of "gaping", blackbirds have come to occupy nearly all habitat types in North and South America.



TEM image of 2019-nCoV particles. Image

Human **coronaviruses**. **Coronaviruses** are believed to cause a significant percentage of all **common** colds in human adults and children. **Coronaviruses** cause colds with major symptoms, e.g. fever, throat swollen adenoids, in humans primarily in the winter and early spring seasons.

Fortunately for us, most viral host transfers to infect the new hosts cause only single infections or limited outbreaks, and it is rare for a virus to cause an epidemic in a new host.

## Cross-Species Virus Transmission and the Emergence of New Epidemic Diseases

Colin R. Parrish, Edward C. Holmes, [...], and Peter Daszak

[Additional article information](#)

### ABSTRACT

Summary: Host range is a viral property reflecting natural hosts that are infected either as part of a principal transmission cycle or, less commonly, as “spillover” infections into alternative hosts. Rarely, viruses gain the ability to spread efficiently within a new host that was not previously exposed or susceptible. These transfers involve either increased exposure or the acquisition of variations that allow them to overcome barriers to infection of the new hosts. In these cases, devastating outbreaks can result.



## 2019 Novel Coronavirus, Wuhan, China

CDC > [2019 Novel Coronavirus Home](#)



🏠 [2019 Novel Coronavirus Home](#)

### 2019-nCoV Situation Summary

[Cases in the U.S.](#)

[Cases Globally](#)

[About 2019-nCoV](#)

[2019-nCoV FAQs](#)

[Information for Travelers](#)

[Healthcare Professionals](#)

[Public Health Professionals](#)

[Laboratories](#)

# 2019 Novel Coronavirus (2019-nCoV), Wuhan, China

This is an emerging, rapidly evolving situation and CDC will provide updated information as it becomes available, in addition to updated guidance.

Updated January 28, 2020

## Background

CDC is closely monitoring an outbreak of respiratory illness caused by a novel (new) coronavirus (named "2019-nCoV") that was first detected in Wuhan City, Hubei Province, China and which continues to expand. Chinese health officials have reported thousands of infections with 2019-nCoV in China, with the virus reportedly spreading from person-to-person in many parts of that country. Infections with 2019-nCoV, most of them associated with travel from Wuhan, also are being reported in a growing number of [international locations](#), including the [United States](#).

Coronaviruses are a large family of viruses that are common in many different species of animals, including camels, cattle, cats, and bats. Rarely, animal coronaviruses can infect people and then spread between people such as with [MERS](#) and [SARS](#).

### On This Page

[Background](#)

[Source and Spread of the Virus](#)

[Situation in U.S.](#)

[Illness Severity](#)

[Risk Assessment](#)

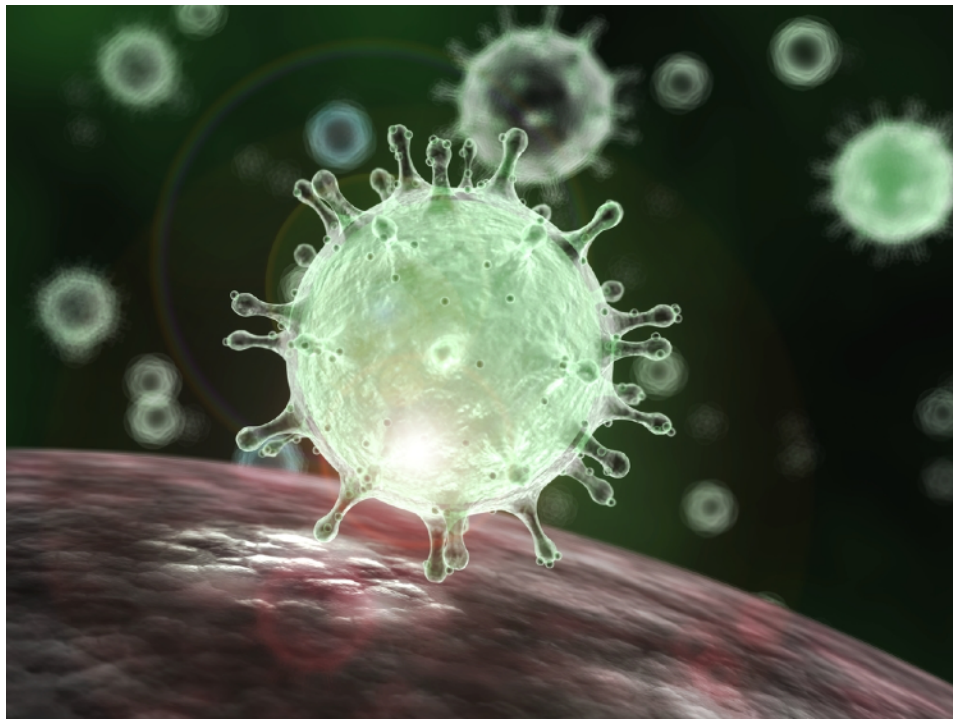
[What to Expect](#)

[CDC Response](#)

[CDC Recommends](#)

[Other Available Resources](#)

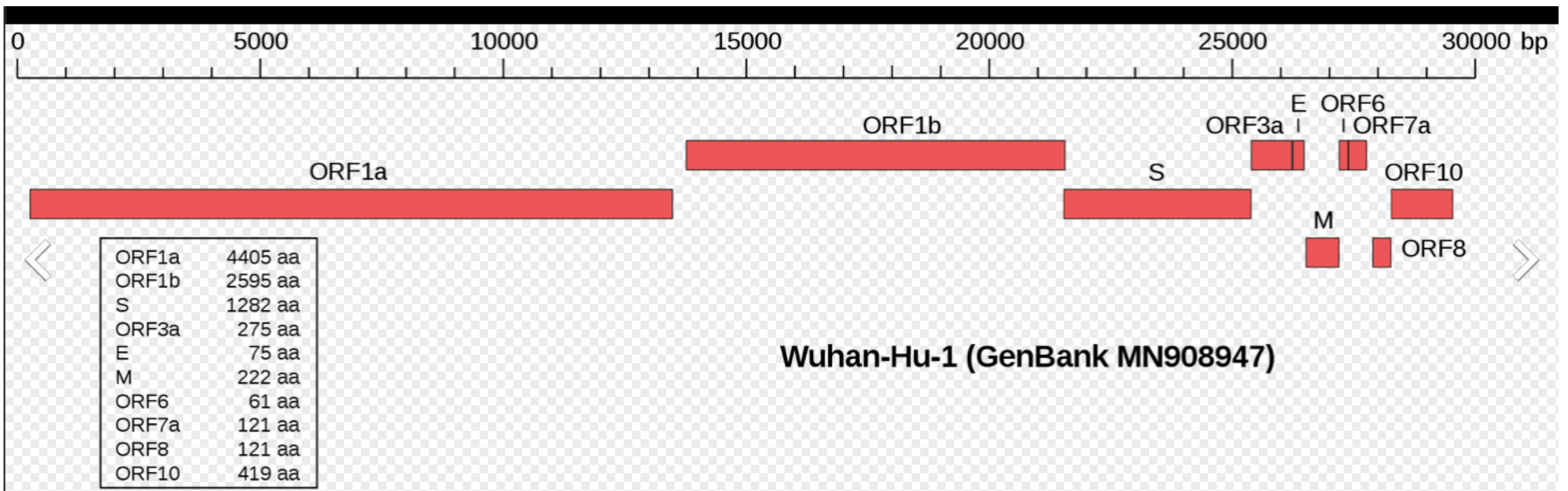
2019-nCoV is a betacoronavirus, like MERS and SARs, all of which have their origins in bats. The sequences from U.S. patients are similar to the one that China initially posted, suggesting a likely single, recent emergence of this virus from an animal reservoir.



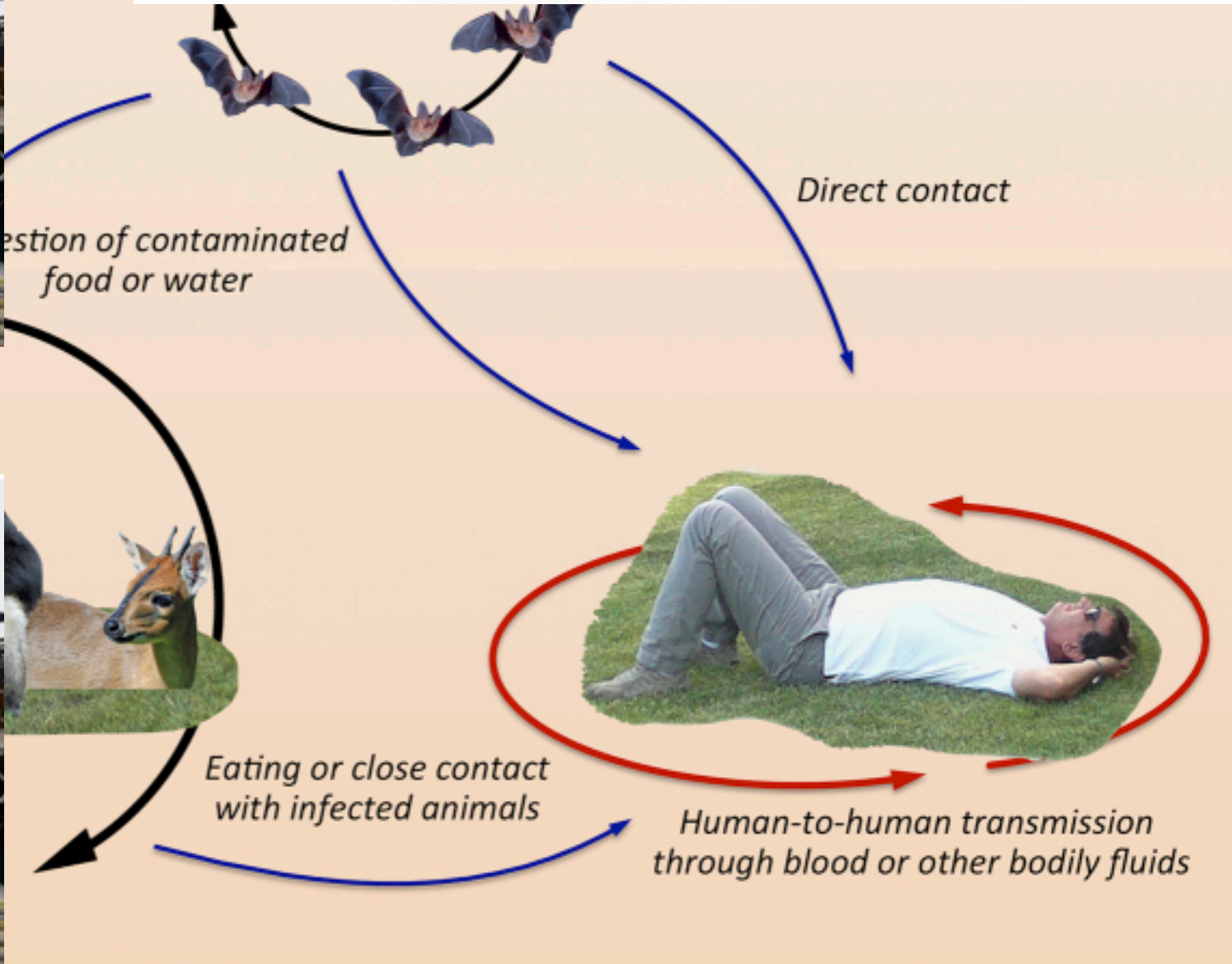
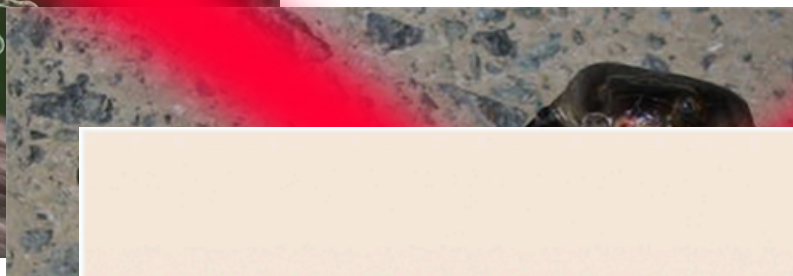
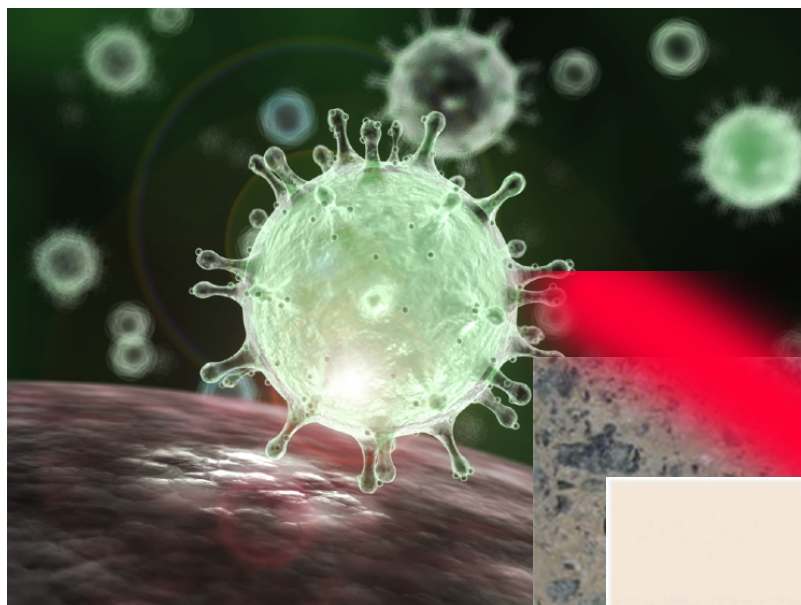
# Hunt for the genome sequence

**2019nCoV**

**2019nCoV -r0 -defined, as of a couple of days ago**









"By testing if the spike protein of a given virus can bind with cell receptors from different species, we're able to see if, in theory, the virus could infect this species," explained study co-author **Antoni Wróbel**. He is a postdoctoral training fellow in the Structural Biology of Disease Processes Laboratory at the Francis Crick Institute, in London.

## Pangolin coronavirus could jump to humans

"Importantly here, we've shown two key things. Firstly, that the bat virus would unlikely be able to infect pangolins.

### Peer-Reviewed Publication

And secondly, that a pangolin virus could potentially infect humans," Wróbel said in an institute news release.



The scientists used a technology called cryo-electron microscopy to see the pangolin coronavirus spike protein in minute detail. Some parts of the virus spike were quite similar to the human version, but others differed.

Scientists at the Francis Crick Institute have found important structural similarities between SARS-CoV-2 and a pangolin coronavirus, suggesting that a pangolin coronavirus could infect humans. Though the research uncovered that the bat coronavirus, known as RaTG13, could not bind with receptors in humans or pangolins, and that the pangolin coronavirus was able to bind to pangolin and human receptors... it still doesn't confirm whether the pangolin virus was a part of SARS-CoV-2's evolution to humans.

While SARS-CoV-2 is thought to have evolved from a bat coronavirus, its exact evolutionary path does not support possible scenarios for how this could happen, the researchers said.

undiscovered bat coronaviruses and, due to differences between bat coronaviruses and SARS-CoV-2, it is thought that the virus may have passed to humans via at least one other species.





TEM image of 2019-nCoV particles. Image credit: Zhu *et al*,

One thing everyone does agree on is that there's only one way to conclusively, definitively, undeniably establish which animal served as the bridge to humans—and that's collecting blood from every winged, webbed, and scaled creature that was in the wet market and analyzing them for the virus.

Finding antibodies would be a strong clue, but the live virus would be even better.

Those investigations are currently underway, according to World Health Organization officials... Until they turn something up, any guesses are just that...

CENTURY OF SCIENCE MICROBES

# Are viruses alive, not alive or something in between? And why does it matter?



We frequently talk about how to kill the coronavirus, but by most definitions, viruses aren't alive.

YUICHIRO CHINO/MOMENT/GETTY IMAGES

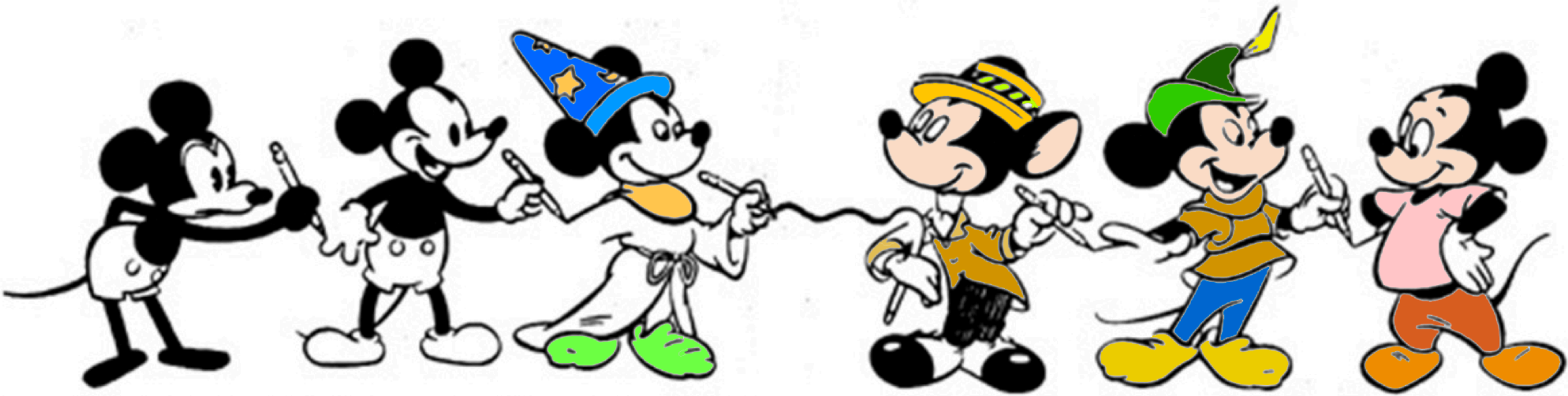
<https://www.sciencenews.org/article/viruses-alive-coronavirus-definition>



# KPCOFGS (redirected from *Kids Prefer Cheese Over Fried Green Spinach*)

Category filter:  

<b>Acronym</b>	<b>Definition</b>
KPCOFGS	Kingdom, Phylum, Class, Order, Family, Genus, Species ( <i>taxonomy order</i> )
KPCOFGS	Kings Play Chess on Funny Green Squares ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Keep Ponds Clean or Frogs Get Sick ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kinky People Come Over for Group Sex ( <i>taxonomy order</i> )
KPCOFGS	King Prawn Curry or Fat Greasy Sausages ( <i>taxonomy mnemonic</i> )
KPCOFGS	Kings Play Cricket on Flat Green Surfaces ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Ken Poured Coffee on Fran's Good Shirt ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Playing Cards on Freeways Get Smashed ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kingdom Phylum Class Order Family Genus Species King Philip Can Only Find Green Socks ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Pick Candy over Fancy Green Salads ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Kids Playing Chess on Freeways Get Smashed ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	Keep Paying Casey Off For Gun Sales ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )
KPCOFGS	King Paul Cried Out for Good Soup ( <i>mnemonic for taxonomy order: Kingdom, Phylum, Class, Order, Family, Genus, Species</i> )



Mickey's evolution during 50 years (left to right). As Mickey became increasingly well behaved over the years, his appearance became more youthful. Measurements of three stages in his development revealed a larger relative head size, larger eyes, and an enlarged cranium—all traits of juvenility. © Walt Disney Productions



Time





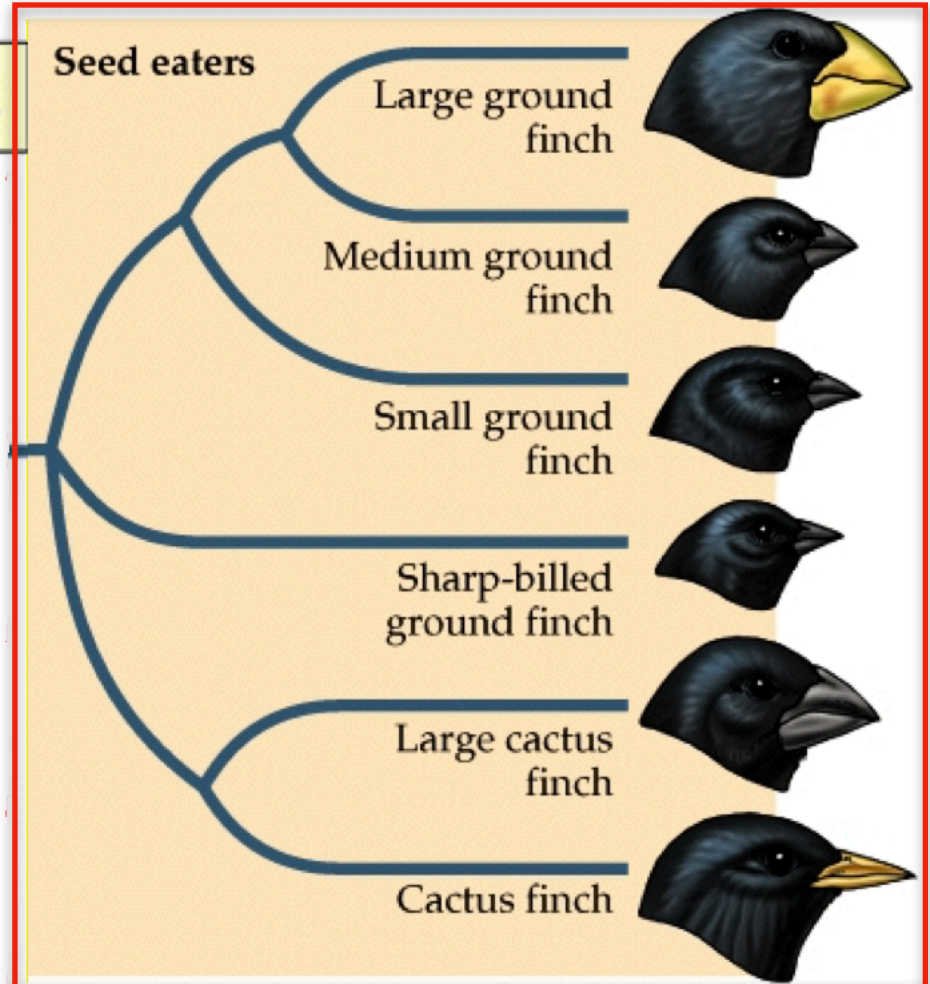
**Charmander - Charmeleon - Charizard**

**LA**

# Allopatric speciation: Darwin's finches



ANCESTOR FINCH  
from South American  
mainland: Blue-black  
grassquit



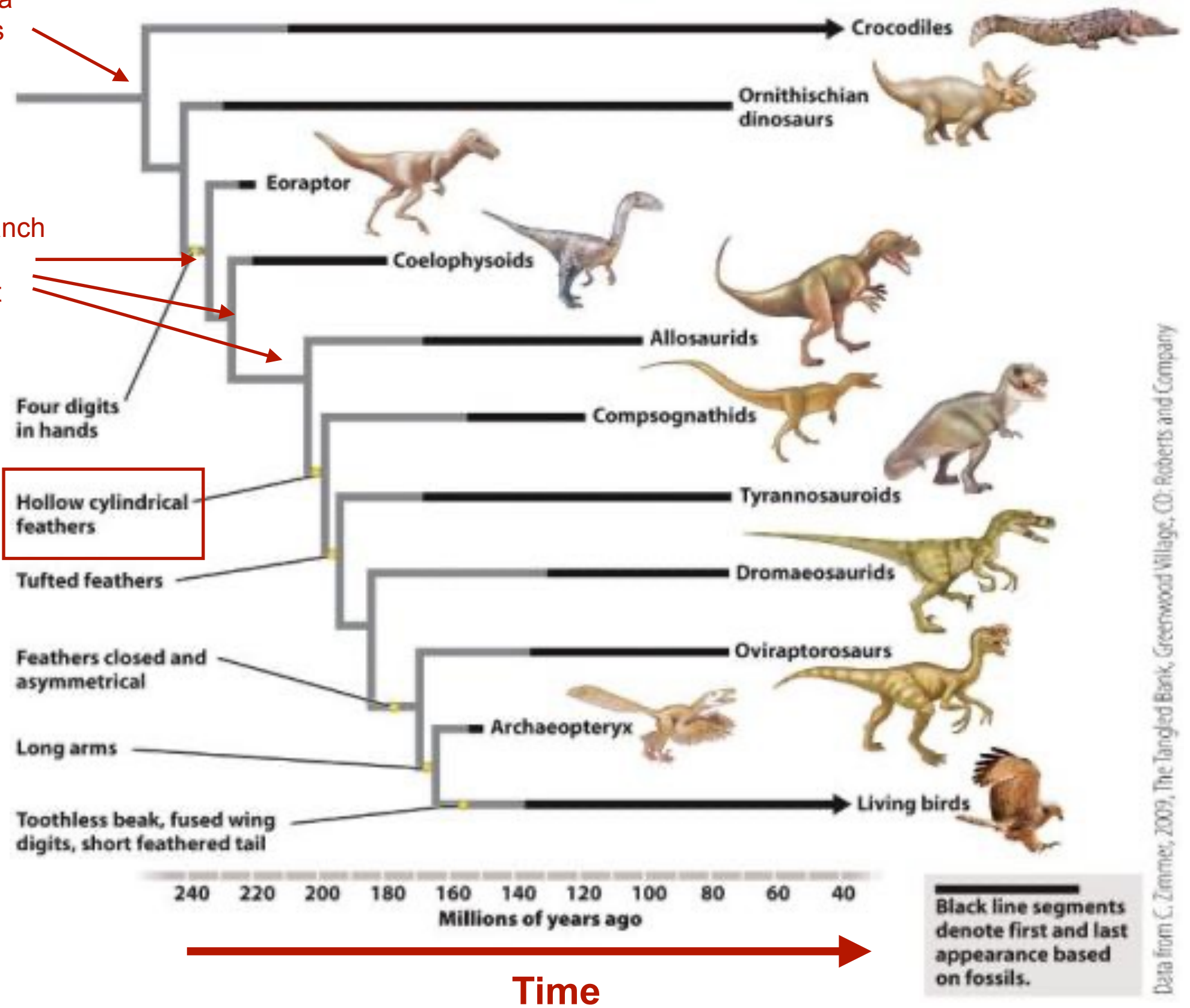
© 2001 Sinauer Associates, Inc.





Split indicates the division in a population forming 2 species

The temporal position of the branch points denotes the order in which the population split

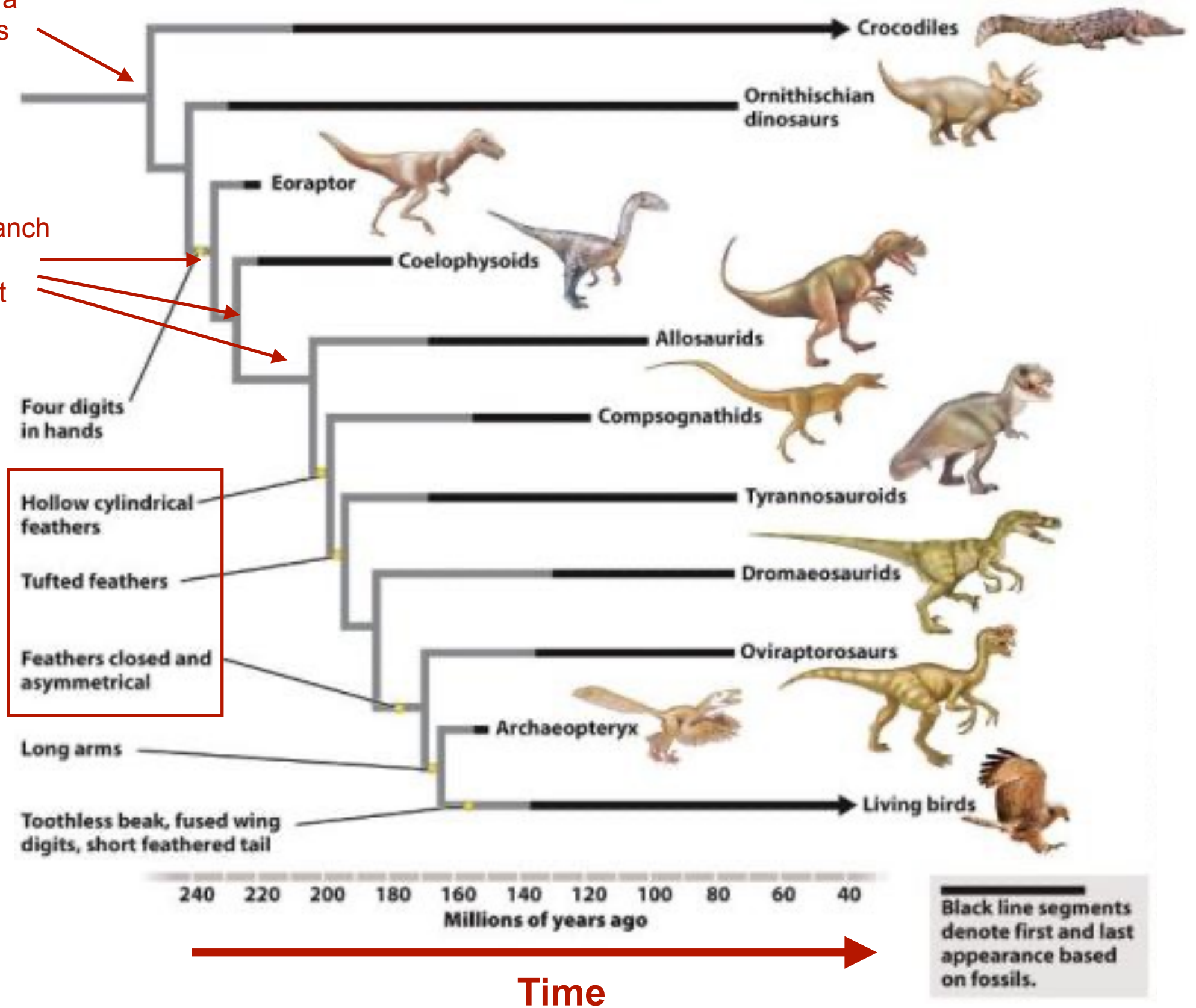


Data from C. Zimmerman, 2009, The Tangled Bank, Greenwood Village, CO: Roberts and Company

## Dinosaur and Bird Phylogeny (1 of 2)

Split indicates the division in a population forming 2 species

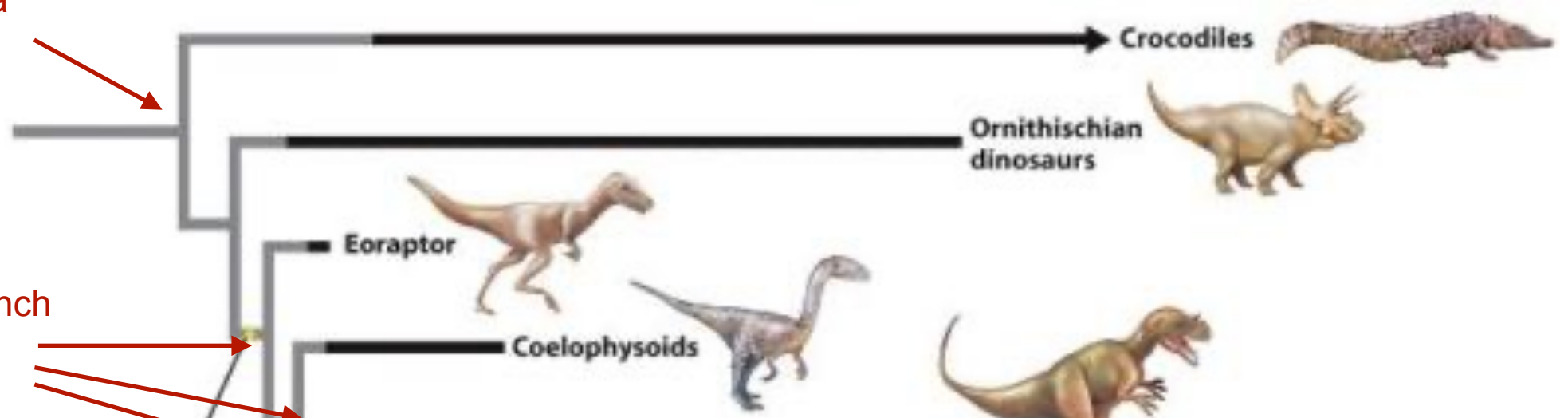
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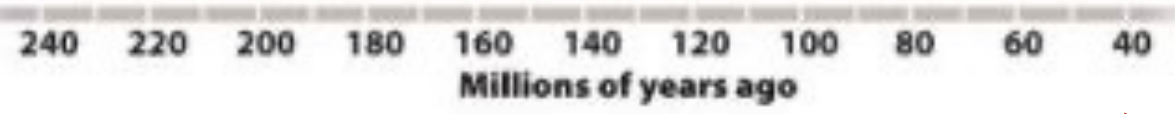
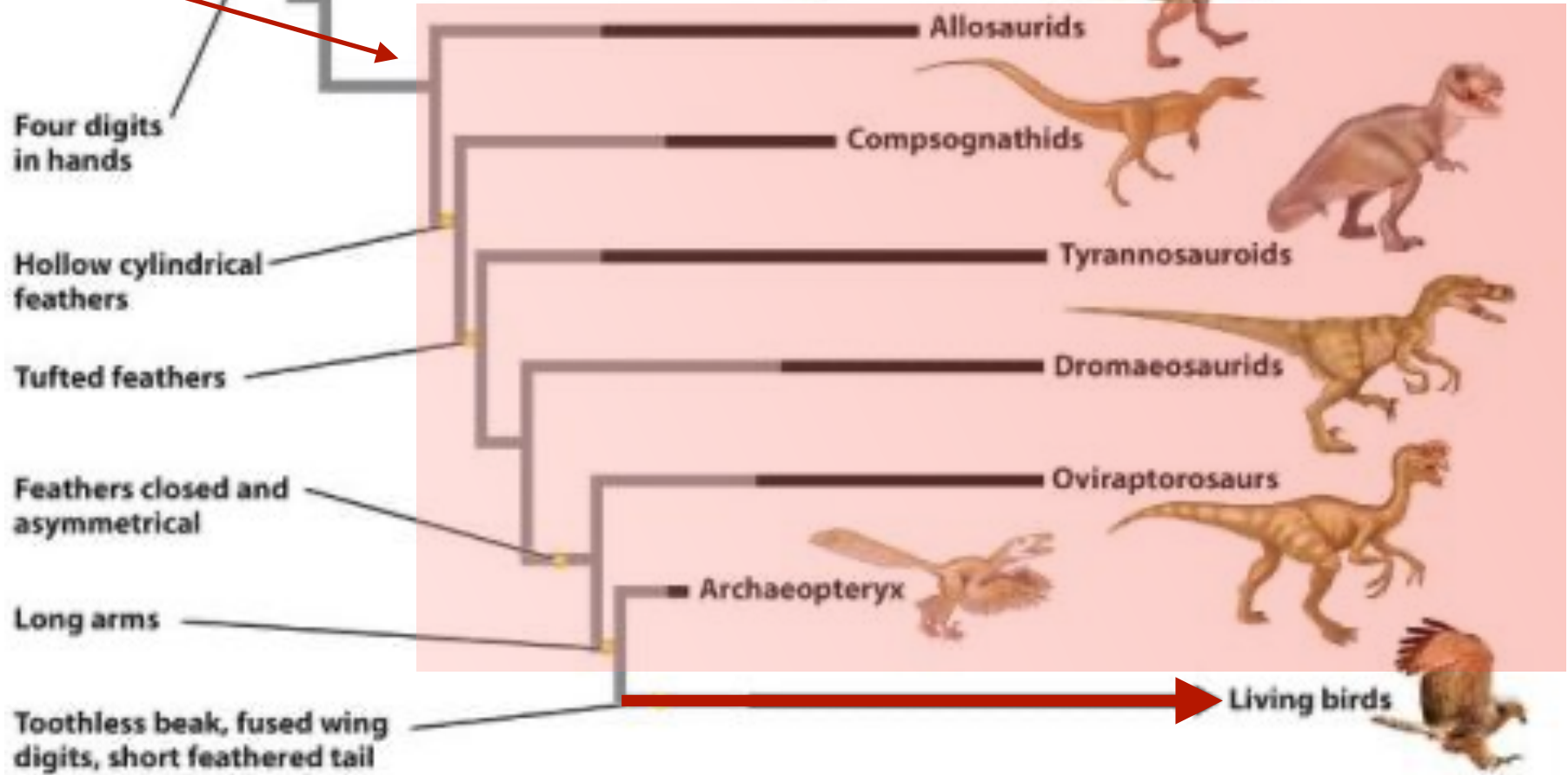
## Dinosaur and Bird Phylogeny (1 of 2)



Split indicates the division in a population forming 2 species



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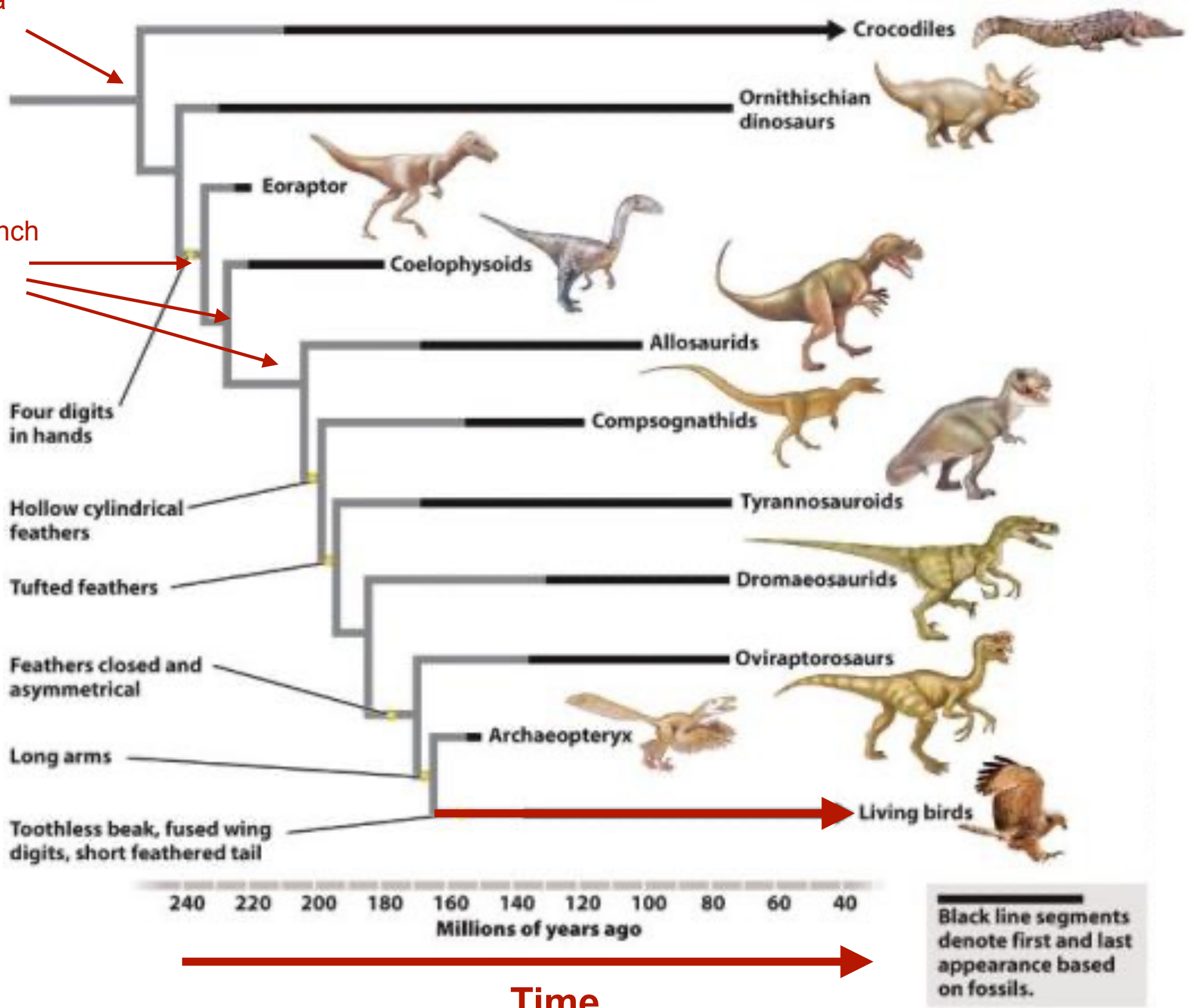


Time

Black line segments denote first and last appearance based on fossils.

## Dinosaur and Bird Phylogeny (1 of 2)

Split indicates the division in a population forming 2 species



The temporal position of the branch points denotes the order in which the population split

Four digits in hands

Hollow cylindrical feathers

Tufted feathers

Feathers closed and asymmetrical

Long arms

Toothless beak, fused wing digits, short feathered tail

Time

240 220 200 180 160 140 120 100 80 60 40  
Millions of years ago

Black line segments denote first and last appearance based on fossils.

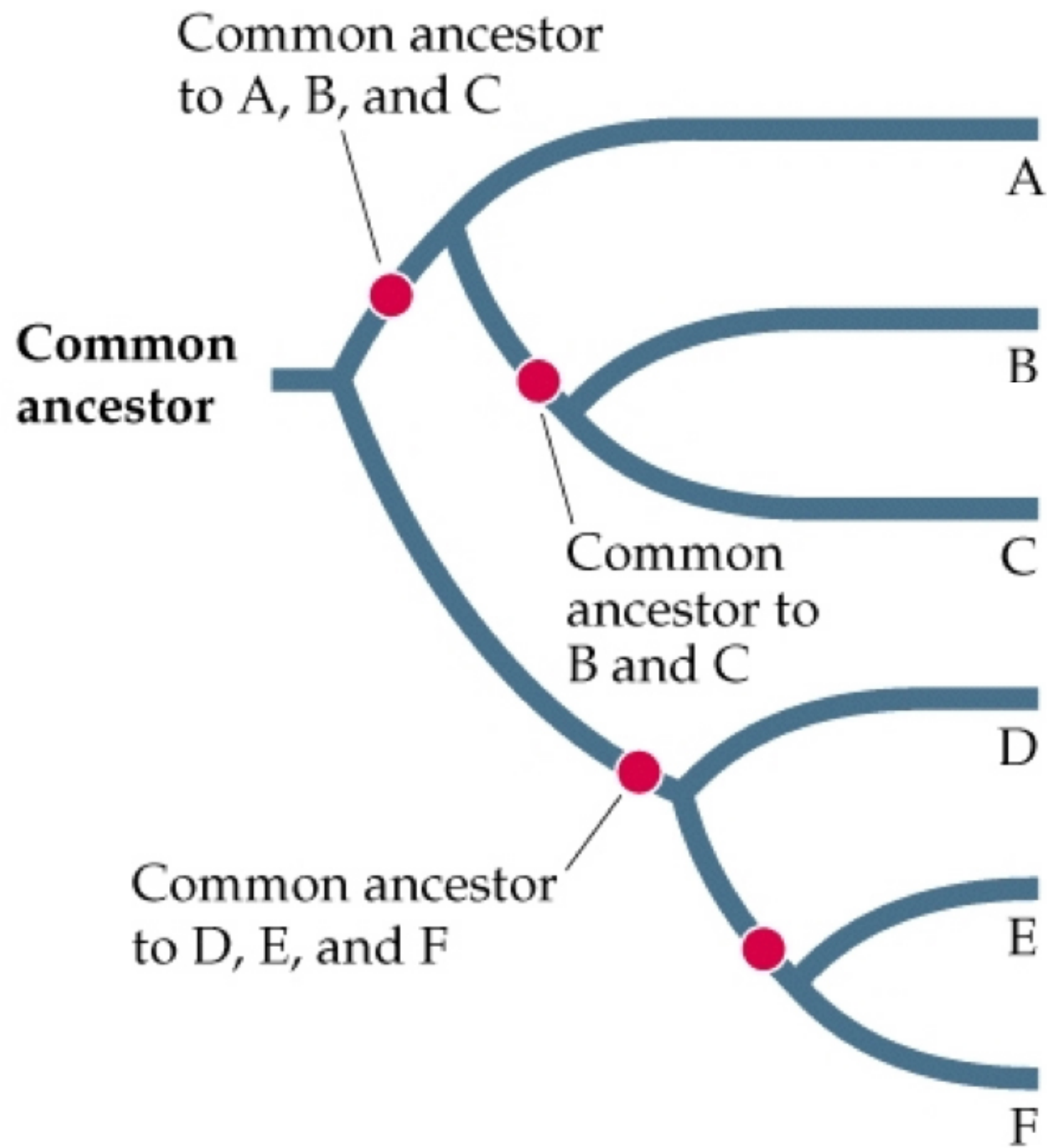
# Dinosaur and Bird Phylogeny (1 of 2)



## Reading Phylogenies



The evolutionary relationships among groups of organisms are commonly depicted as a branching tree called a phylogeny.



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**paraphyletic taxon:**  
includes some but not  
all descendants of a  
single ancestor

**polyphyletic taxon:**  
contains members with  
more than one recent  
common ancestor

**monophyletic taxon:**  
includes all  
descendants of a  
single ancestor



## 23.1 Eight Vertebrates Ordered According to Unique Shared Derived Traits

TAXON	DERIVED TRAIT <sup>a</sup>						
	JAWS	LUNGS	CLAWS OR NAILS	FEATHERS	FUR	MAMMARY GLANDS	FOUR- CHAMBERED HEART
Hagfish	-	-	-	-	-	-	-
Perch	+	-	-	-	-	-	-
Salamander	+	+	-	-	-	-	-
Lizard	+	+	+	-	-	-	-
Crocodile	+	+	+	-	-	-	+
Pigeon	+	+	+	+	-	-	+
Mouse	+	+	+	-	+	+	+
Chimpanzee	+	+	+	-	+	+	+

<sup>a</sup>A plus sign indicates the trait is present, a minus sign that it is absent.

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**“Operational Taxonomic Unit” ... OTU**

