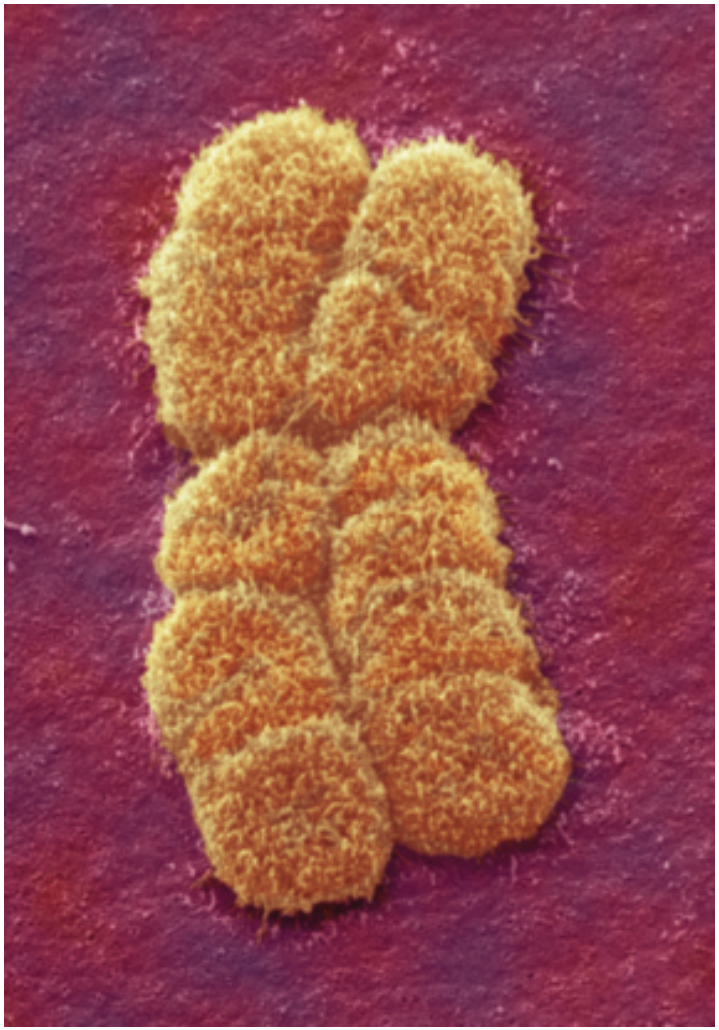
Evolution and Genetics

Grade 11 Biology SBI3U 12

Our Next Steps

- We've looked at Darwin, selection, and evidence for evolution

- We can't consider evolution without looking at another branch of biology:
- Genetics

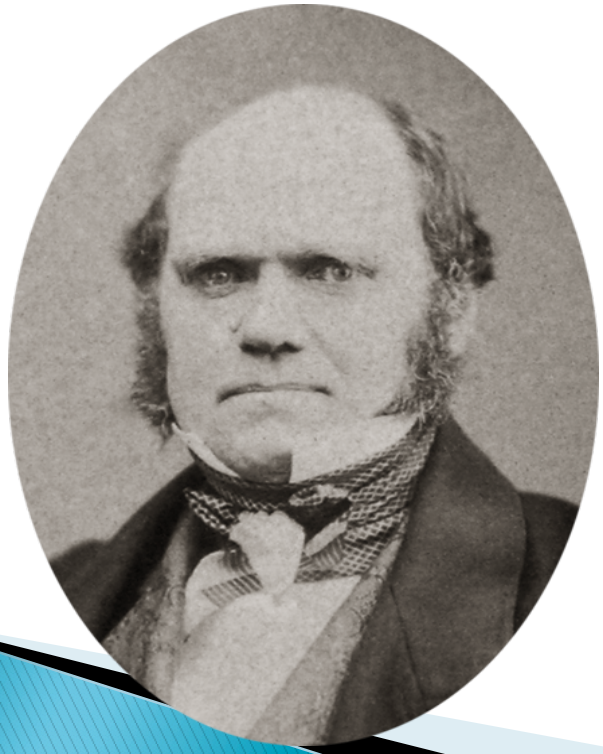


Another View

- Around the same time Darwin was developing his theory, a Austrian monk was making his own observations
- He focused on how traits were passed from one generation to the next
- Early studies in Genetics

Unifying Theories

- Much later, we would realize that the theories of genetics and evolution are closely linked
- Genetics can help explain evolution



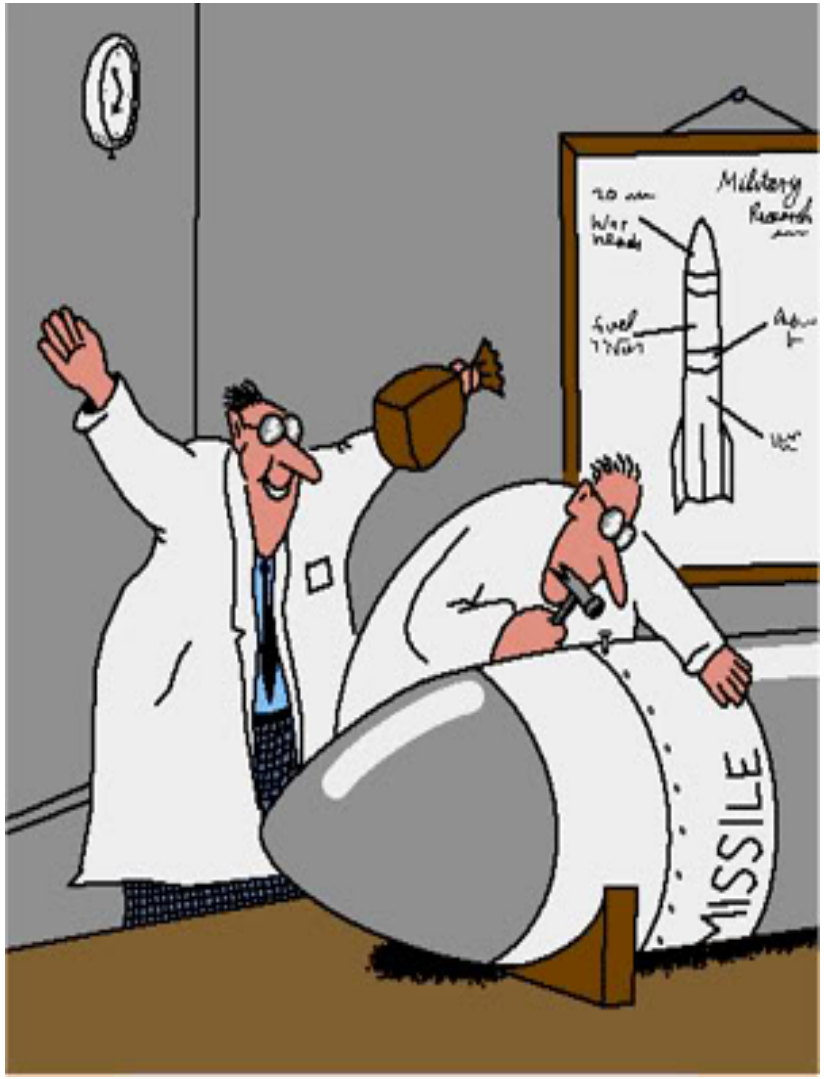
Modern Evolutionary Synthesis

- **Modern Evolutionary Synthesis**: the modern theory of evolution that takes into account all branches of biology

- This includes genetics
- it also includes the plate tectonic theory we've looked at

Darwin 2.0

- For Darwin, evolution was the changing of inherited traits in a species over time
- We now consider evolution as changes in the gene pool of a species over time.
- **Gene Pool**: the complete set of all gene variations within a species or population



Genetic Variations and Selection

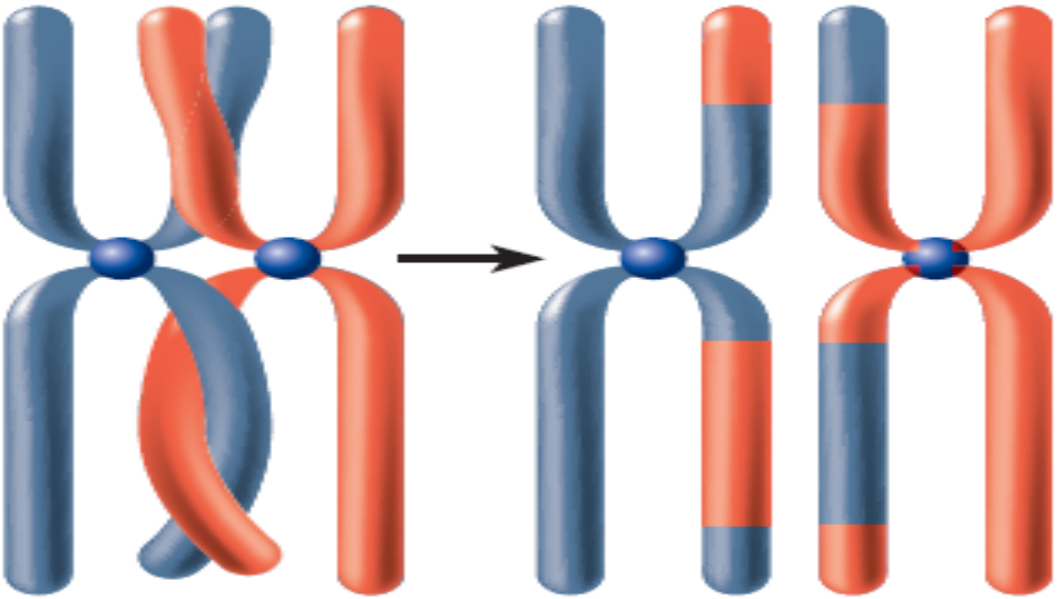
- Genes code for different traits
- Individuals have different traits because they have different combinations of gene variations

Genetics and Natural Selection

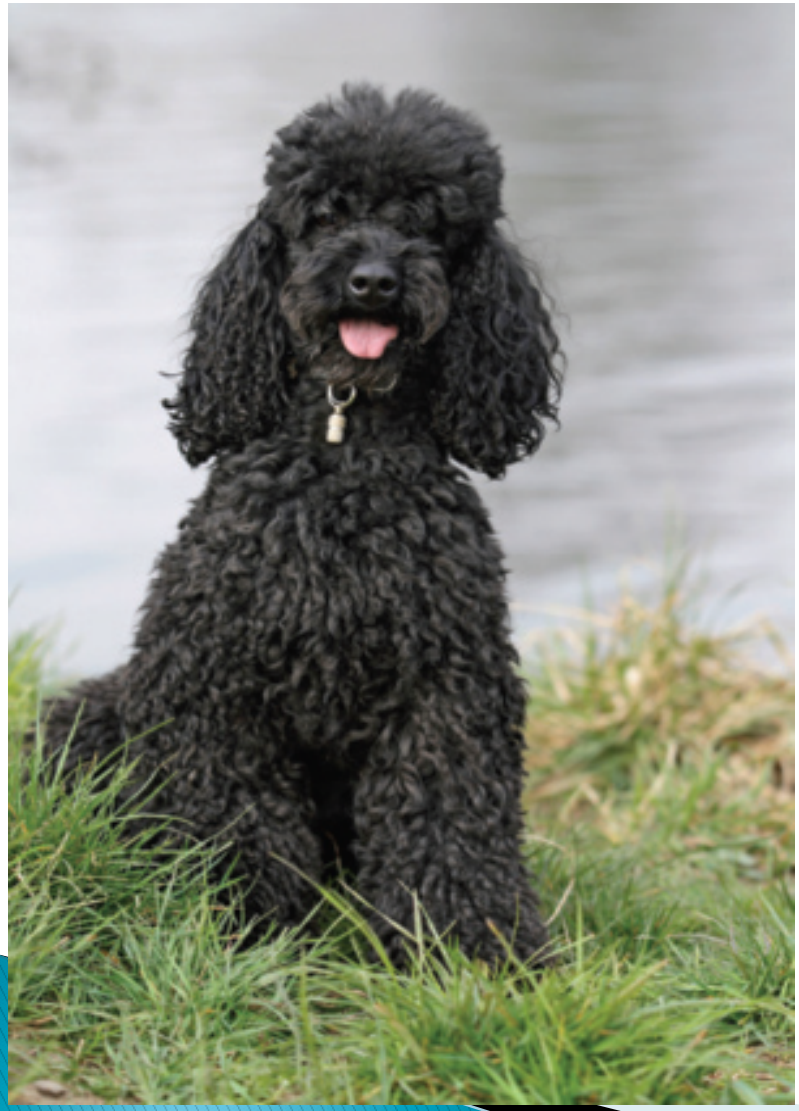
- Some of these combinations are favoured: this is natural selection

Remember Meiosis?

- At the end of meiosis, a sex cell has only one set of chromosomes.
- Reproduction leads to variety: new combinations of genes (both from mother and father)
  - Crossover events lead to even more variety: genes get shuffled around between homologues



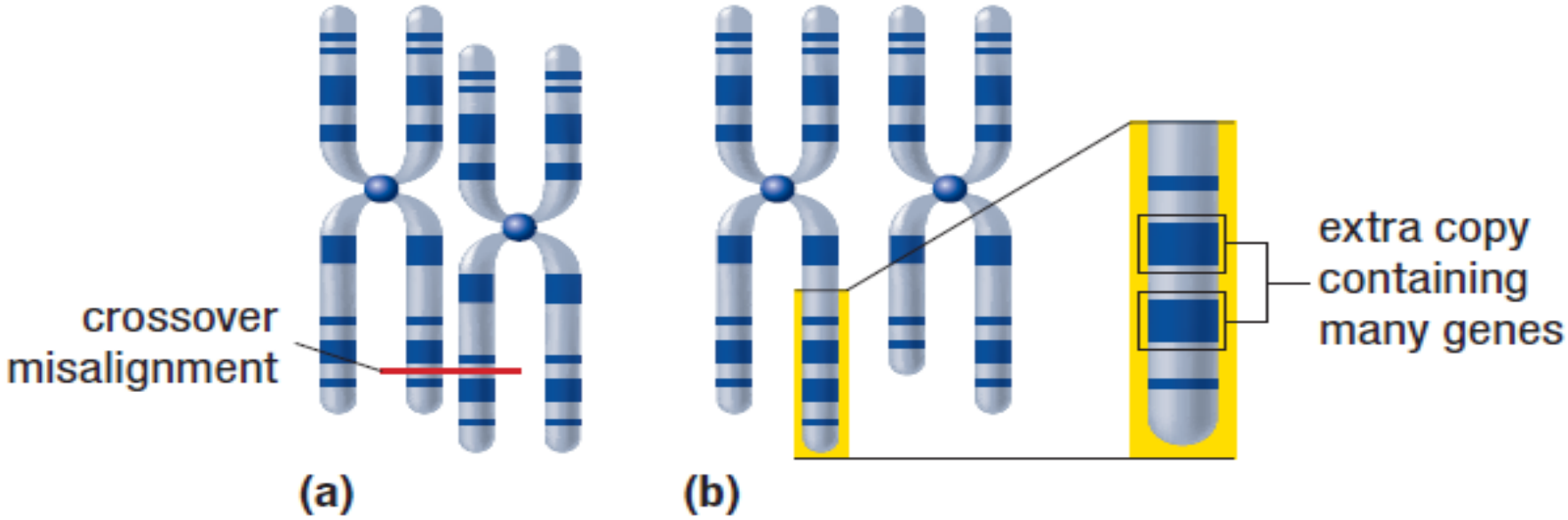
Mutation



- Sexual reproduction and crossing over have the same purpose:
  - Introduce new varieties of genetic combinations
- New changes in DNA are called **mutations**

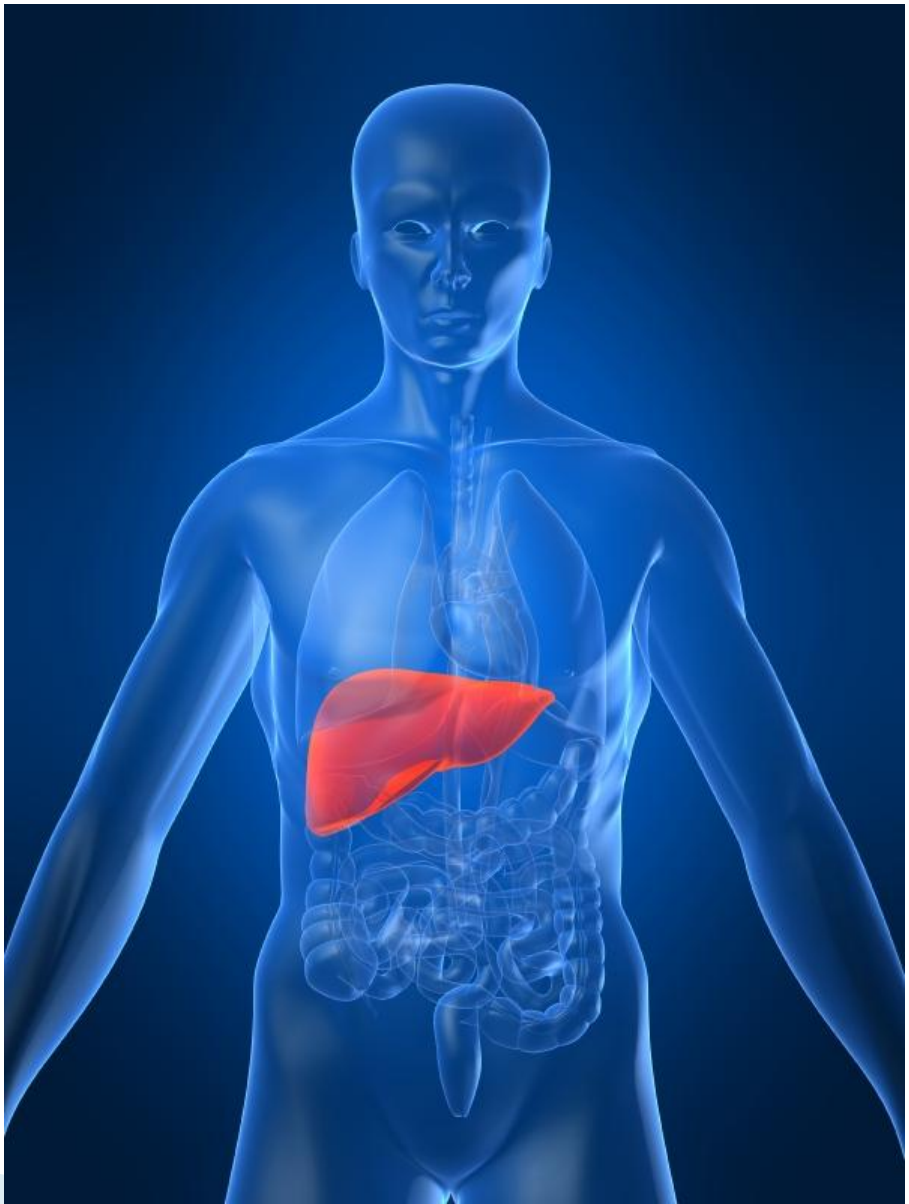
Mutations

- Mutation events happen in many different ways
- A gene may be lost, switched, or modified
- An individual can also gain duplicates of genes



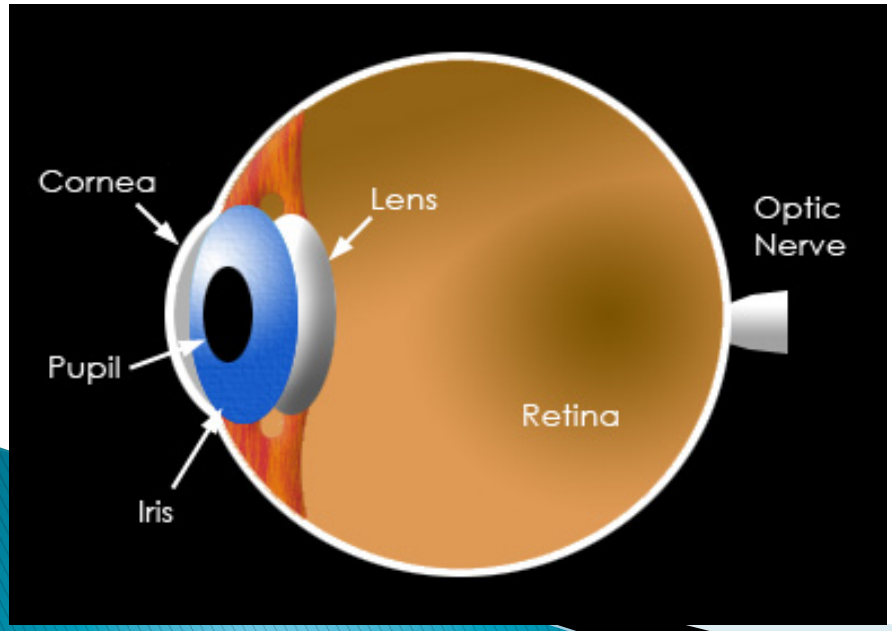
Mutations and Survival

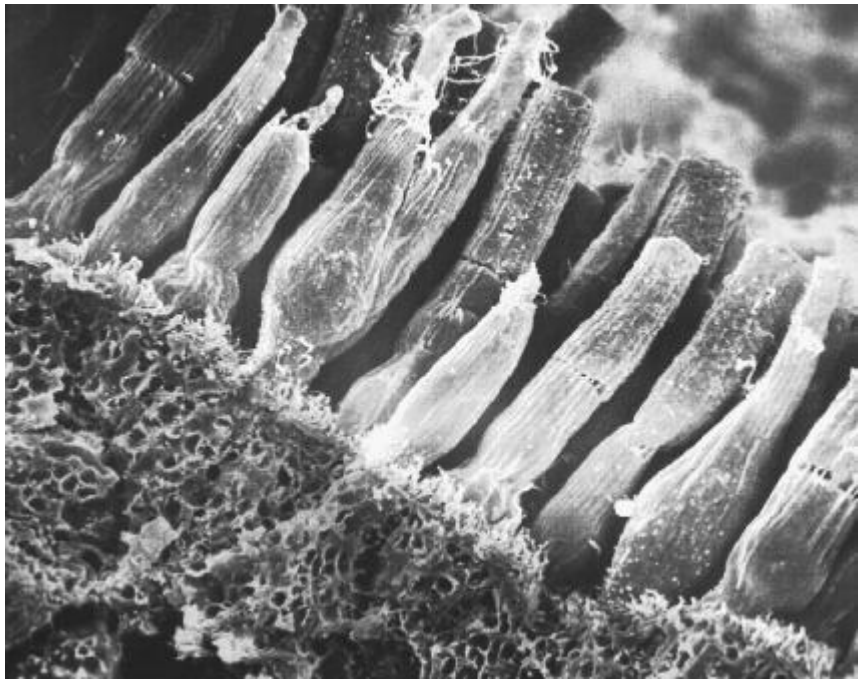
- These mutations can affect an individuals chances of survival
- Missing genes is often harmful
- Having extra copies of genes might be useful
  - Eg: Cyp450: an enzyme in the liver that breaks down foreign substances



Gene Duplication

- This is an important type of mutation
- A mutation to a gene can often be harmful, even fatal
- But having an extra copy means that if that gene mutates, there is still another copy to make sure the cell functions properly
- New and novel mutations may now occur
  - Eg: rod and cone cells in eyes





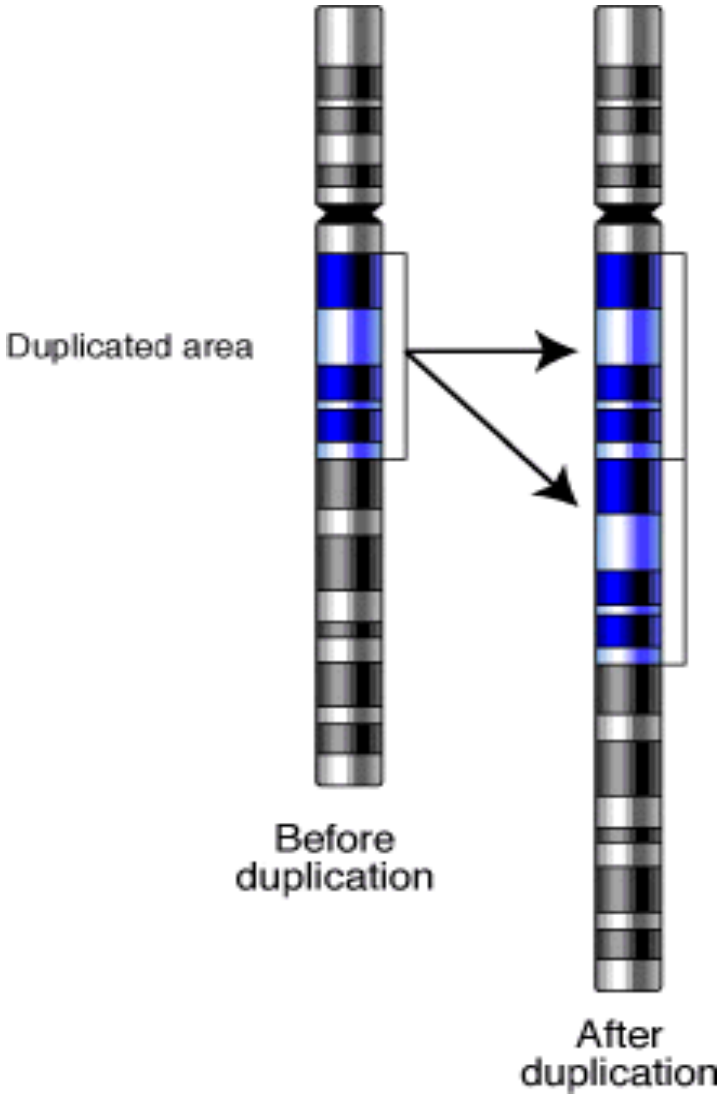
The Effects of Mutations

- **Beneficial Mutations**:
  - Relatively rare
  - Favoured by natural selection
  - Tend to accumulate in populations over time
  - Eg: opposable thumbs for gripping

- **Harmful Mutations**:
  - More common than beneficial mutations
  - Selected against, and have no influence on populations
  - Eg: ???

The Effects of Mutations

- **Duplication Mutations**:
  - Often neutral
  - Do not immediately benefit the individual
  - Source of new genetic material with potential to evolve into new genes

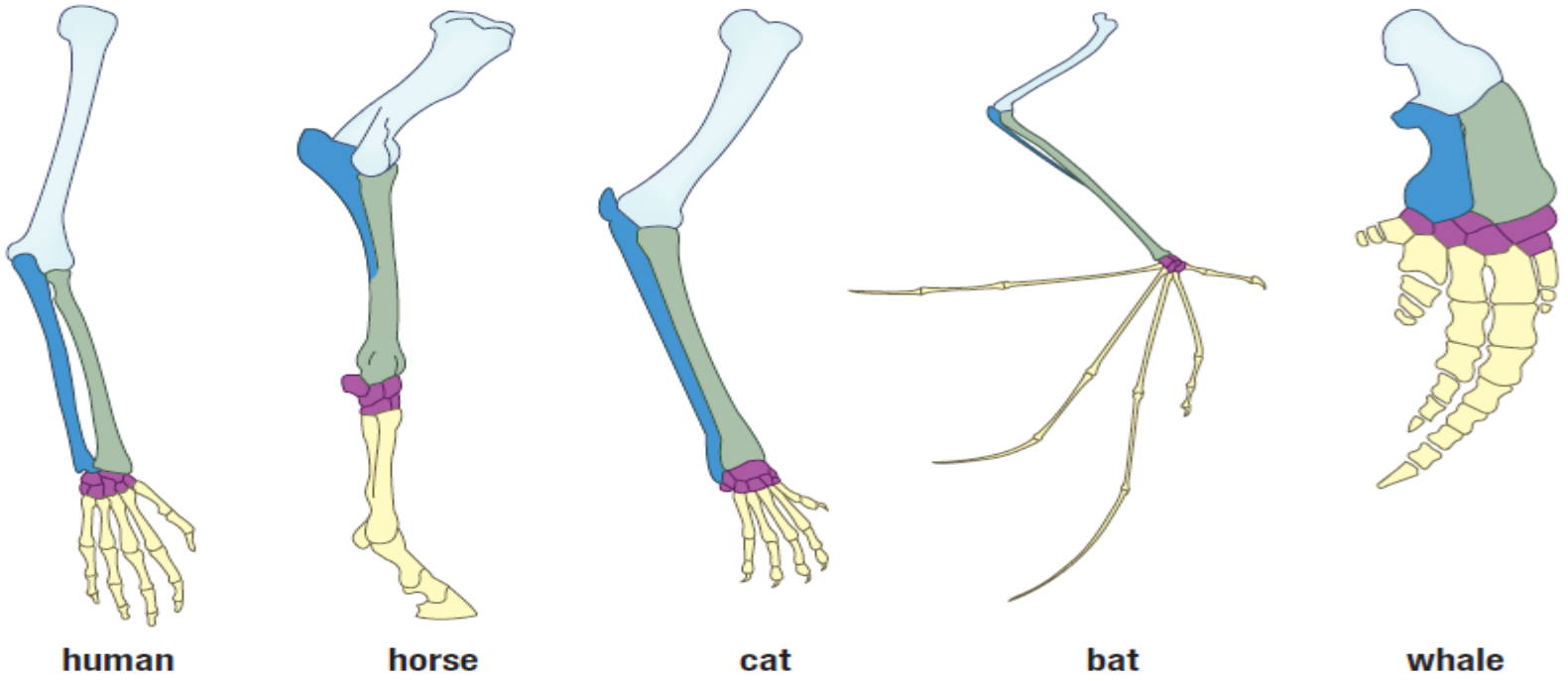


Mutation Rates

- It is estimated that with such a large genome, each human may average several mutations
- With well over seven billion people worldwide, that's a lot of genetic variability

Homologous Genes

- The mammalian forearms suggested a common ancestor
- These homologous features arise because of homologous genes

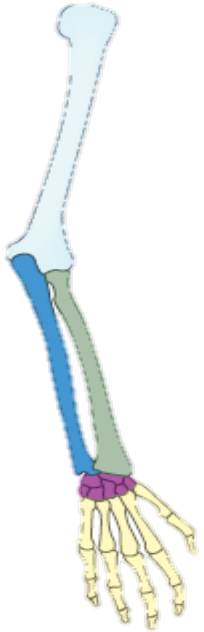


Homologous Genes

- Homologous genes share a common ancestor, but have mutated over time
- The more closely related two species are, the more similar their homologous genes will be

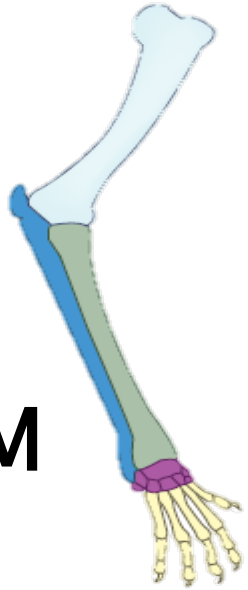
- Eg:

Human:



FOREARM

Cat:



FORERAM

Pseudogenes

- **Pseudogene**: A vestigial gene that has undergone mutations and no longer serves a useful purpose

- Eg: Dolphins has 1000 genes for olfactory (smell) receptors, but only use 200 of them
  - Why?

Pseudogenes

- Dolphins has 1000 genes for olfactory (smell) receptors, but only use 200 of them
- Smell receptors detect airborne chemicals, so are of no use to dolphins