

# Ideas That Shaped Darwin's Thinking

# Learning Targets

- Describe ideas and discoveries that influenced Darwin's theory of evolution.

# Before Darwin

- During Darwin's time, most Europeans believed that the Earth and all its forms of life had been created only a few thousand years ago and had not changed since creation.
- Rocks and major geological features were thought to have been produced suddenly by catastrophic events that humans rarely, if ever, witnessed.
- People thought the Earth was YOUNG.

# Before Darwin

- By the time Darwin set sail, numerous fossil discoveries had produced evidence that life on Earth had changed.
- Some scientists adjusted their ideas to include several periods of creation, each preceded by a catastrophic event that killed off many forms of life.
- Darwin began to realize that his observations also did not fit with the view that life was unchanging.

# An Ancient, Changing Earth

- During the 18<sup>th</sup> and 19<sup>th</sup> centuries, scientists studied the Earth in great detail and gathered information suggesting that Earth was very old and had changed slowly over time.
- Two scientists who formed important theories based on this evidence were James Hutton and Charles Lyell.
- Hutton and Lyell helped scientists recognize that Earth is many millions of years old, and the processes that changed the Earth in the past are the same processes that change it today.

# Hutton and Geological Change

- In 1795, geologist James Hutton proposed that layers of rock form very slowly.
- Some rocks are moved up by forces beneath the Earth's surface, others are buried and still others are pushed up from the sea floor to form mountains ranges.
- The resulting rocks, mountains, and valleys are then shaped by rain, wind, heat and cold temperatures (weathering and erosion).

# Hutton and Geological Change

- Most of these processes operate extremely slowly, often over millions of years.
- Hutton proposed that Earth had to be much more than a few thousand years old.

# Lyell's Principles of Geology

- Just before Darwin set sail, he was given the first volume of geologist Charles Lyell's book *Principles of Geology*.
- Lyell stressed that the same processes that shaped the Earth millions of years earlier continue in the present.
- Volcanoes release hot lava and gases now, just as they did on ancient Earth.
- Erosion continues to carve out canyons, just as it did in the past.
- Lyell's work explained how awesome geological features could be built up or worn down over long periods of time.



# Lyell's Principles of Geology

- Lyell helped Darwin appreciate the significance of geological phenomena that he had observed on his journey.
- Darwin had witnessed a spectacular volcanic eruption.
- Darwin wrote about an earthquake that had lifted a stretch of rocky shoreline – with mussels and other animals attached to it – more than 3 meters above its previous position.
- He noted that fossils of marine animals were displaced many feet above sea level.
- Darwin then understood how geological processes could have raised these rocks from the sea floor to a mountaintop.

# Lyell's Principles of Geology

- This understanding of geology influenced Darwin in two ways.
  1. Darwin thought that if the Earth could change over time, life might change as well.
  2. Darwin also realized that it would have taken many, many years for life to change in the way he suggested.
- This would have been possible only if the Earth were extremely old.

# Lamarck

- French naturalist, Jean-Baptiste Lamarck was among the first scientists to recognize that living things have changed over time – and that all species were descended from other species.
- He also recognized that organisms were somehow adapted to their environments.
- In 1809, the year Darwin was born, Lamarck published his hypothesis.

# Lamarck

- Lamarck proposed that all organisms have an innate (inborn) tendency toward complexity and perfection.
- As a result, by selective use of disuse of organs, organisms acquired certain traits during their life time that they were not born with or lost certain traits that they were born with in order to live more successfully in their environment.
- He thought that these traits could then be passed on to their offspring.
- Over time, this process led to change in a species (evolution).

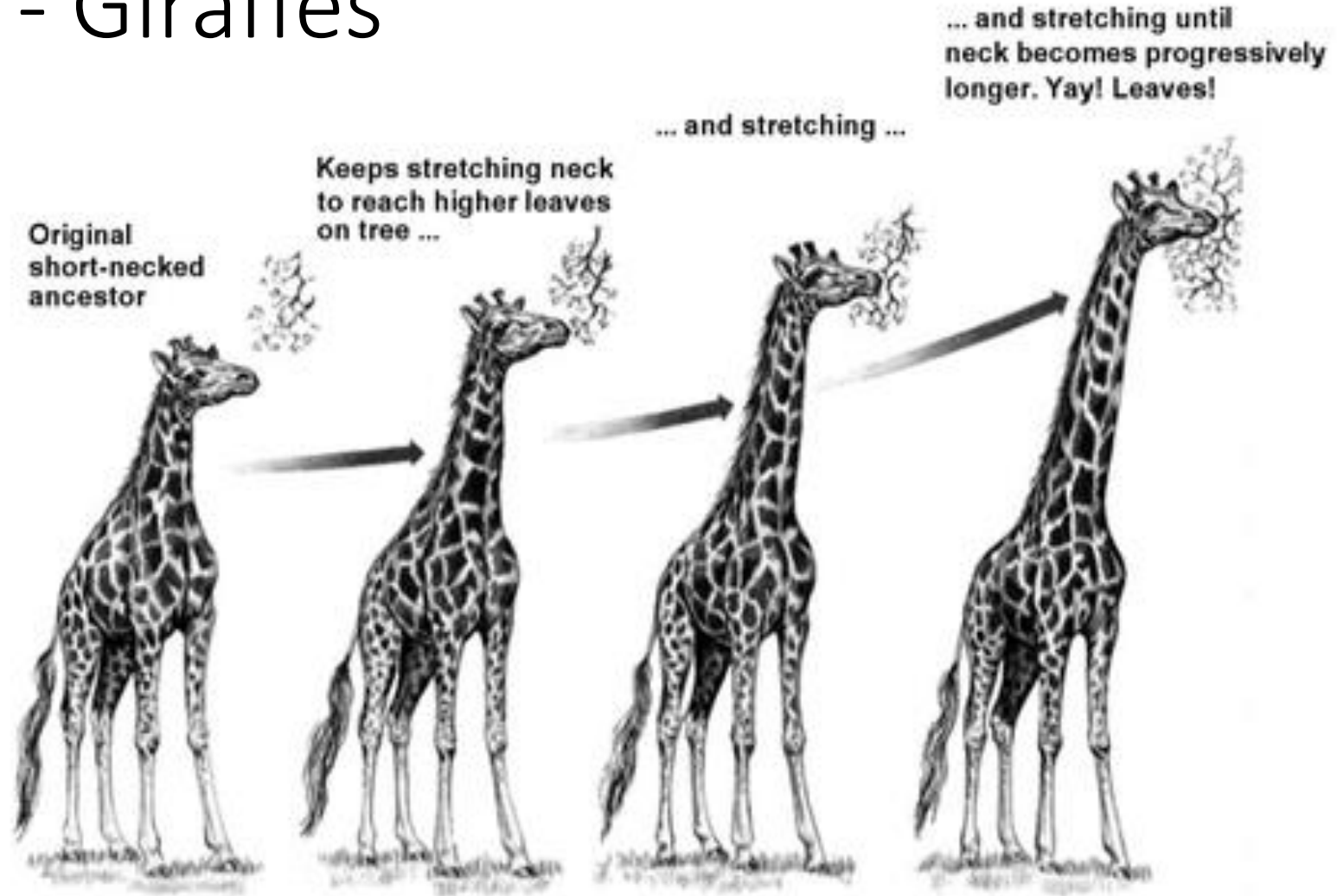
# Lamarck – Examples

- According to Lamarck, the ancestors of birds acquired an urge to fly.
- They began trying to use their front limbs to fly.
- Over many generations, as birds kept trying to fly, eventually their front limbs were transformed into wings.
- Conversely, if a winged animal did not use its wings – an example of disuse – the wings would decrease in size over generations and finally disappear.

# Lamarck – Webbed Feet



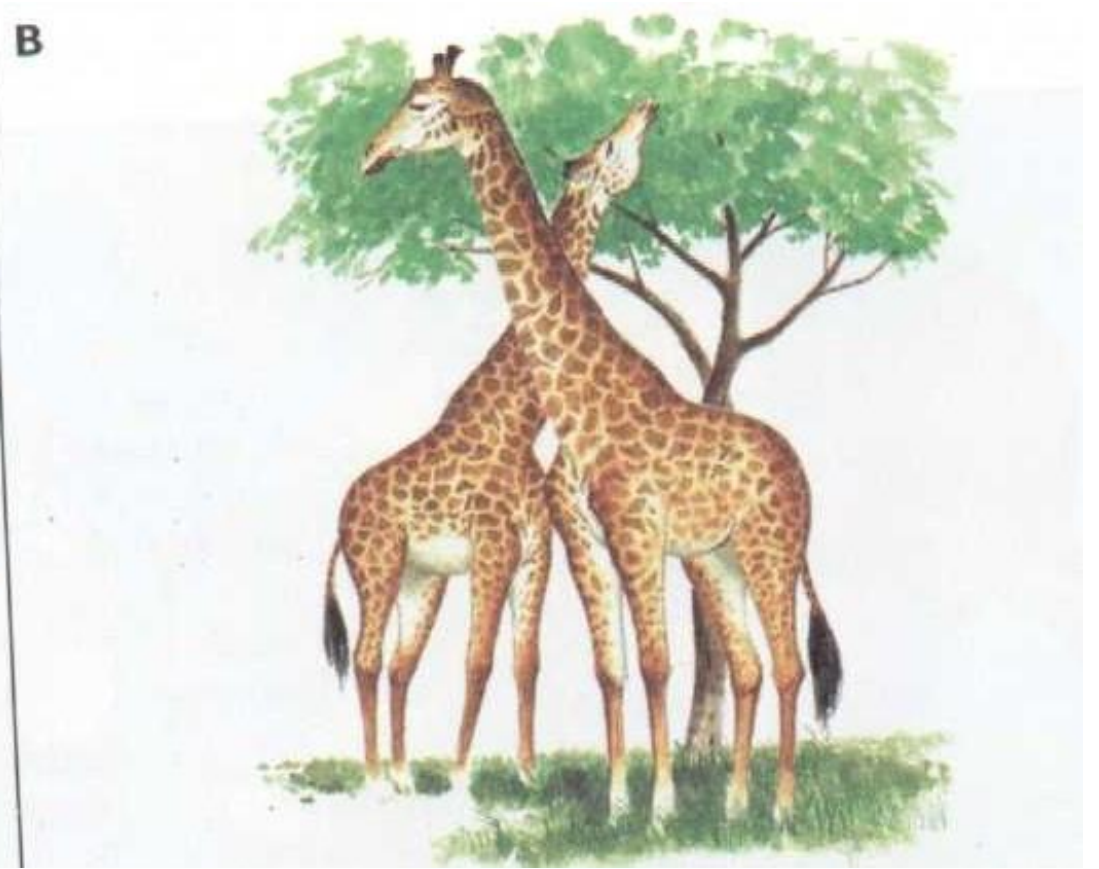
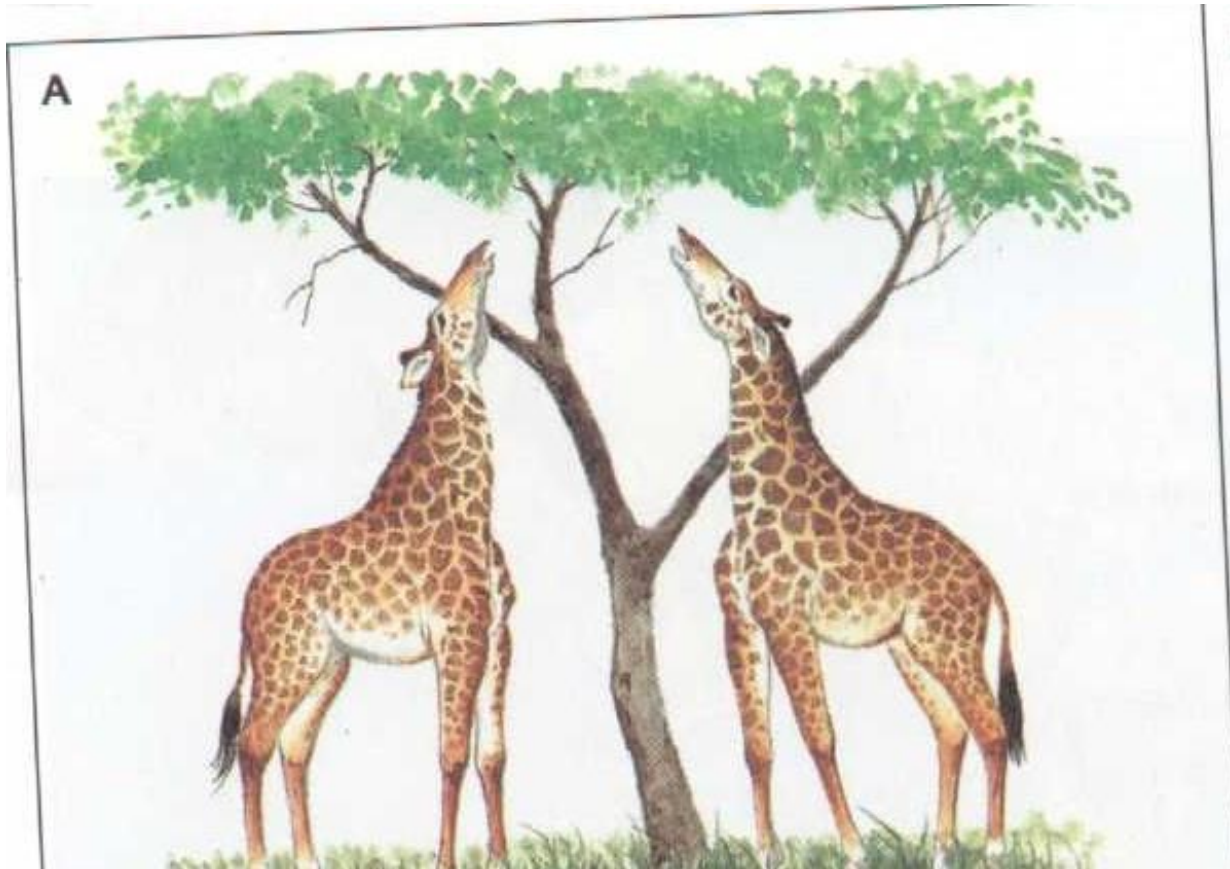
# Lamarck - Giraffes



**Lamarck's Giraffe**



# Lamarck – Giraffes





# INHERITANCE OF ACQUIRED CHARACTERISTICS

The male fiddler crab uses its front claw to attract mates and ward off predators.



"USE or DISUSE" = Use it or lose it

Through repeated use, the front claw becomes larger.



The fiddler passes on this acquired characteristic to its offspring



# Lamarck

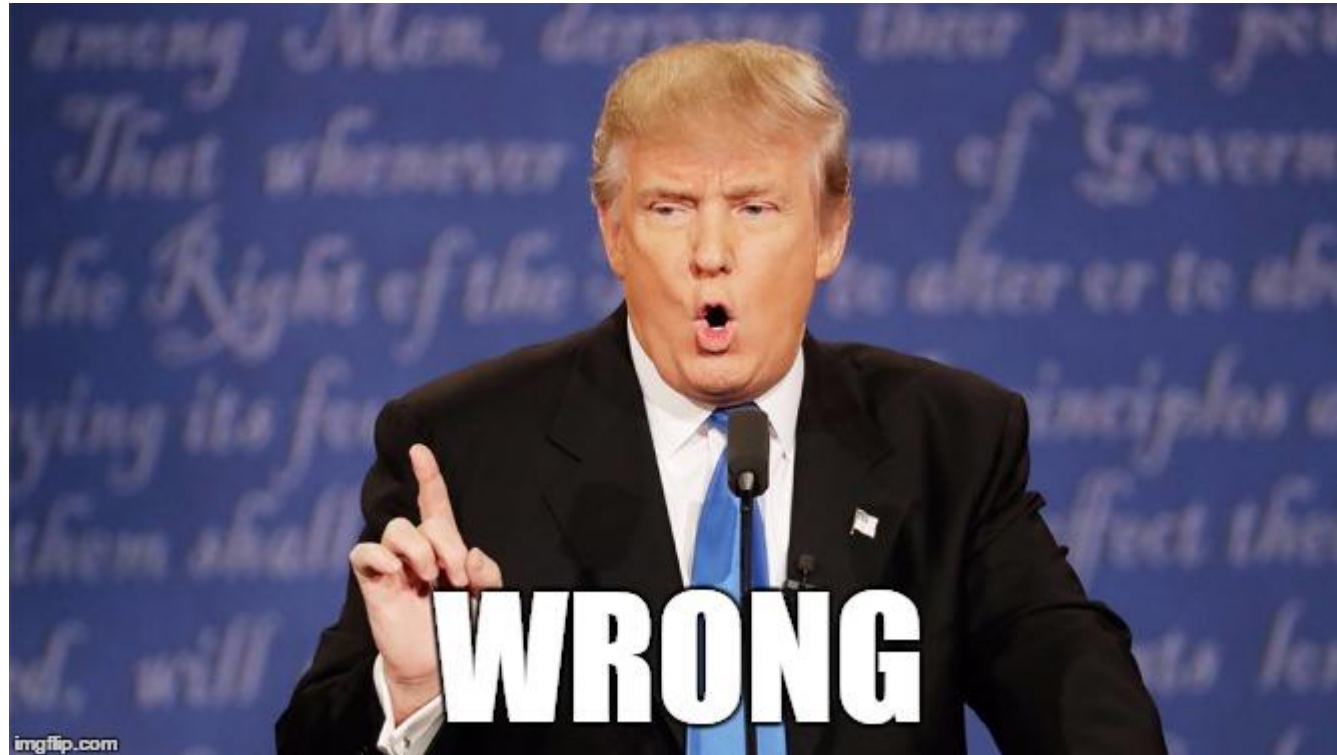
- According to Lamarck, explain how might fish have evolved using the concepts of use/disuse?





# Lamarck's Theory

- Lamarck's theory of natural selection was...



# Lamarck's Theory

- Lamarck's theory was wrong in several ways.
- Lamarck did not know how traits were inherited.
- He did not know that an organism's behavior has no effect on its heritable characteristics.
- Lamarck was one of the first to develop a scientific hypothesis of evolution and to realize that organisms are adapted to their environments.
- He paved the way for the work of later biologists.

# Population Growth

- Another important influence on Darwin came from the English economist Thomas Malthus.
- In 1798, Malthus published a book in which he noted that babies were being born faster than people were dying.
- Malthus reasoned that if the human population continued to grow unchecked, sooner or later there would be insufficient living space and food for everyone.
- The only forces he observed that worked against this growth were war, famine and disease.

# Population Growth

- Darwin realized that this reasoning applied even more strongly to plants and animals than it did to humans because humans produce far fewer offspring than most other species do.
- A mature maple tree can produce thousands of seeds in one summer, and one oyster can produce millions of eggs each year.
- If all the offspring of almost any species survived for several generations, they would overrun the world.

# Population Growth

- Clearly, this has not happened, because continents are not covered with maple trees, and oceans are not filled with oysters.
- The overwhelming majority of a species' offspring die.
- Further, only a few of those offspring that survive succeed in reproducing.

# Population Growth

- What causes the death of so many individuals?
- What factor or factors determine which ones survive and reproduce, and which do not?
- Answers to these questions became central to Darwin's explanation of evolutionary change.