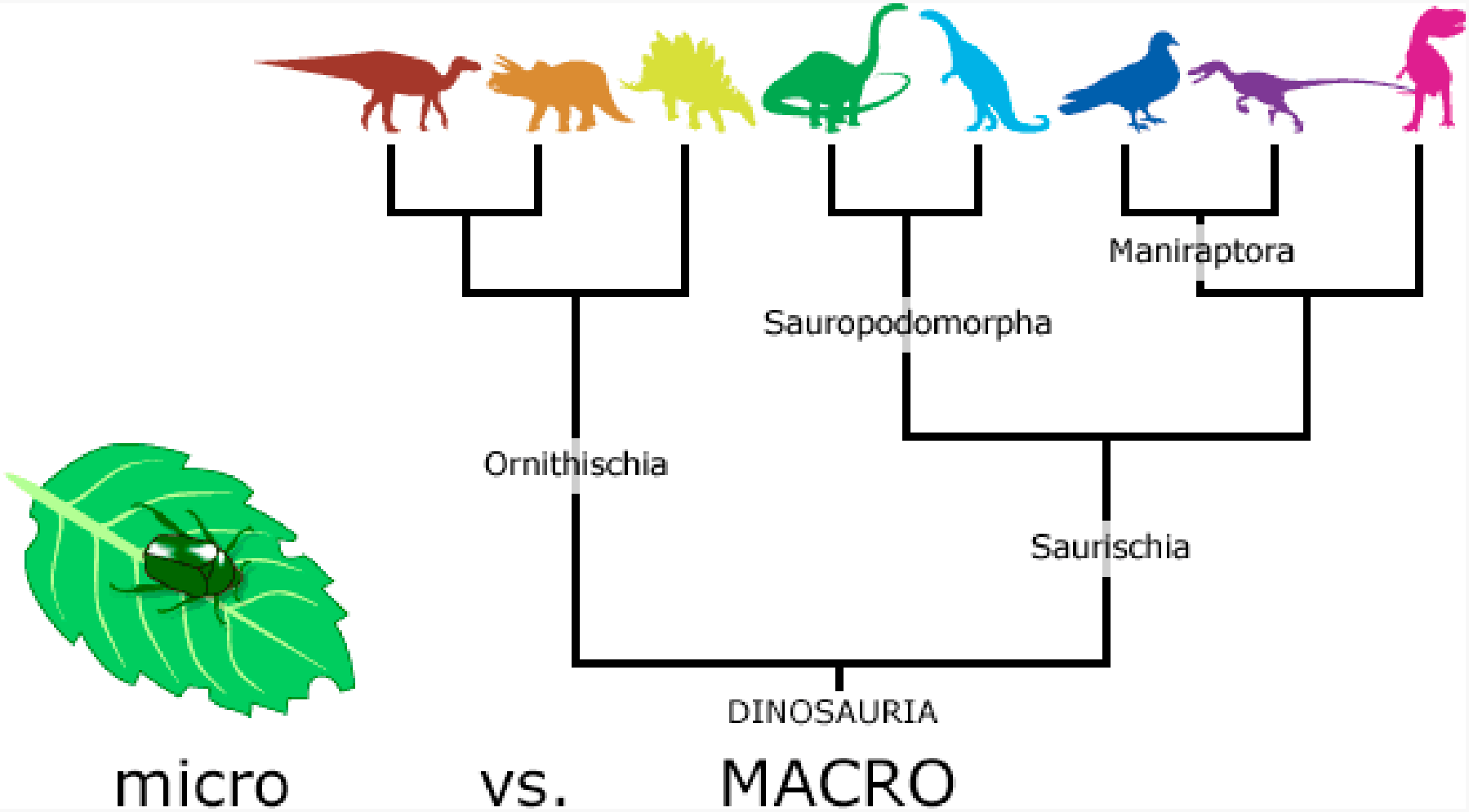
What is evolution?

Change through time

Biological evolution
change in allele frequencies in populations
genetic changes in populations

Microevolution
changes within populations and species due to natural selection and other evolutionary forces (mutation, drift)
processes eventually leading toward speciation

Macroevolution
big changes between species, genera, families, phyla
takes place over long periods of time

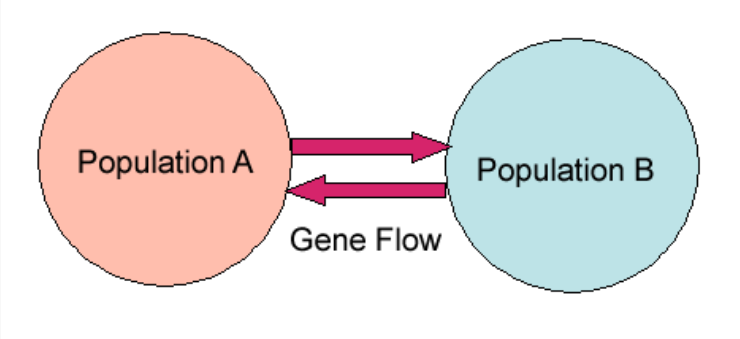

Maniraptora
Sauropodomorpha
Ornithischia
Saurischia
DINOSAURIA
micro
vs.
MACRO

Microevolution - Populations

Geocarpon minimum

Robinia pseudoacacia

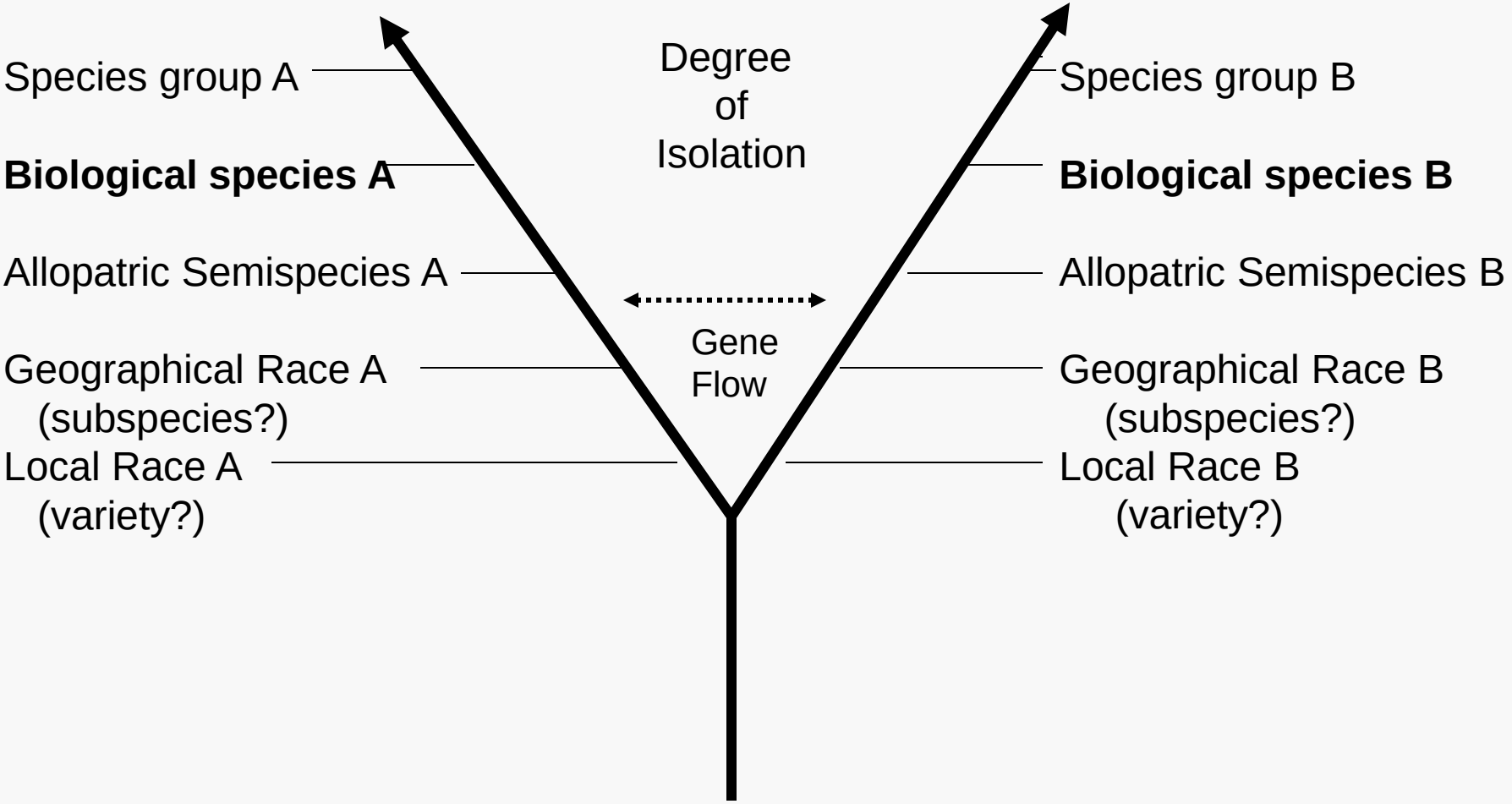
How did the distribution get that way?



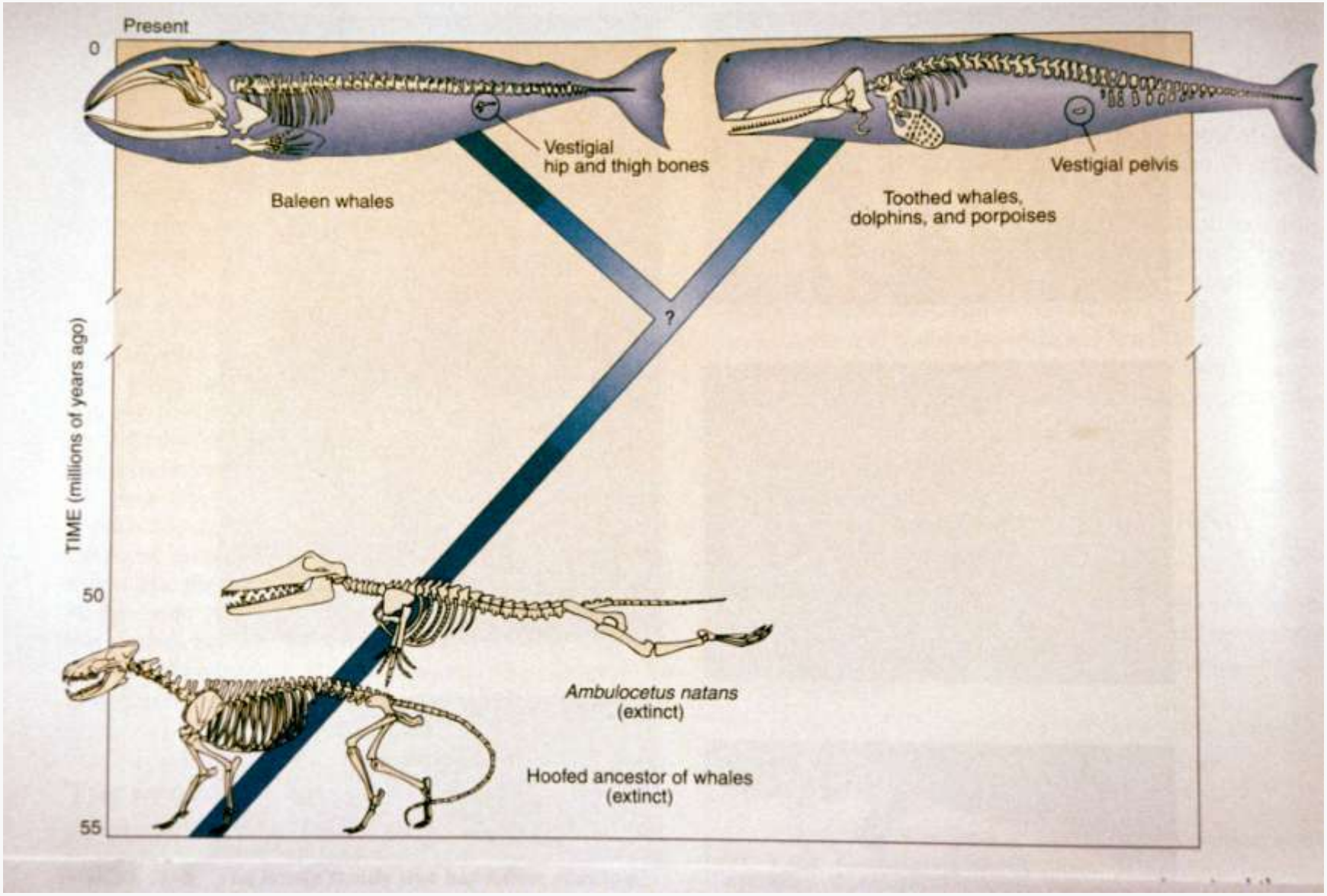
Is gene flow interupted?

Stages in Divergence Leading to Biological Species

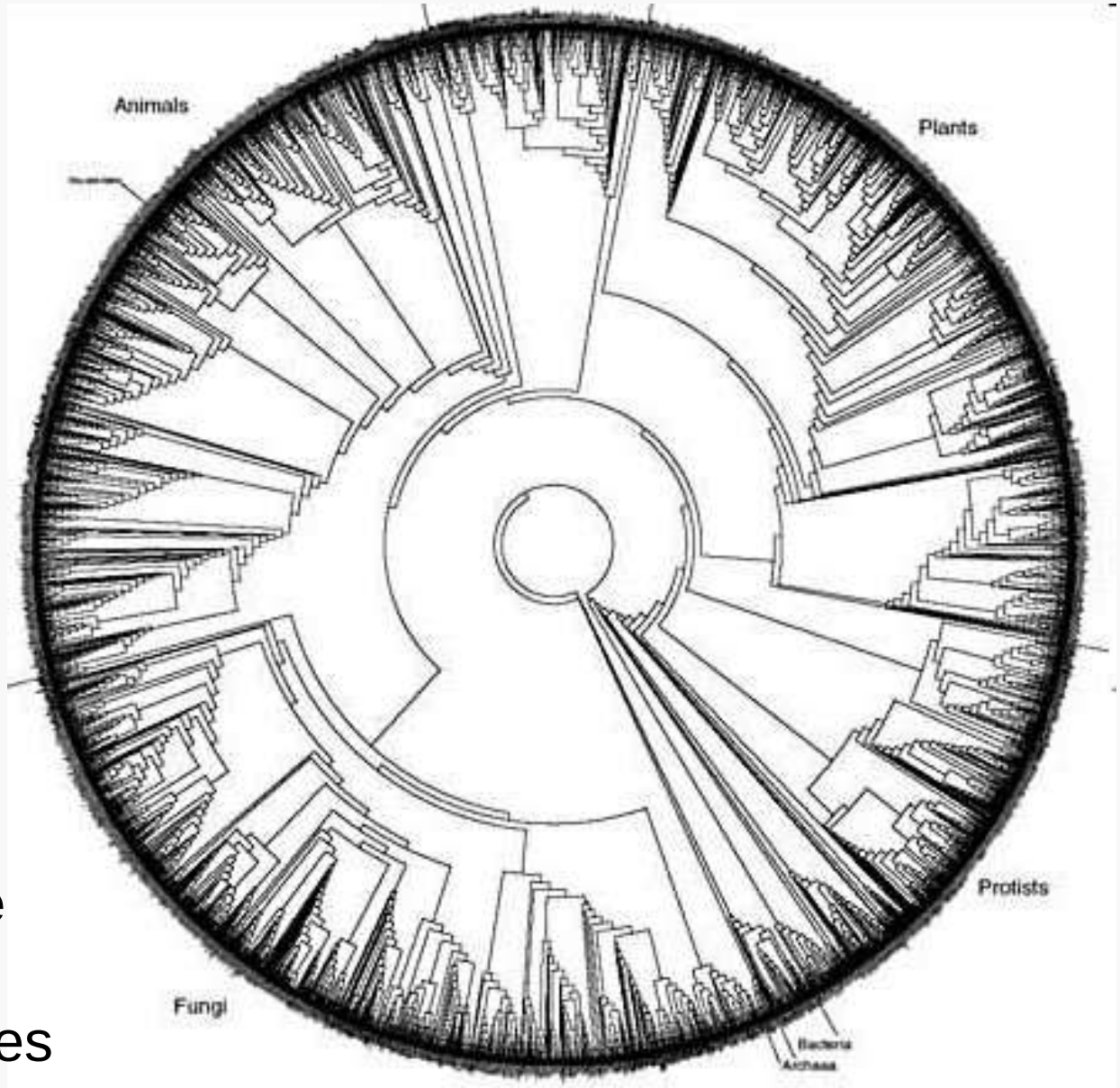
from V. Grant, 1981



Macroevolution – evolution of whales from quadrupeds



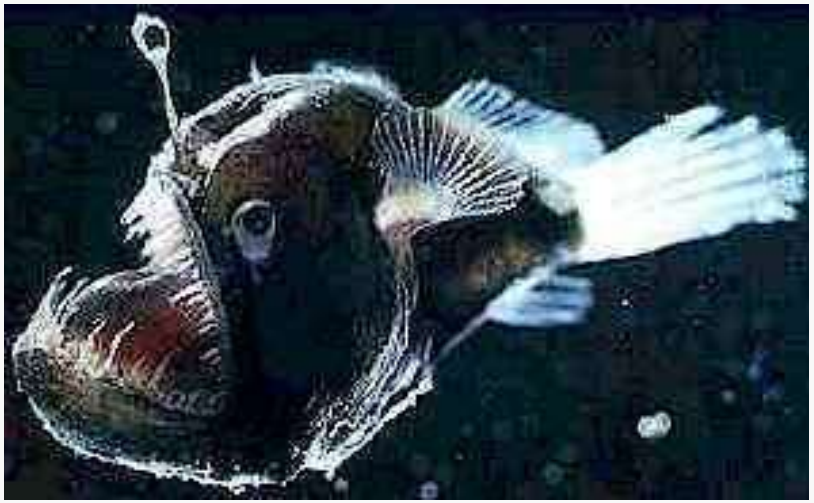
Diversity of Life is Enormous
30 million species?
How did this diversity arise?



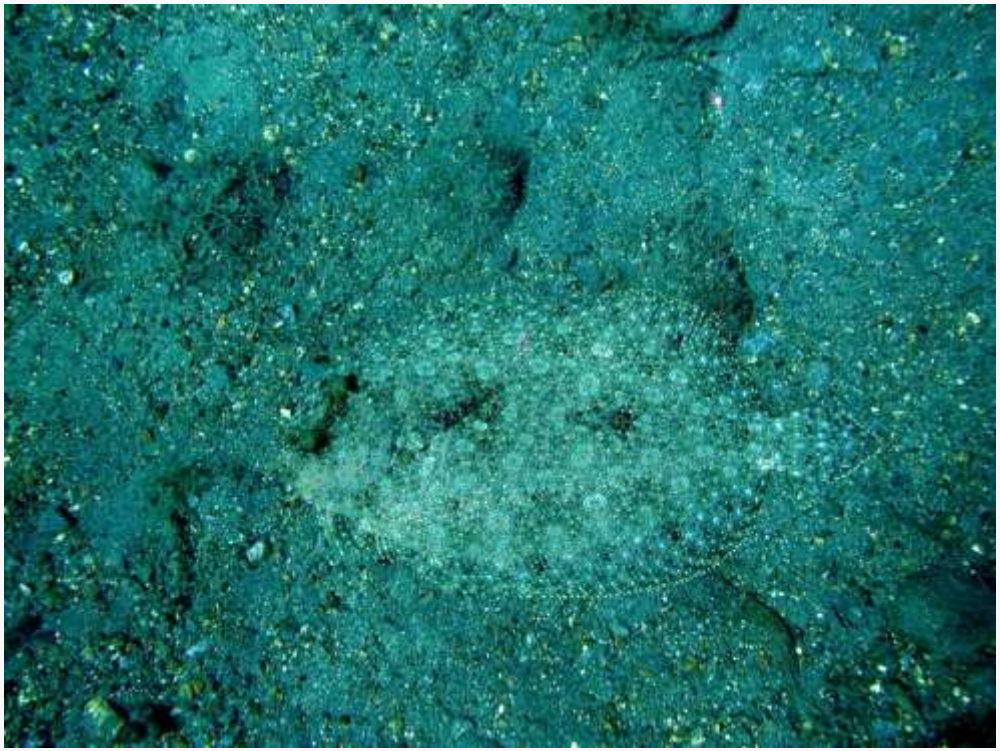
Tree of Life
ssRNA
3,000 species

Adaptation – a critical concept.

Living things show marvelous adaptations.




© Stephen Street



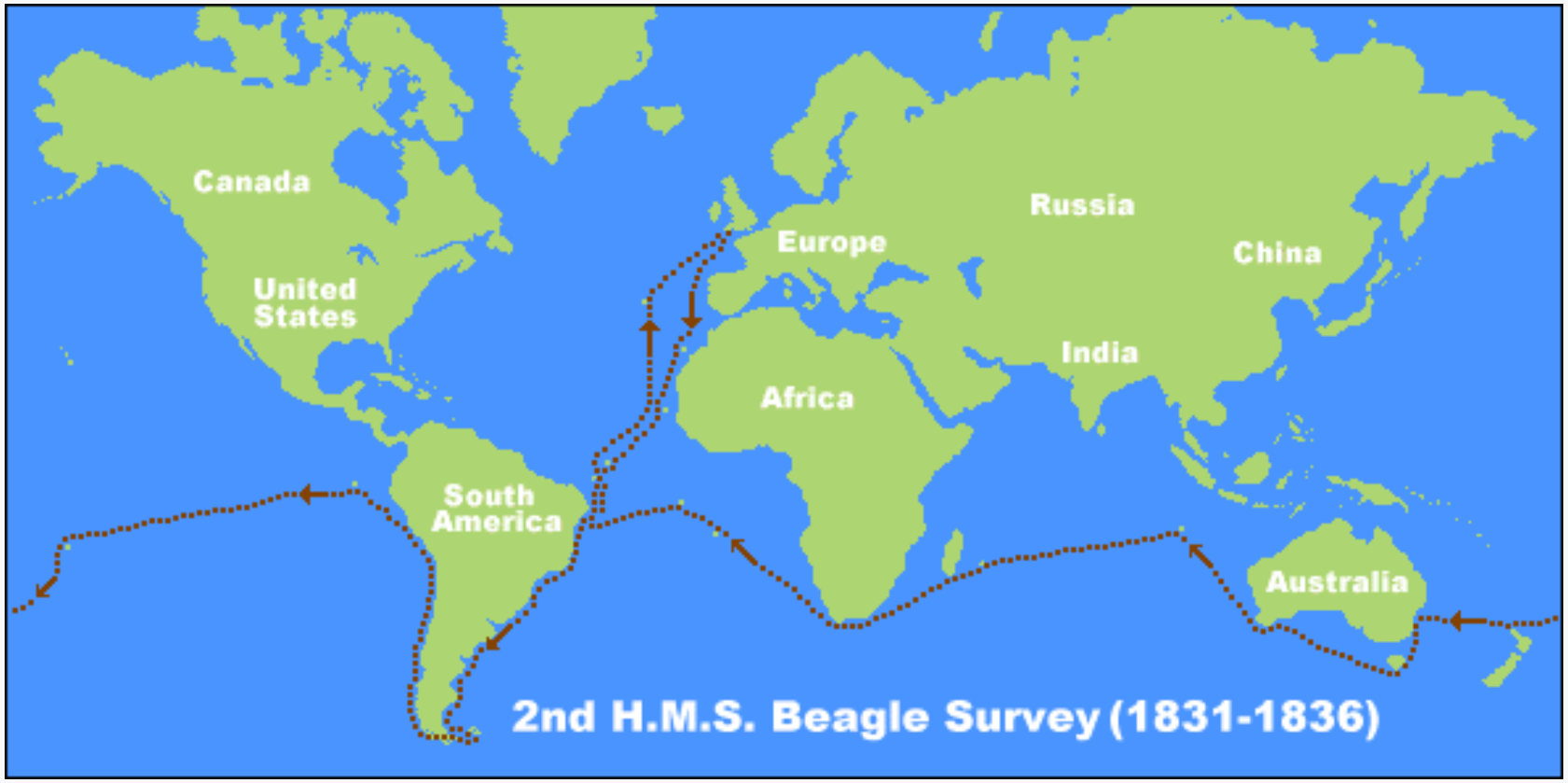
Mechanism for Evolution?

Charles Darwin (1809 – 1882)

On the Origin of Species (1859)

"**Descent** with **modification**"

Photo of Darwin from Wikipedia; image of "Darwin's hawk moth" pollinating its Malagasy orchid from http://botany.si.edu/events/sbsarchives/sbs2008



The Beagle spent five years circumnavigating the globe.

The Galapagos

Darwin was particularly influenced by observations made in the Galapagos Islands, some 500 miles off the coast of Ecuador.

The islands are inhabited by a diverse group of organisms that differ from those found on the mainland.

Marine iguana

Darwin's

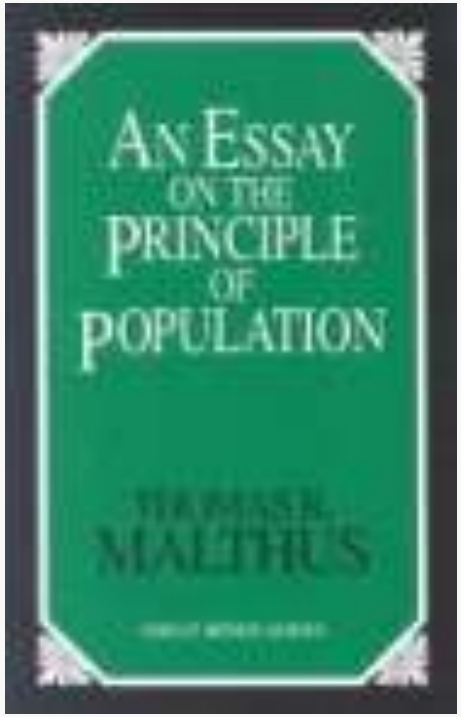
Finches

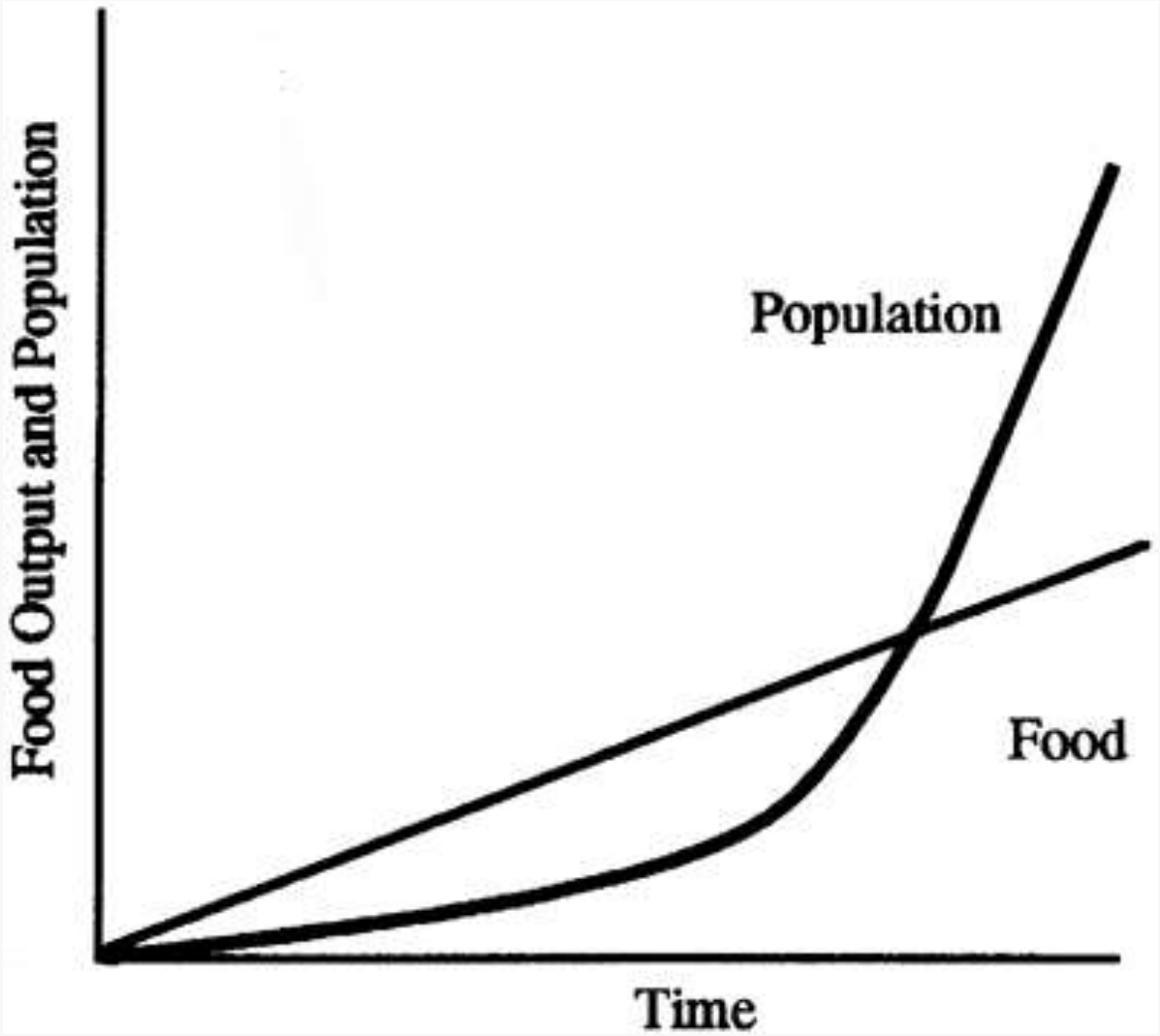
similar

but each

adapted

Thomas R. Malthus (1766-1834)
Essay on the Principle of Population (1798)



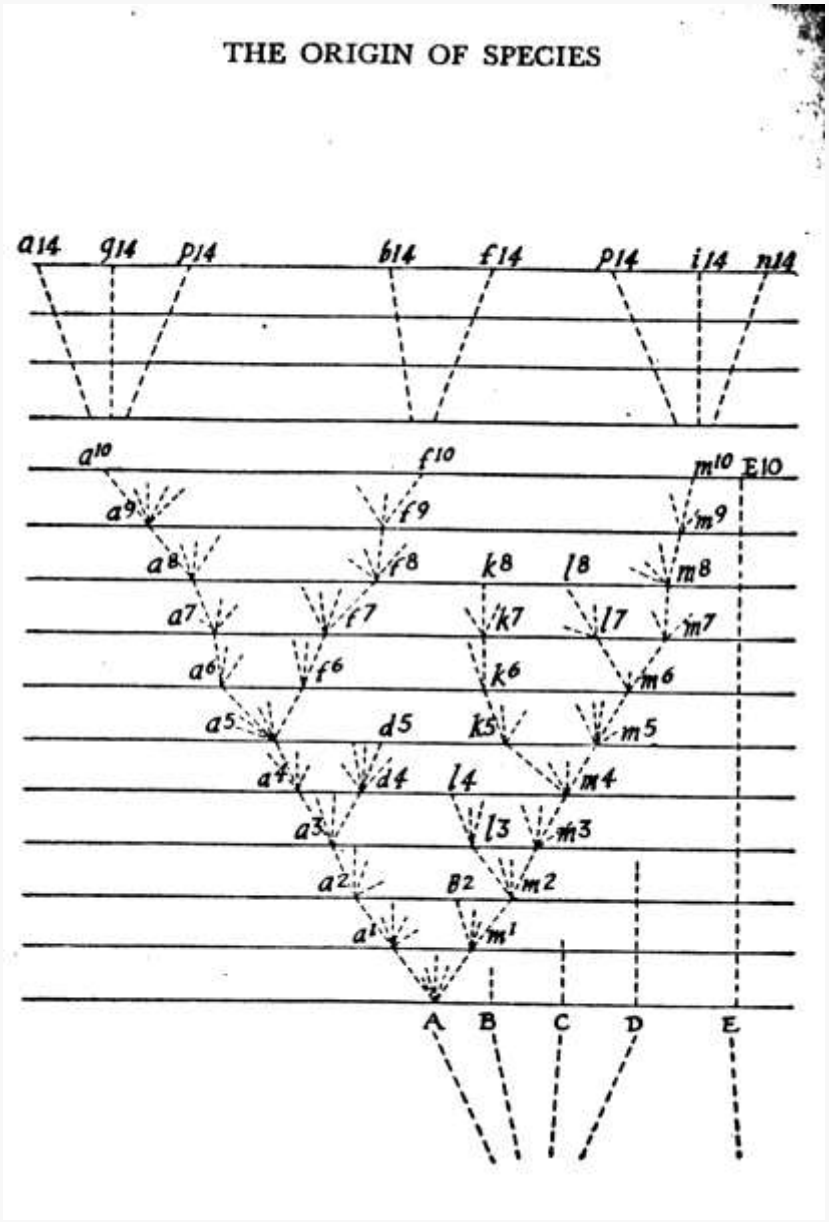


What is the Mechanism of Evolution?

"Preservation of Favored Races in the Struggle for Life" = Natural Selection

1. There is **variation** in function or behavior between individuals.
2. Some traits are more **adaptive** than others.
3. Traits are **heritable**.
4. Individuals that are more **"fit"** live to reproduce or **reproduce more**.
5. Less adaptive traits become less common in populations. (The gene frequencies or proportions change.)

What is the Mechanism of Evolution?



Charles Darwin 1859
"Origin of Species by Natural Selection, or the Preservation of Favored Races in the Struggle for Life"

•Descent from Common Ancestor

Evolution

Allele frequency change through time in a population

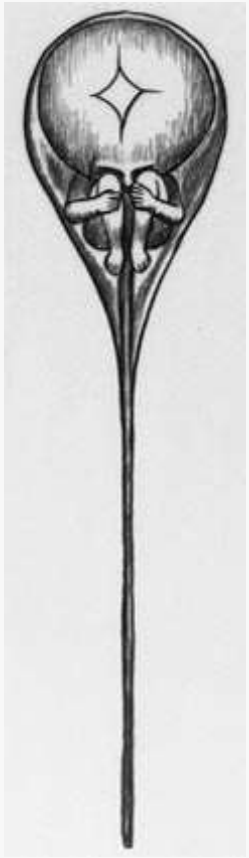
Population – a group of conspecific individuals contemporaneously occupying the same place

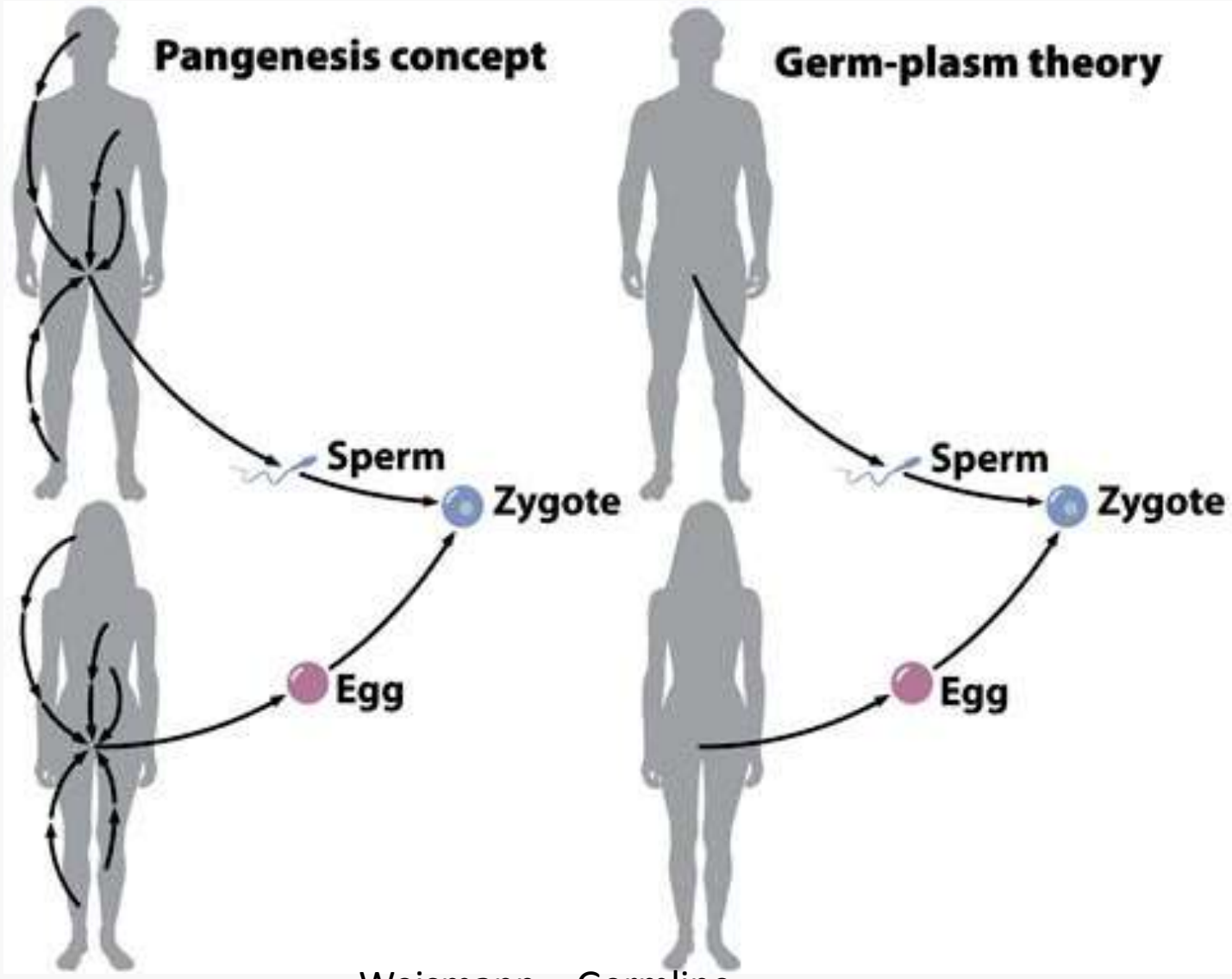
Some Mechanisms of Evolution

Mutation
Genetic accommodation – adaptive evolution
Random processes (*e.g.*, genetic drift)
Gene flow via emigration & immigration
Artificial selection
Natural selection
Sexual selection

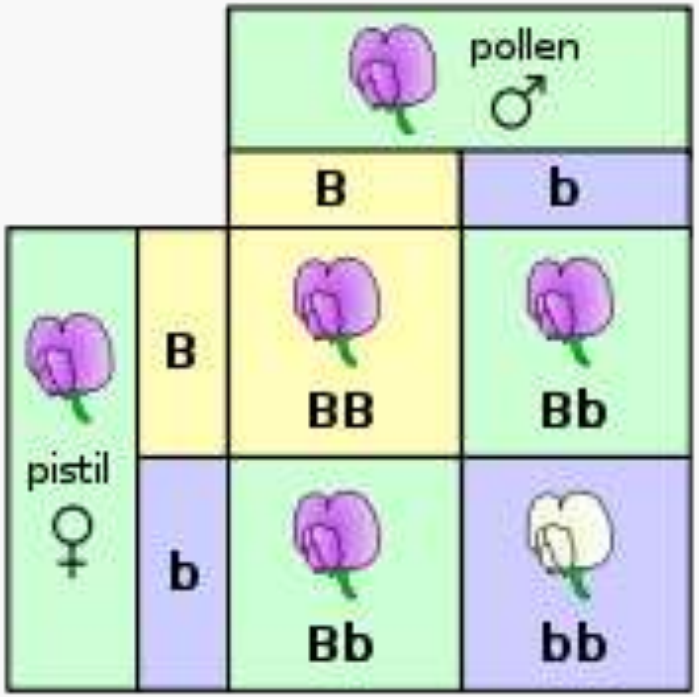
Darwin's Problem…… at first the mechanism was poorly understood because biologists did not understand **the nature of heredity**.

Most people believed in Lamarck's theory of **inheritance of acquired characters**, or in **blending inheritance**, or that the mechanism was by sudden **mutations**.





Weismann – Germline
significance of meiosis for reproduction and inheritance - 1890



FIRST LAW:

1. Each trait due to a **pair of hereditary factors** which
2. **segregate during gametogenesis**

SECOND LAW:

3. Multiple sets of hereditary factors **assort independently**

Mendel‘s work with peas showed that the “blending” explanation was wrong

Results were ignored for 30 years, but rediscovered around the turn of the century.

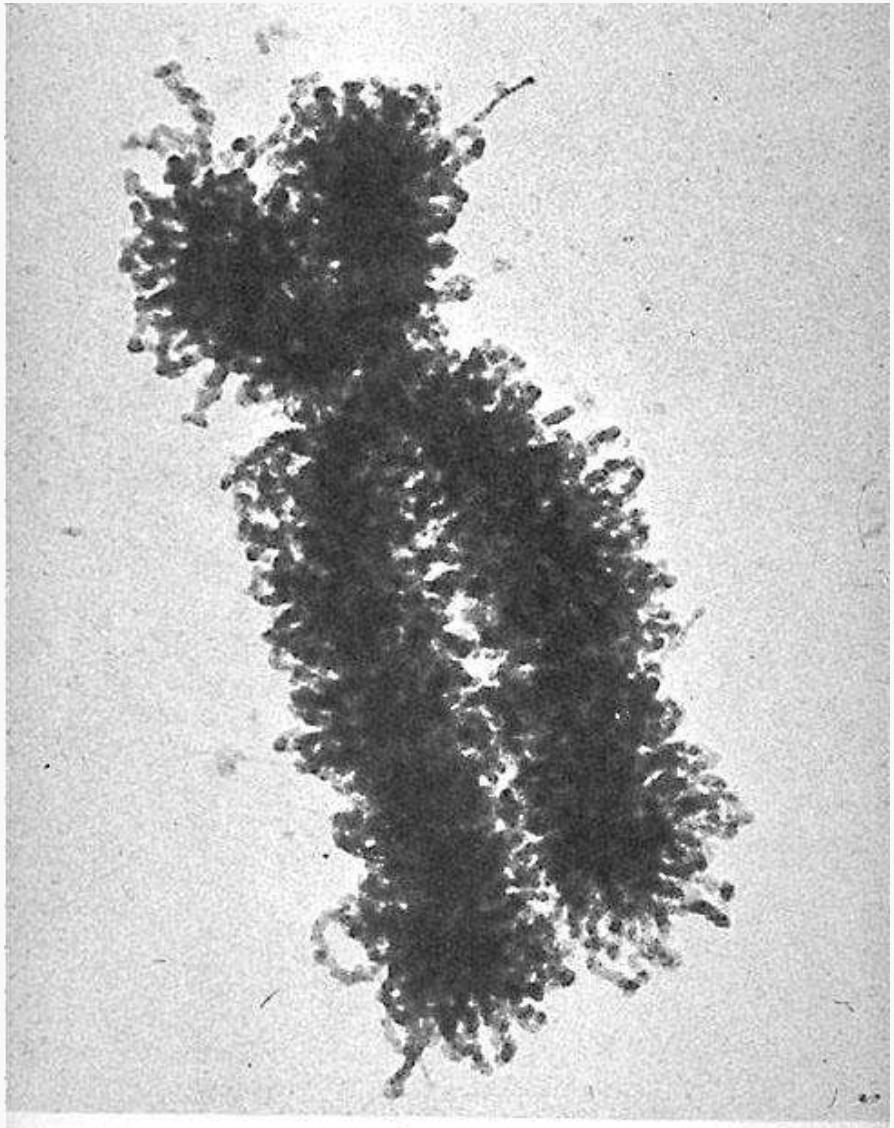
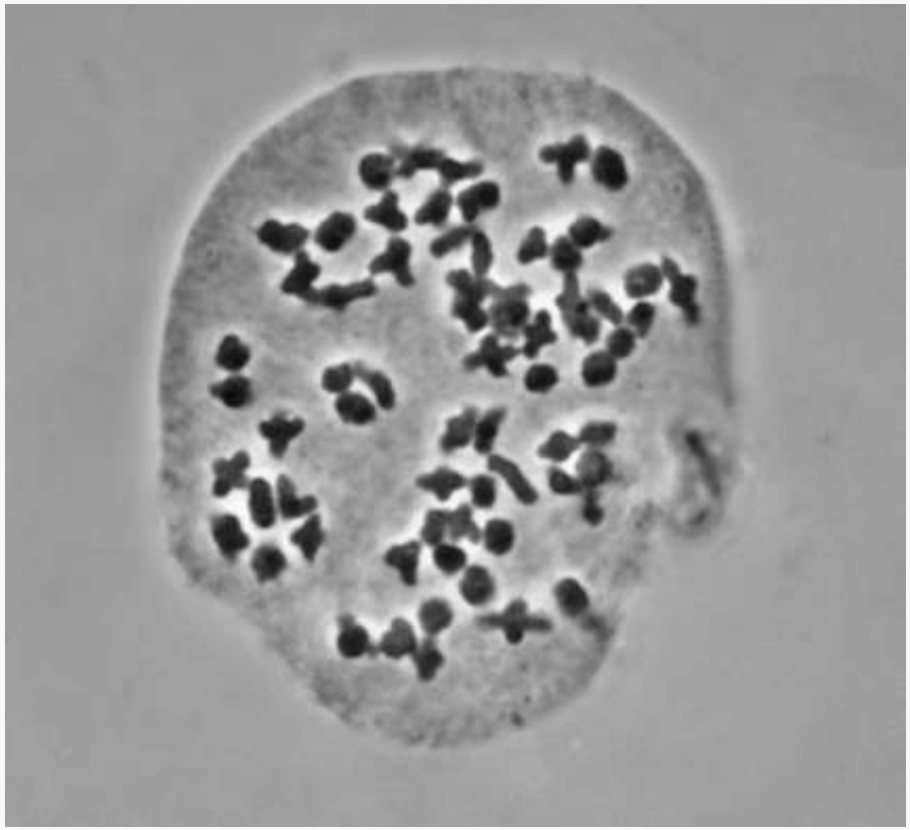
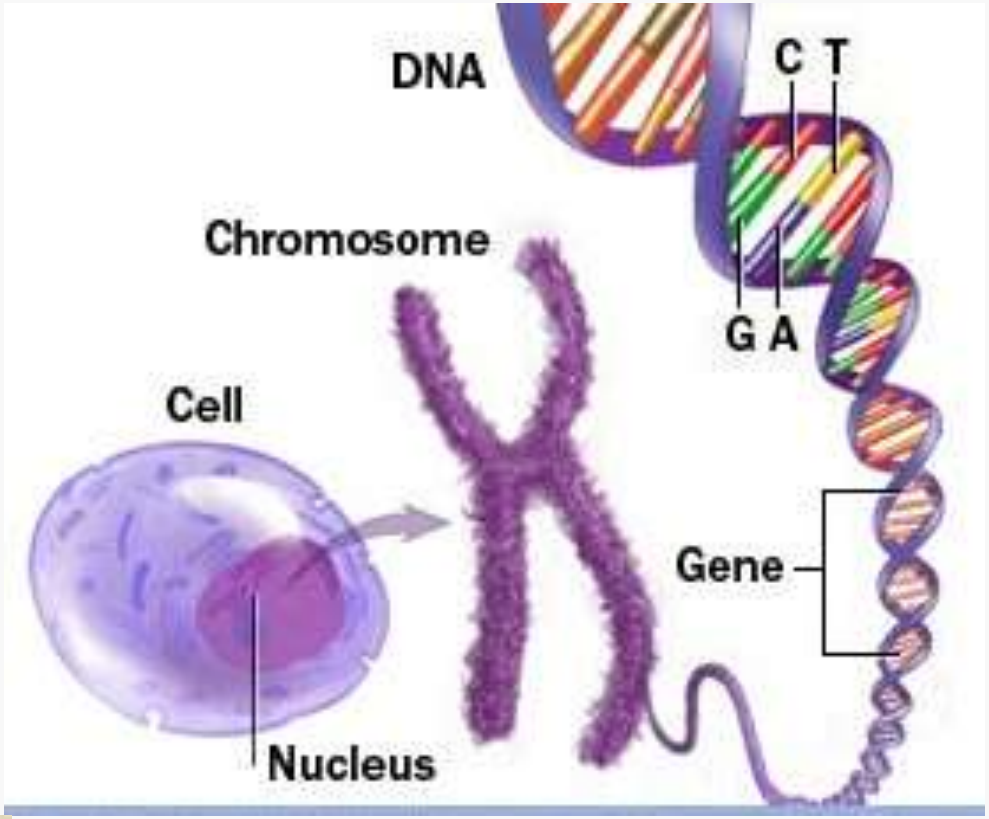
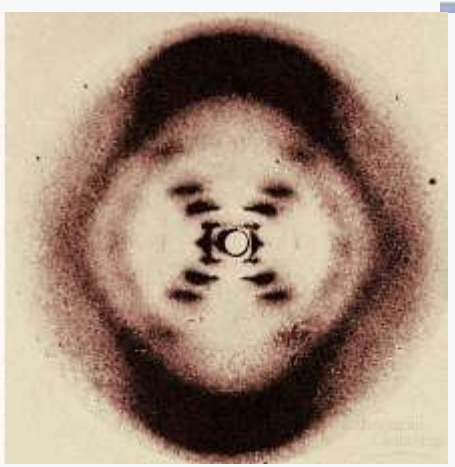


FIGURE 1-14
An electron micrograph of a human chromosome. Chromosome XII from a HeLa cell culture. (Courtesy of Dr. E. Du Praw.)



Watson and Crick – DNA is genetic material





Rosalind Franklin,
X-ray diffraction of DNA

Why Study Evolution?

Occupies a central position in biology, essential for understanding all fields within biology.

Intellectually interesting and stimulating, offers answers to basic questions of our origins, relationships to other creatures.

Helps us to understand evolution of diseases, human behavior.

Is fun, lots of outdoor work, computers, DNA lab

Active area of research, possible to get a Job using evolutionary biology, conservation genetics.

Helps to interpret current news and research discoveries

“*Nothing in biology makes sense except in the light of evolution*”

Theodosius Dobzhansky (1900 – 1975)

An architect
of the
Modern Synthesis of Evolutionary Biology

Photo of Dobzhansky from Wikipedia

End