



### One more before Darwin

- Thomas Robert Malthus (1766-1834): economist
  - much of human suffering (disease, war, famine, homelessness) was the result of too many people competing for limited resources

### Some of Darwin's observations from his voyage on the *Beagle*

- Fossils on a continent are related to the existing organisms on that continent (time)
- Organisms of one climatic zone are related to organisms of other climatic zones on the same continent (dispersal)
- Organisms on islands are related to organisms of the nearest mainland

### Early criticisms of Natural Selection

- Two potential problems were raised:
  - The earth was too young for such extraordinary diversity to arise by natural selection (assumed to be a very slow, gradual process)
  - Blending inheritance would decrease variation that is required for natural selection to work

### The problem of insufficient time

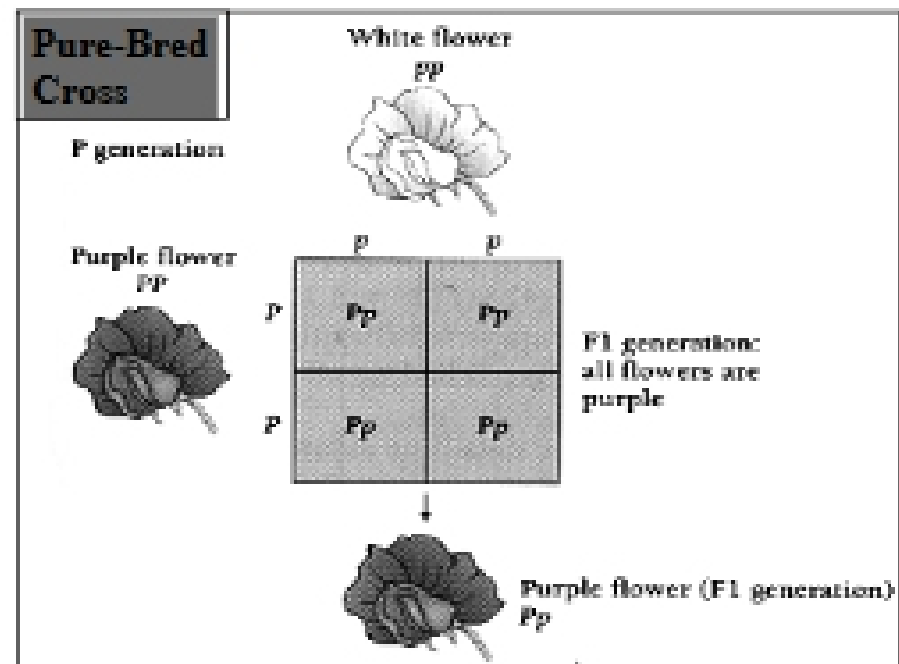
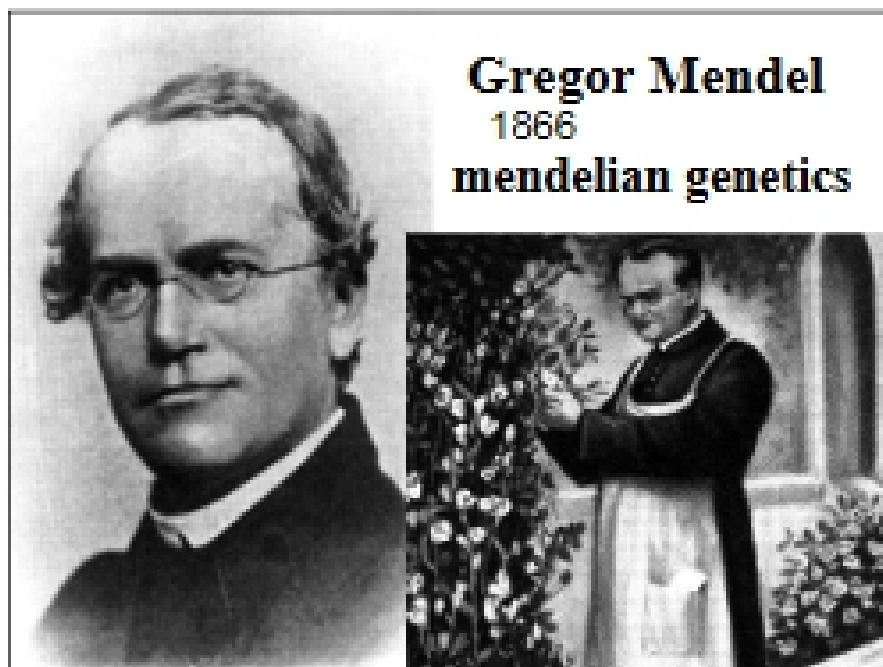
- Lord Kelvin determined that the earth was 40 my old
  - Calculated based on cooling rate of molten mass
- Earth actually 4.6 billion years old
  - Kelvin did not know about internal heating by radioactive decay

### Blending inheritance

- If offspring represent an average of their parents, variability should decrease by half with every generation
  - Tall and short parents should have medium-sized kids and their kids should be clustered even more tightly around an average height.
- *Is blending inheritance observed?*

### During but unknown to Darwin

Gregor Mendel (1822-1884): monk and botanist



## GENES

- Mendel called them "heritable factors"
  - They are separable
  - They are discrete
  - They are individual
- They maintain their character generation after generation.

## Why was this huge?

- Tangibility
- Mathematically accessible (can make predictions about offspring)  
CALCULABILITY
- The study of heritable characters was thrown open to new expertise

## After Darwin: Mendel and The Modern Synthesis

- In the early 20<sup>th</sup> century genetics (especially population genetics) was applied to evolutionary theory
- The Modern Synthesis defines evolution as a *change in the frequencies of alleles or genotypes in a population (micro level)*

## Evolution by Natural Selection Is Completed with 3 Inferences

- *Observation 4:* individuals of a population vary
- *Observation 5:* some variation is heritable
- **INFERENCE 2:** those individuals with heritable traits that promote survival and reproduction will leave more offspring
- **INFERENCE 3:** over time, traits promoting survival and reproduction will accumulate