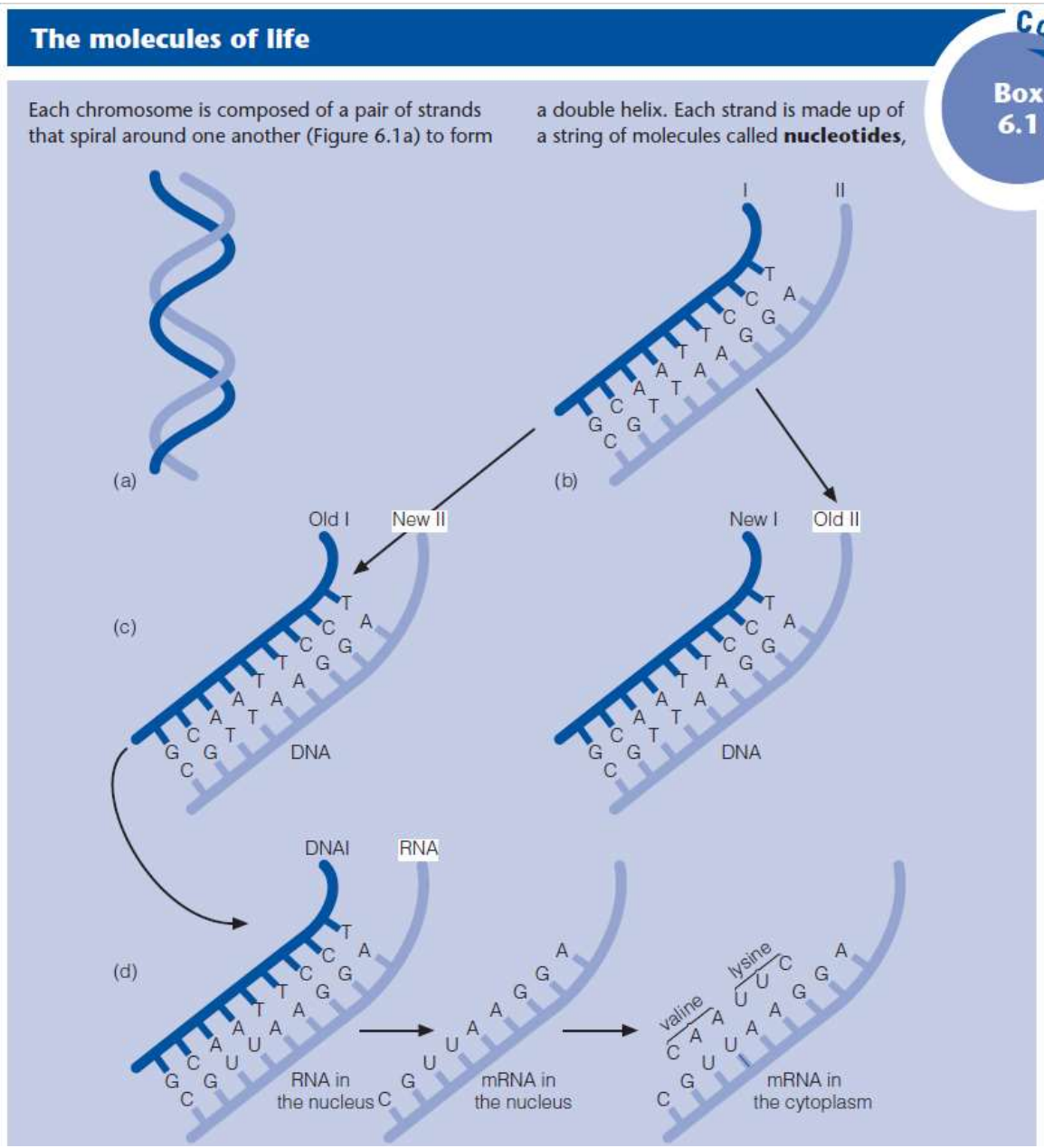
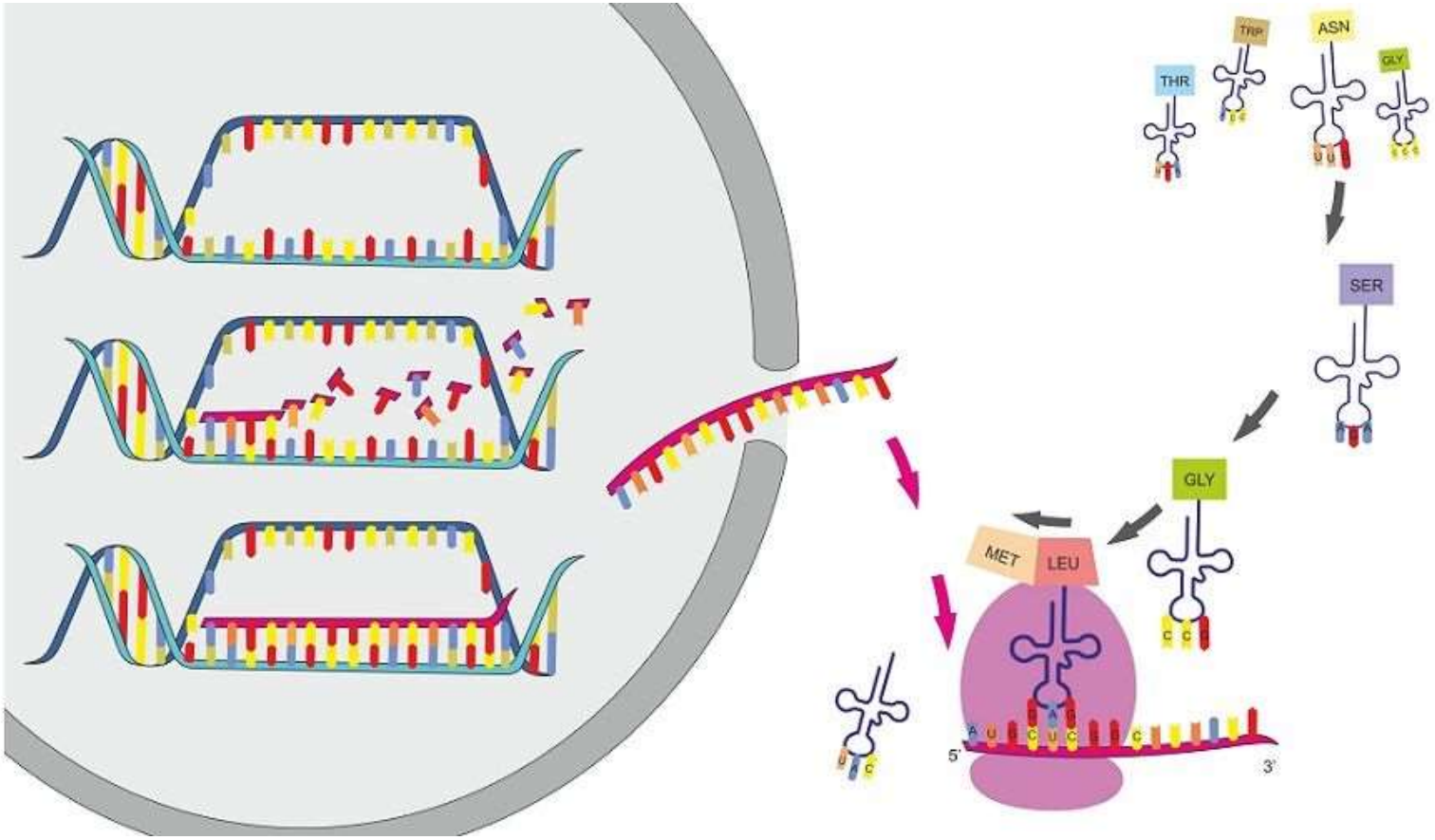
Zoogeography

Lesson 11



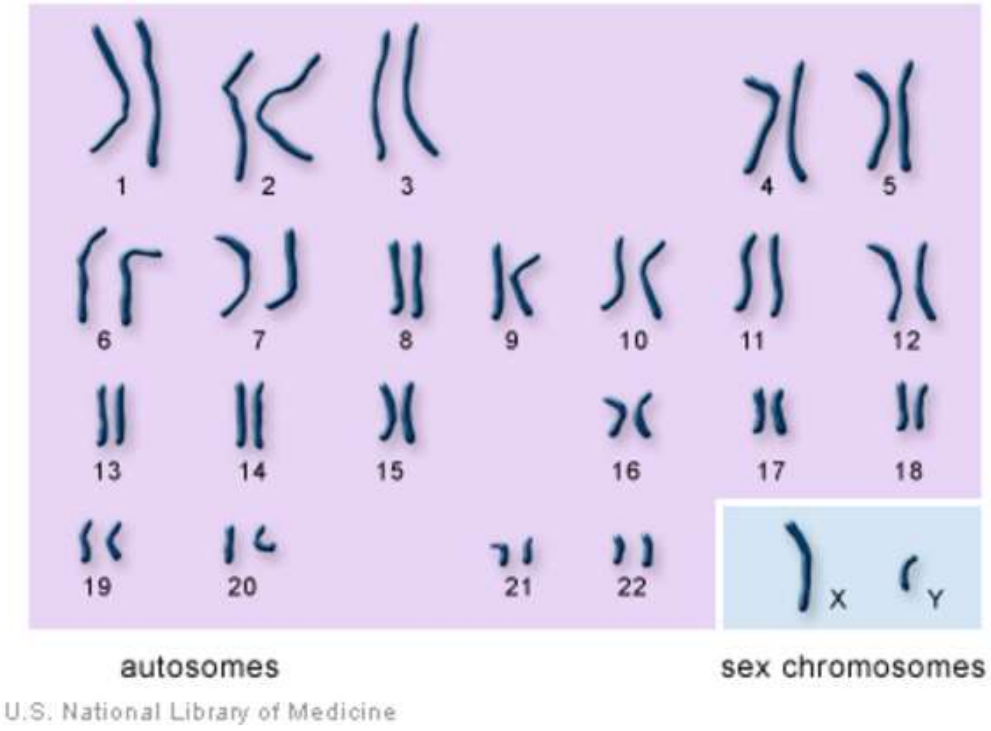
- (a) The DNA thread is made up of two strands that spiral around one another in a double helix.
- (b) The two strands are connected to one another via their nucleotides, which bind together in pairs: A (adenosine) and T (thymine), or C (cytosine) and G (guanine).
- (c) At cell division, the two strands separate, and each goes to one of the new cells, where it builds a new strand identical to the old one.
- (d) During the synthesis of proteins, a thread of DNA first builds a thread of RNA, in which U (uracil) has replaced the T (thymine).
- This thread of RNA detaches itself to form messenger RNA (mRNA), which travels from the nucleus to the ribosome in the cytoplasm. There, the nucleotides in the mRNA act as triplets, each of which forms a template for the formation of a particular amino acid – here, valine and lysine.

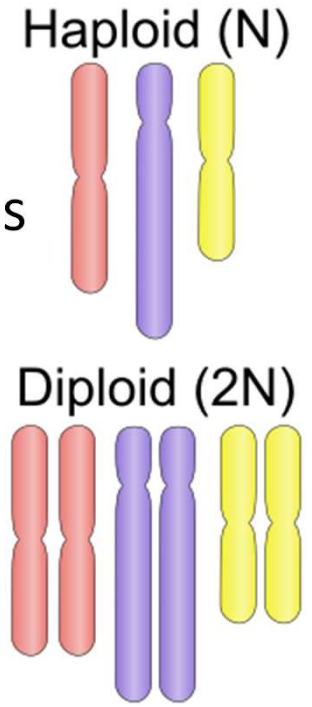
Protein synthesis



Ploidy: the number of complete sets of chromosomes in a cell

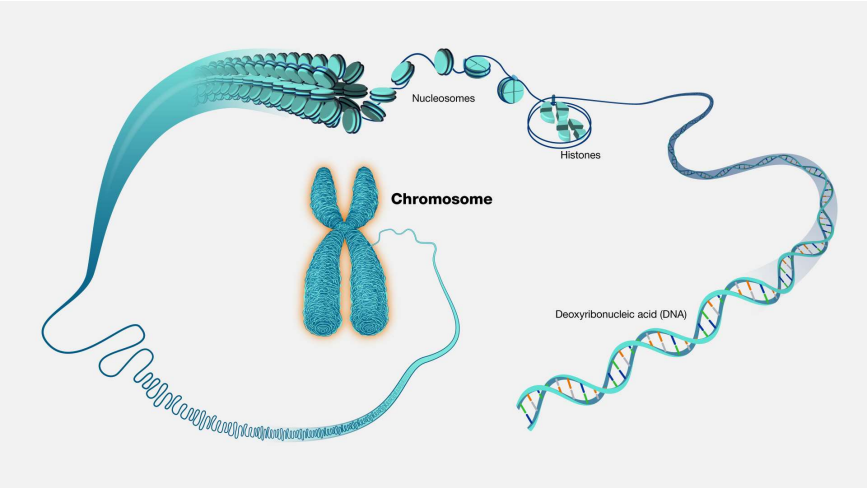
- **Haploid** condition: one complete set of chromosomes in an organism's cells
- **Diploid**: two com sm's cells
- **Triploid**
- **Tetraploid**
- **Pentaploid**
- **Hexaploid**
- **Heptaploid** (or se

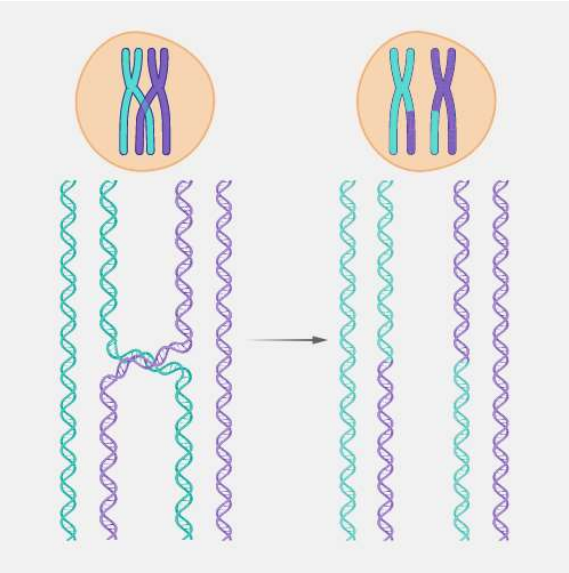




- **Haploid:**
- **Diploid**: mammals
- **Triploid**: planaria, seedless banana, watermelon, oyster and tilapia
- **Tetraploid**: amphibians, reptiles, insects
- **Pentaploid**
- **Hexaploid**: some strains of wheat plant
- **Heptaploid** (or septaploid)

While rare in animals, is common among plants





- **Haplotype**: is a set of genes in an organism that are inherited together from a single parent.
- **Recombination:** is a process by which pieces of DNA are broken and recombined to produce new combinations of alleles (during the process of production of sperm and ova).

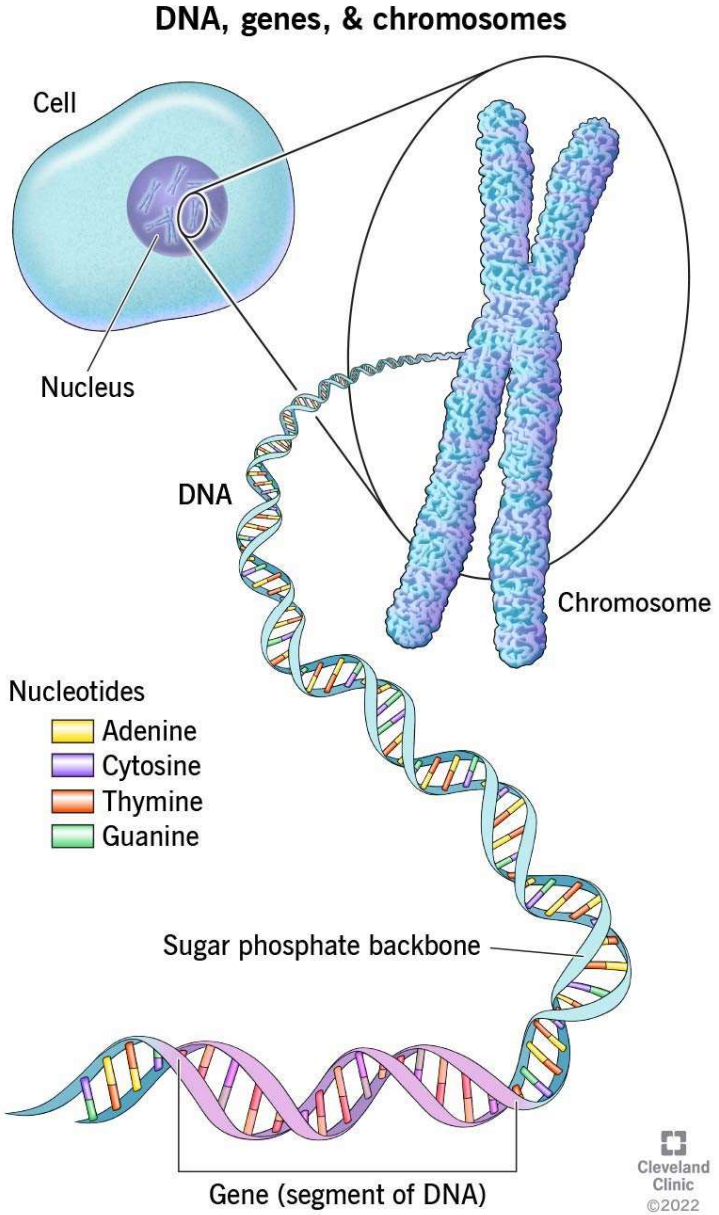
the next generation have some characteristics of each of its parents, rather than being a simple replica of one of them

Evolution is therefore possible because of competition between individuals that differ slightly from one another.

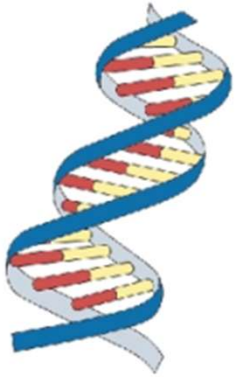
- Sparrow: they vary in as many ways as do different individual human beings

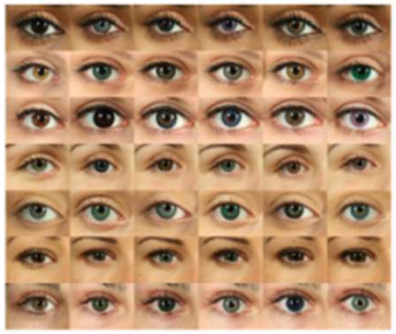
The Mechanism of Evolution: The Genetic System

- It is the biochemical activity of these genes that is responsible for the characteristics of every cell of an individual, and thus for the characteristics of the organism as a whole.
- Each gene exists in a number of slightly different versions, or **alleles**
- Many different alleles of each gene may exist, and this is the main reason for much of the variation in structure that Darwin noted.



- The total of all the genes, which makes up the total genetic inheritance of an organism, is known as its **genotype.**
- The activity of the genotype produces the characteristics of the individual (its morphology, physiology, behaviour etc.); this is known as the **phenotype.**





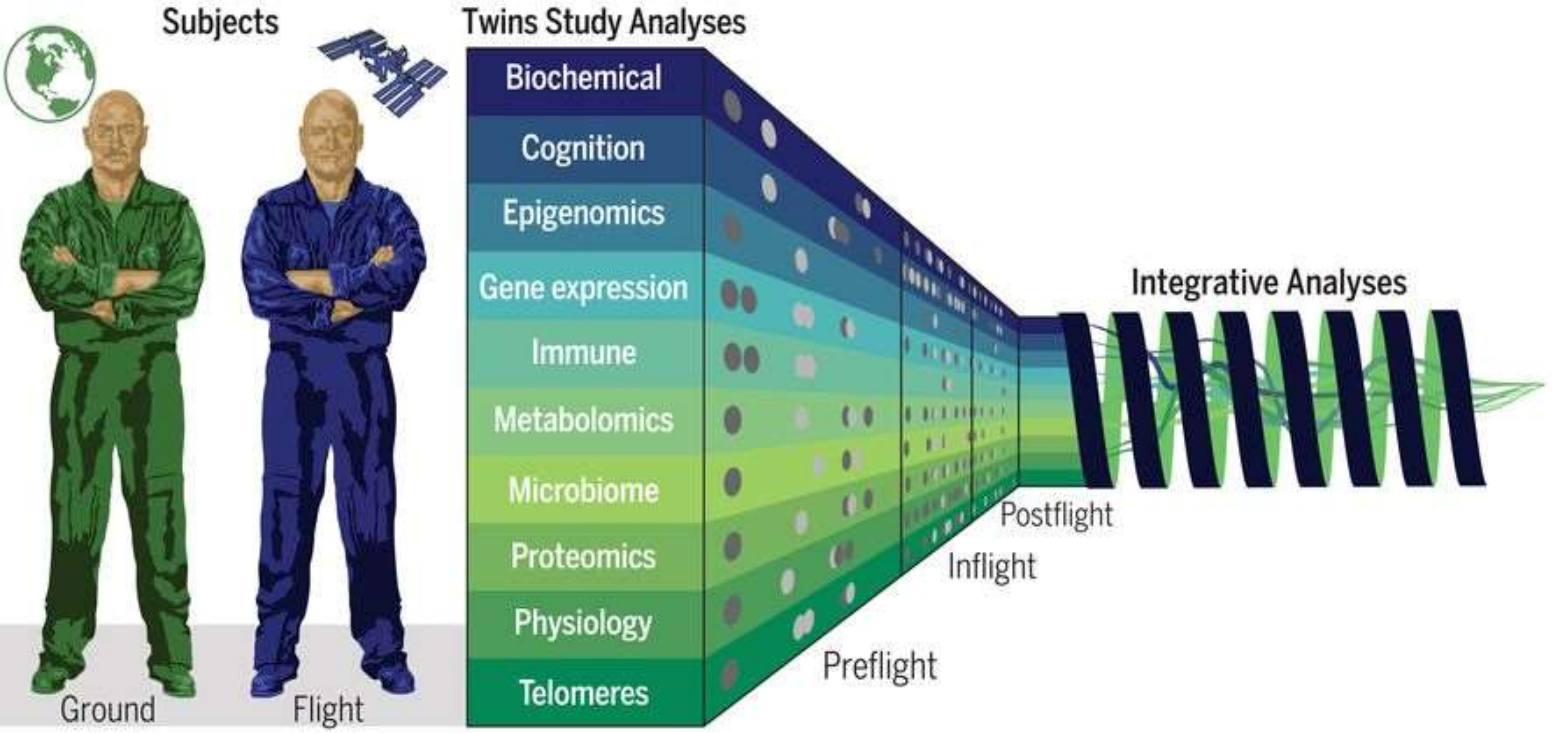
Genotypes are the genetic make-up of an individual.

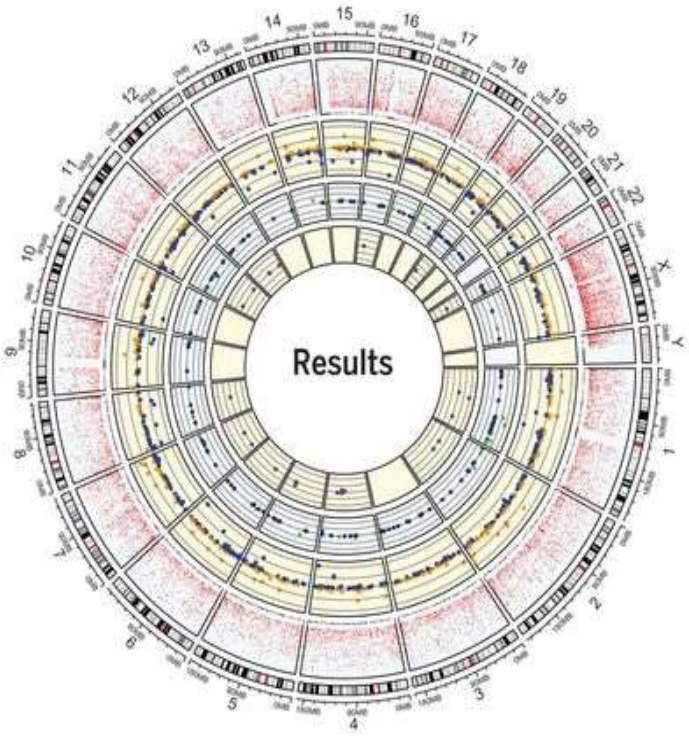
Phenotypes are the physical traits and characteristics of an individual and are influenced by their genotype and the environment.

- This slight plasticity of the genotype is valuable from an evolutionary point of view, for it makes it possible for a single genotype to survive in slightly different habitats.

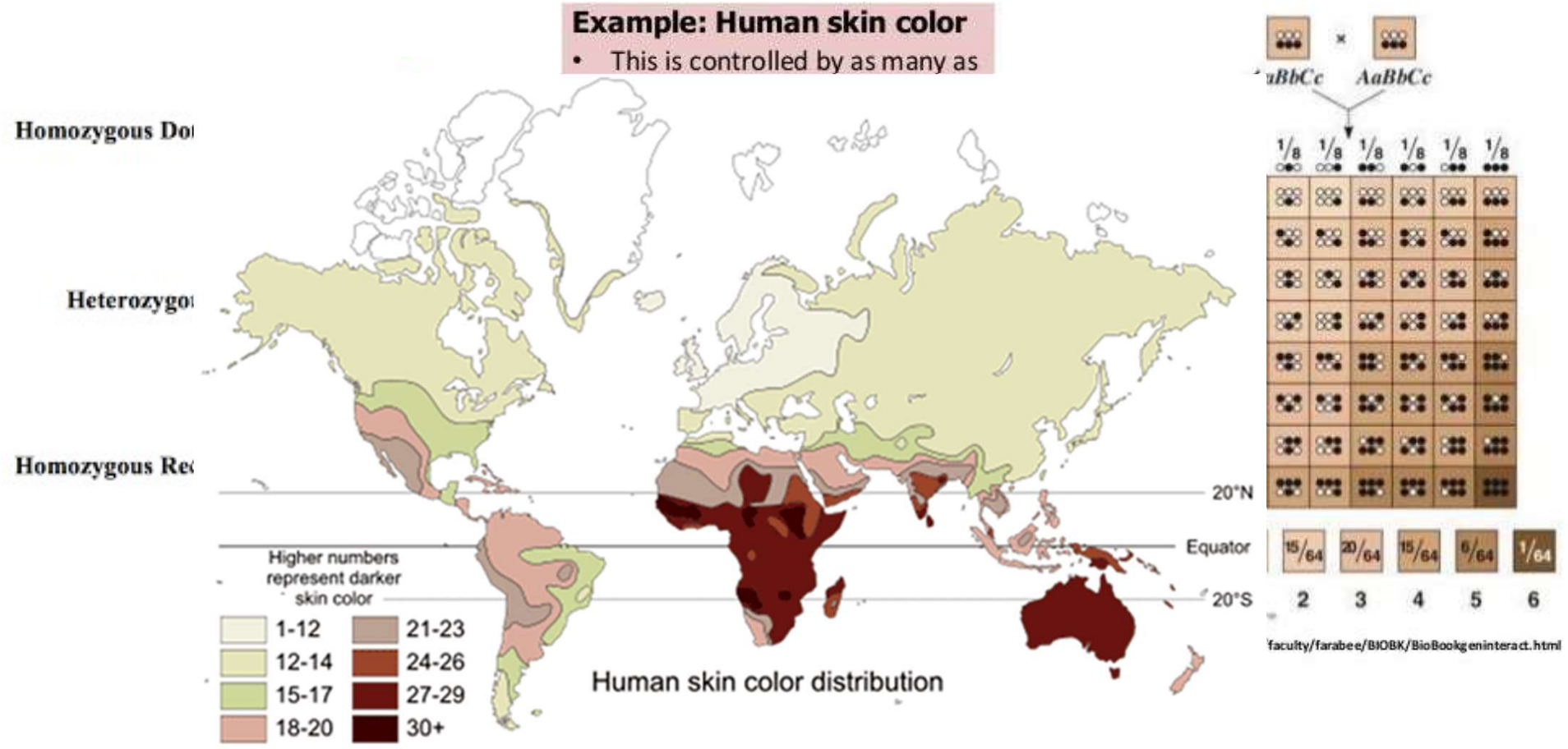
- NASA astronaut Scott Kelly recently spent one year in space, while his identical twin brother Mark stayed on Earth.
- identified many of the effects of microgravity on human physiology. Muscles, especially those that help support the body's posture against gravity, waste away, bones become less dense, increased pressure in the skull leads to visual impairments and the amount of blood in the body reduces. As if that wasn't enough, the heart also gets smaller as it can pump blood to the brain more easily and cosmic radiation can lead to increased cancer risk.

Ticking clock of the cell





- An individual, of course, inherits characteristics from both its parents.



The genetic system that provides two vital properties of the organism:

- First, it provides the stability that ensures that its complex systems will function and be adapted to the demands of the environment.
- Second, it provides the plasticity that allows it to respond to minor changes in that environment.

But how do modifications of its characteristics take place?

slight error in duplication process

- This may happen in the cell divisions that lead to the production of the sexual gametes (the male sperm or pollen, and the female ovum or egg).
- so, the individual resulting from that sexual union may show a completely new character, unlike that of either parent (colourless hair).

Such sudden alterations in the biochemical structure of the genes are known as **mutations**.

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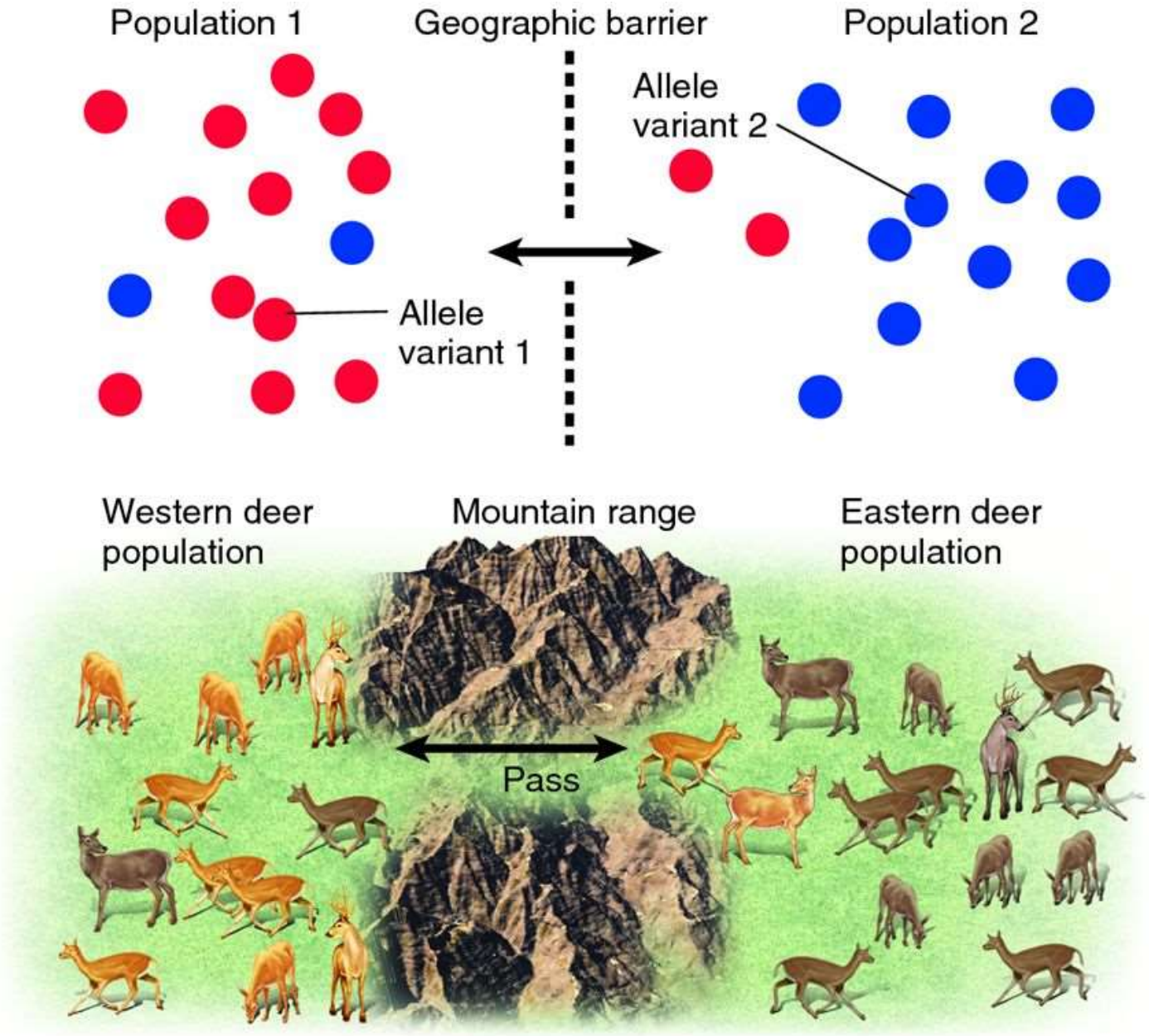
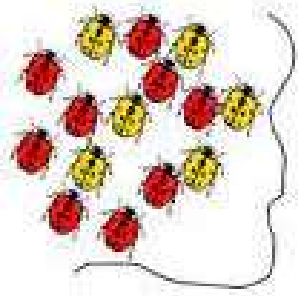
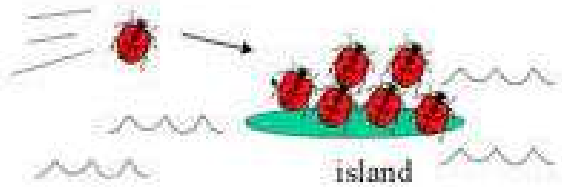
- First, ne … us, spread t…
- Second, … , and each ma… , no two individu… same genetic …



- Any of new characteristics that confer an advantage on the organism are likely to spread gradually through the population and so change its genetic constitution.
- However, chance, as well as its genetic constitution, plays a role in determining whether a particular individual survives and breeds.
- Even if a new, favourable genetic change appears in a particular individual, it may by chance die before it reproduces, so that the new mutation or recombination disappears.





- In smaller populations, however, chance will play a greater role in controlling whether a particular allele becomes common or rare or disappears; this effect is known as **genetic drift** because it is not controlled by selective pressures.
- Smaller populations therefore contain less genetic variability and are less closely adapted to their environment; they are therefore more likely to become extinct than larger populations (This can be a particular problem in island populations).

Amish People

- Small group of Amish people moved from Switzerland to US in 1800s = founder effect
- Their way of life and religious beliefs keep their population isolated = decreased genetic diversity

A result of genetic drift

The Founder Effect in Action: Among the Amish, babies with Ellis-Van Creveld Syndrome are born with six fingers

- All that is now required for the appearance of a new species is that some of the new characteristics of this isolated population fit it for a way of life that is in some fashion different from that of the ancestral population from which it became isolated.

From Populations to Species

- However great may be the area of land (or water) within which a particular species is found, it is not present everywhere there.
- Any area is a patchwork quilt of differing environments.
- As a result, the species is broken up into many individual populations that are separate from one another.
- no two patches of woodland, no two freshwater ponds, will be absolutely identical, even if they lie in the same area of country.

- Each population independently responds to the particular environmental changes that take place in its own location.
- The response of each population is also dependent on the particular pattern of new mutations and of new genetic combinations that have taken place within it.
- Each population will therefore gradually come to differ from the others in its genetic adaptations.
- Provided that the barriers between the two populations are great enough to prohibit genetic exchange between them, the foundations for the appearance of a new species have now been laid.

- If two such divergent populations should meet again when the process of divergent adaptive change has not gone very far, they may simply interbreed and merge with one another.
- If they have become significantly different in their adaptations, they may still be able to mate and have fertile offspring, known as hybrids; these are likely to have a mixture of the characters of their two parents.

Isolating mechanisms

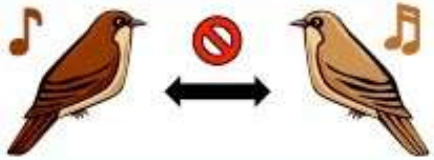
- evolution will then favour the appearance of any characteristics that reduce the likelihood of hybridization:

1) systems that prevent mating between related species from taking place, Pre-mating isolating mechanisms.
2) systems that lead to reduced fertility if such mating does take place, Post-mating isolating mechanisms.

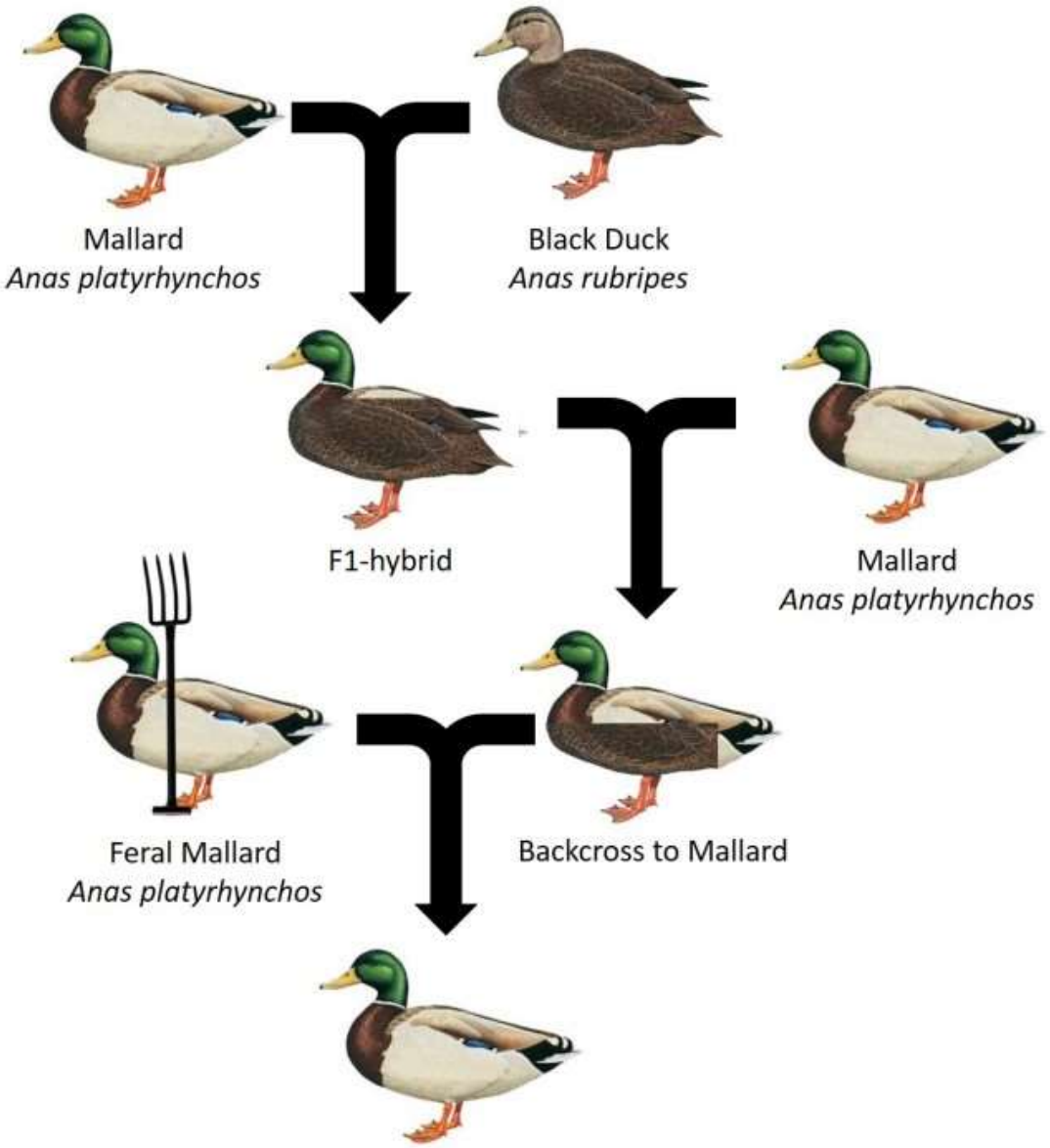
Pre-mating isolating mechanisms

- In the case of Darwin's finches, related species recognize one another because they have different songs, and they do not mate with an individual that sings the 'wrong' song.

  - Sometimes the preference for the mating site may differ slightly. For example, the North American toads *Bufo fowleri* and *Bufo americanus* live in the same areas but breed in different places

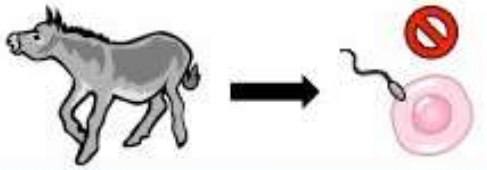
Pre-zygotic Isolating Mechanisms		Example	
Temporal	Occurs when two species mate at different times of year	Frogs live in same pond but breed during different seasons (summer vs spring)	
Ecological	Occurs when two species occupy different habitats	Lions and tigers can potentially interbreed, but usually occupy different habitats	
Behavioural	Occurs when two species have different courtship behaviours	Certain groups of birds will only respond to species-specific mating calls	
Mechanical	Occurs when physical differences prevent copulation / pollination	Certain breeds of dog are morphologically incapable of mating due to size	

- However, where the group concerned is rapidly evolving, such pre-mating barriers may not have had sufficient time to become effective.
- in ducks, where colour pattern and behaviour are the pre-mating barriers, 75% of the British species are known to hybridize.



Post-mating isolating mechanisms

- if pollen of another species does reach the stigma of a flower, in many cases it is unable even to form a pollen tube because the biochemical environment in which it finds itself is too alien. It cannot therefore grow down to fertilize the ovum.
- Similarly, in many animals the spermatozoa of a different species cause an allergic reaction in the walls of the female genital passage, and the spermatozoa die before fertilization.

Post-zygotic Isolating Mechanisms		Examples	
Hybrid Inviability	Hybrids are produced but fail to develop to reproductive maturity	Certain types of frogs form hybrid tadpoles that die before they can become a frog	
Hybrid Infertility	Hybrids fail to produce functional gametes (sterility)	Mules are sterile hybrids resulting from mating between a horse and a donkey	
Hybrid Breakdown	F_1 hybrids are fertile, but F_2 generation fails to develop properly	The offspring of hybrid copepods have less potential for survival or reproduction