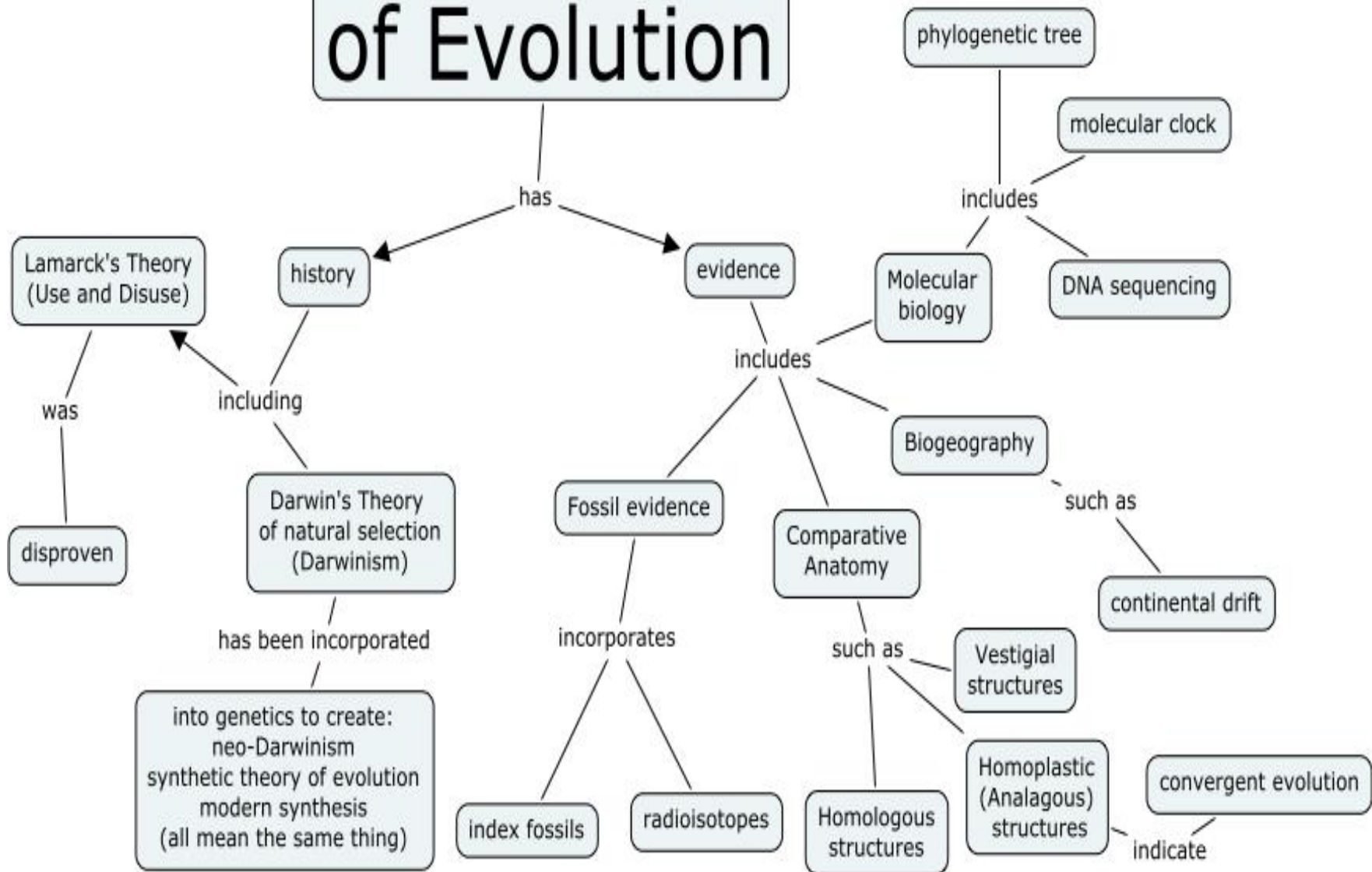


The Theory of Evolution



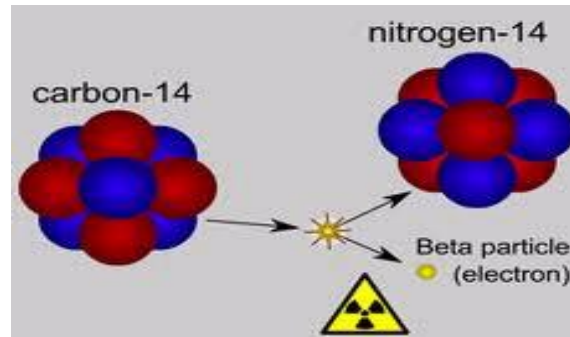
The Age of Earth

- Earth is believed to be about 4.5 billion years old.



Radiometric Dating

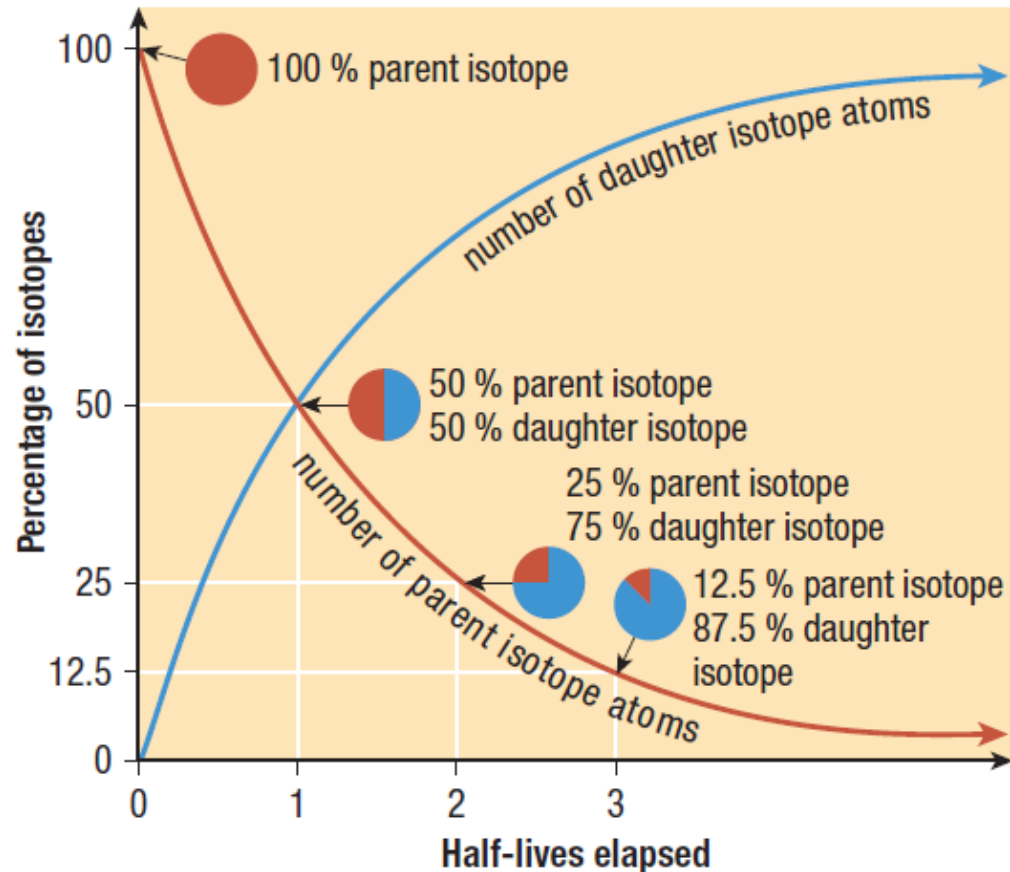
- Radioisotopes are atoms that undergo radioactive decay.



- One of the neutrons changes to a proton

Half-life

- The time it takes for half of any radioisotope to decay.



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

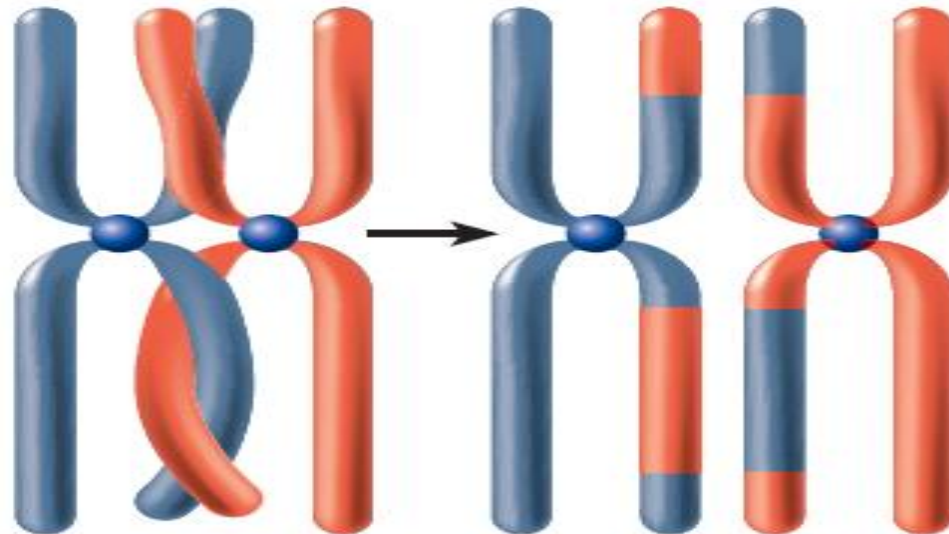
Genetic Variations and Selection



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

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



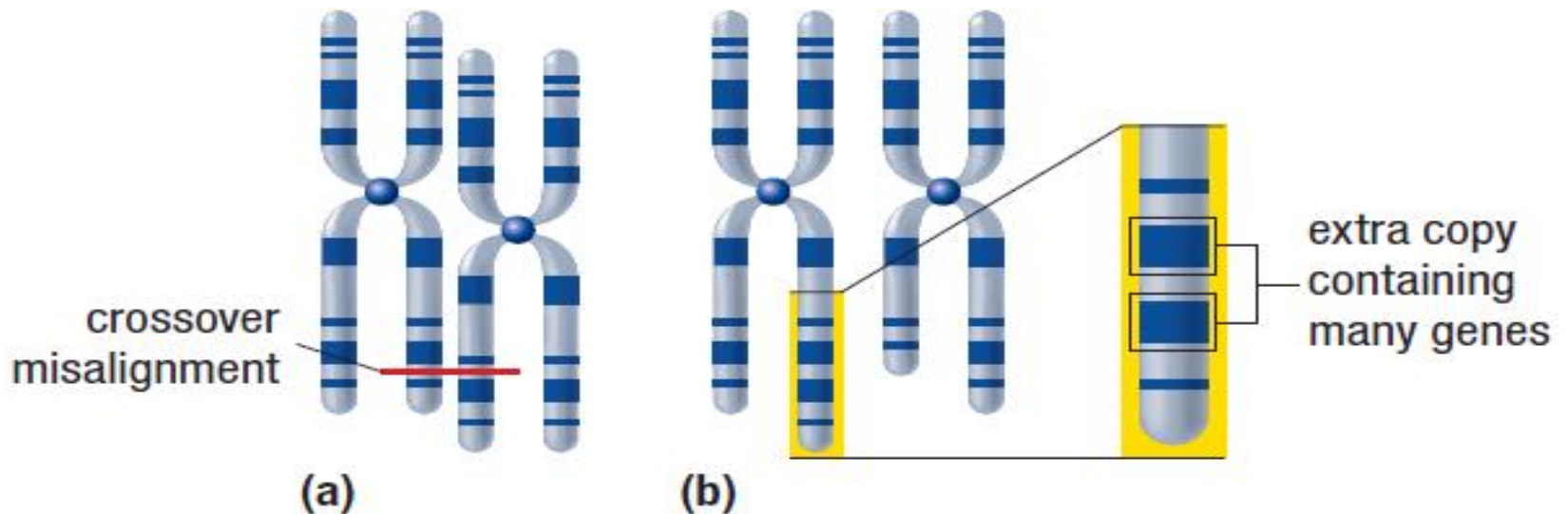
Genetic Variation



- Sexual reproduction and crossing over have the same purpose:
 - Introduce new varieties of genetic combinations

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

- Mutations can be neutral, beneficial or harmful!

Mutations and Survival

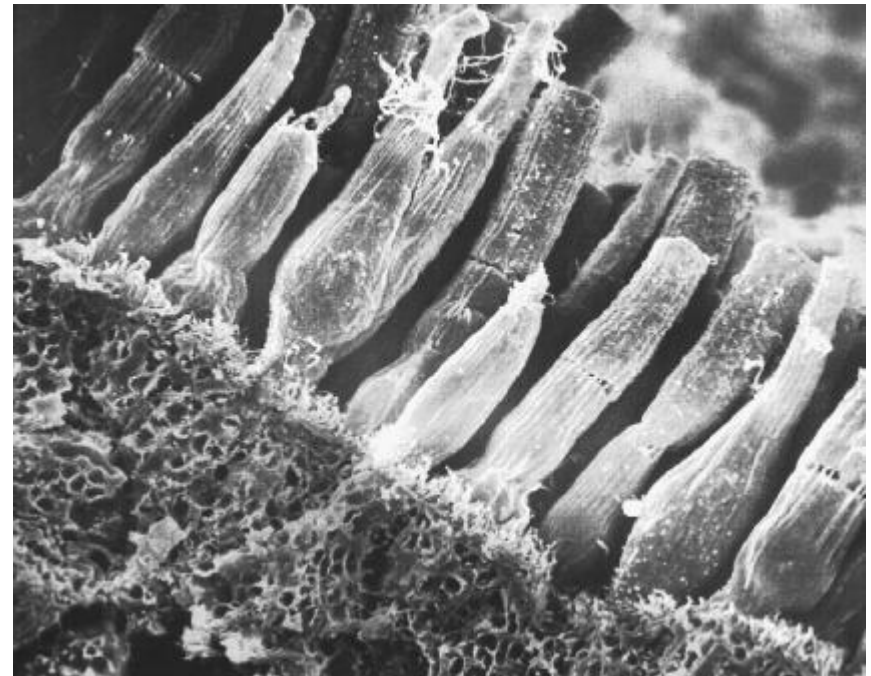
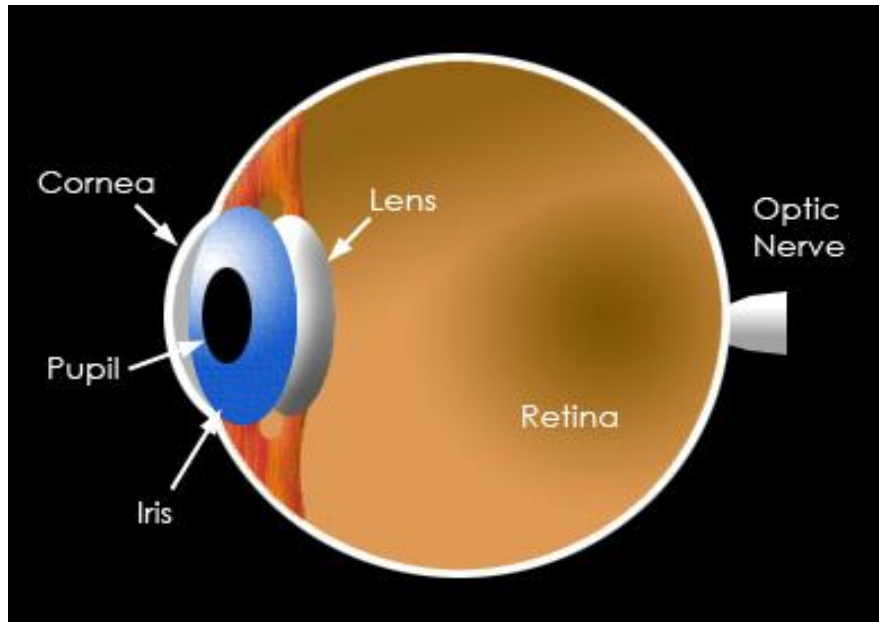
- Mutations can affect an individual's **chances of survival**
- Missing genes is often **harmful**
- Having **extra copies** of genes might be useful
 - Eg: human populations that eat a lot of starch have two copies of genes for starch proteins, make double the protein



Type of Mutations:

Gene Duplication

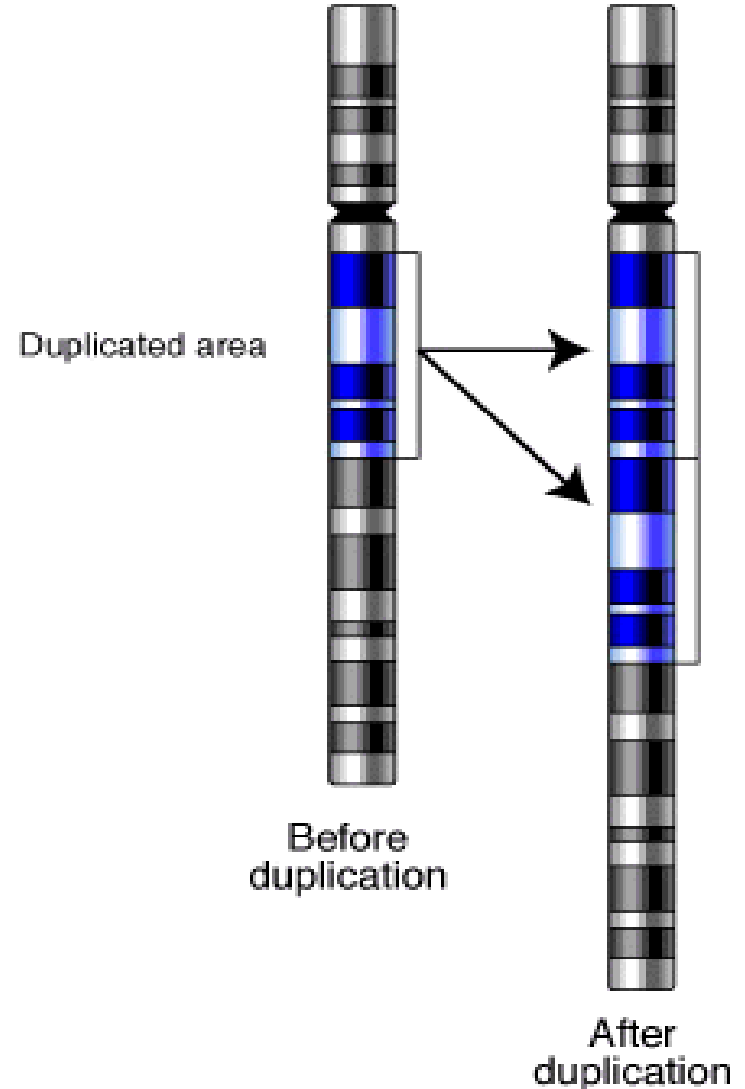
- This is an important type of mutation
- A mutation to a gene can often be harmful, even fatal
- But having an extra copy means that if that gene mutates, there is still another copy to **make sure the cell functions properly**
- **New and novel mutations** may now occur
 - Eg: rod and cone cells in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



Types of Mutations:

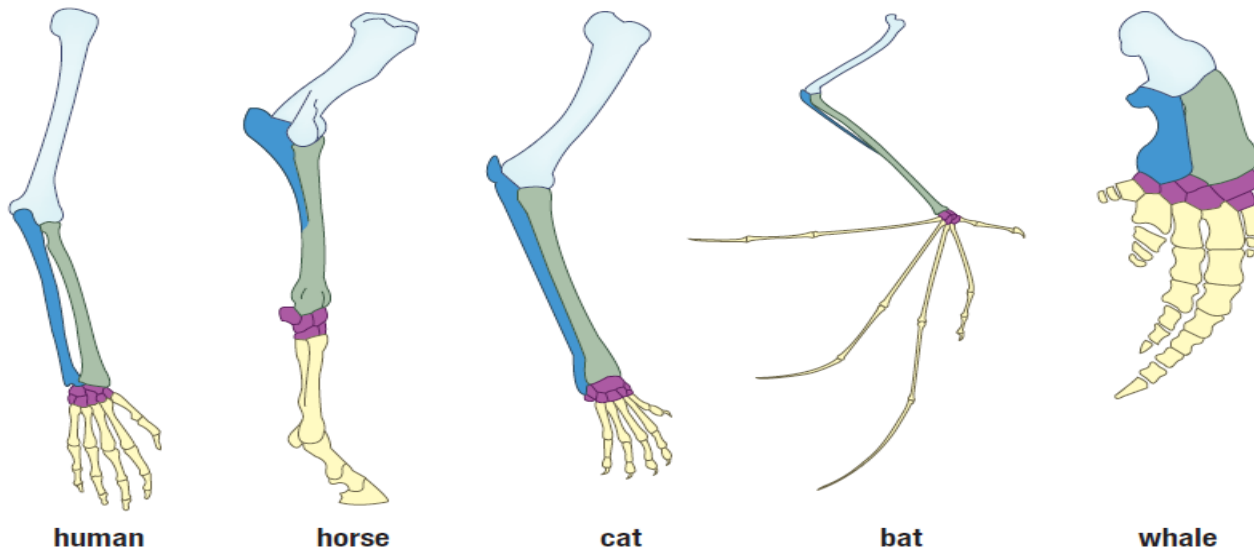
Gene Duplication

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



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

cow	CTATG	GTTCC	TAAGC	ACAAG
deer	CTATG	GTTCC	TAAGC	ACGAA
whale	CTATC	CTTCC	TAAGC	ATAAA
hippo	CTATC	CTTCC	TAAGC	ATAAA
pig	CCATT	GTTCC	CAAGC	GTAAA
rat	CCATC	TTTCC	TAAGC	TCAAA

Pseudogenes

- **Pseudogene:** A **vestigial** gene that has undergone mutations and no longer **serves a useful purpose**
- Eg: Dolphins have 1000 genes for olfactory (smell) receptors, but only use 200 of them
 - Why?



Pseudogenes

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

