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## **AS Biology Unit 2**

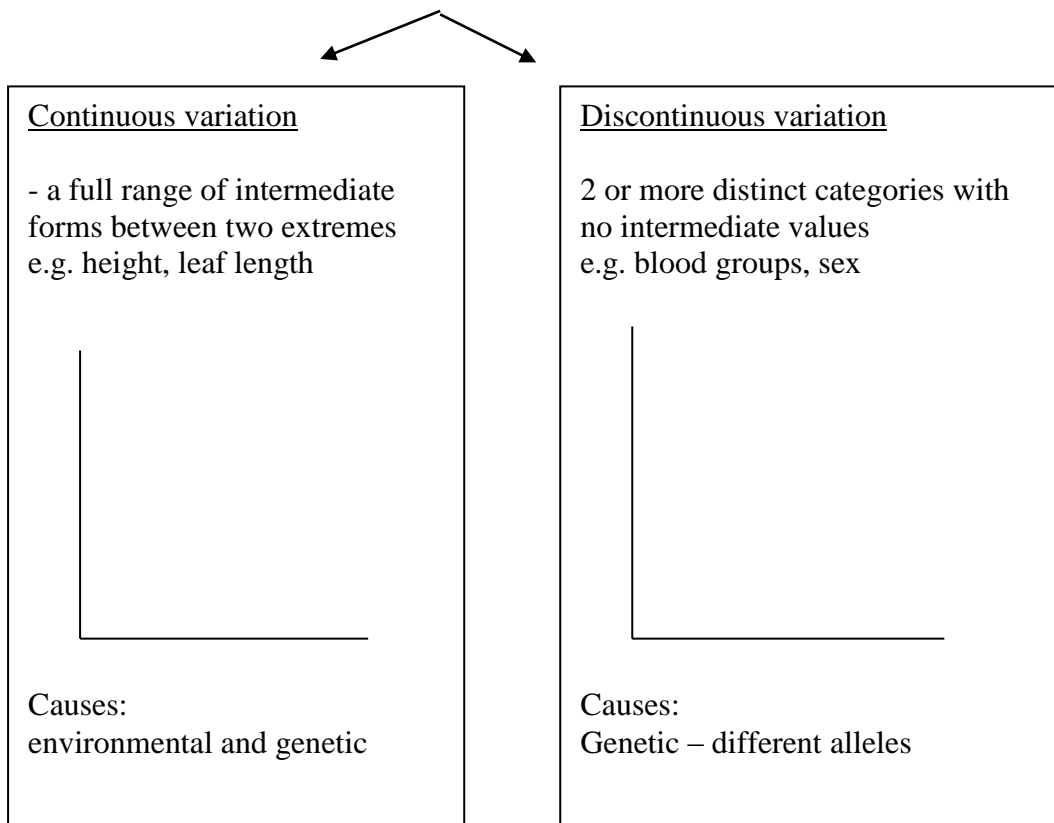
# **Variation, DNA & Meiosis**

## Variation

Variation = differences between individuals Caused by

- Mutation
- Meiosis
- Fusion of gametes

### Continuous or discontinuous variation?



List 3 human characteristic features which show continuous variation and 3 which show discontinuous variation

Continuous

- 1.
- 2.
- 3.

Discontinuous

- 1.
- 2.
- 3.

**Standard deviation** is a measurement of the variation about the mean value

### **Nucleotides, nucleic acids, DNA and RNA**

DNA (deoxyribonucleic acid) and RNA (Ribonucleic acid) are polymers made up of sub-units (monomers) called **nucleotides**

### **Structure of a nucleotide**

### **Organic bases**

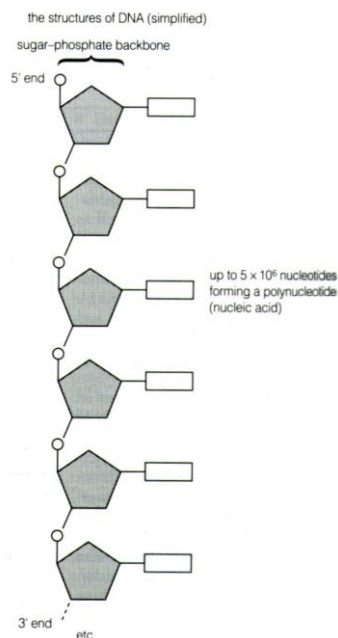
4 different organic bases occur in DNA:

- **Adenine (A)**
- **Guanine (G)**
- **Thymine (T)**
- **Cytosine (C)**

RNA is similar but the organic base **Uracil (U)** replaces **Thymine (T)**

These bases are classified chemically as **purines** (A and G) or **pyrimidines** (T, U and C). If you are confused, the easiest way to remember is that the pyrimidines has a Y in their name.

Nucleic acids are formed from nucleotides by a condensation reaction



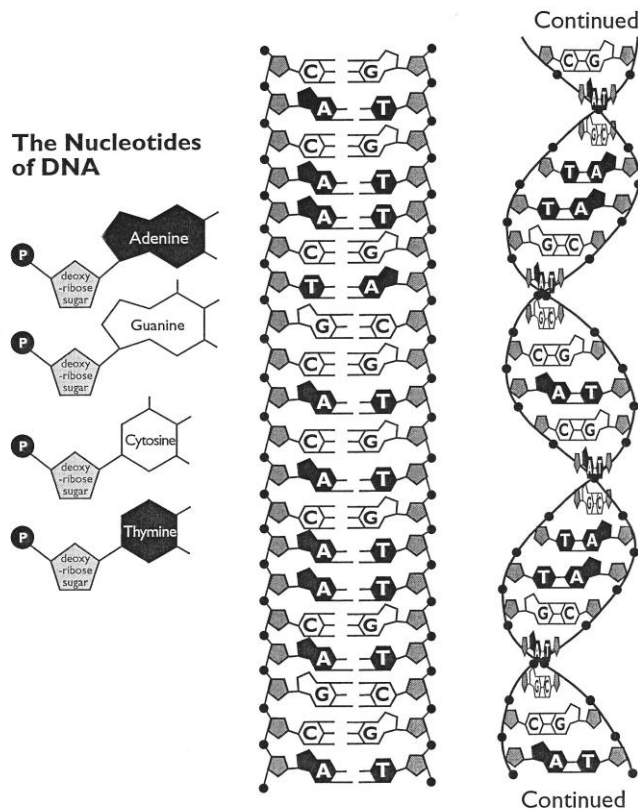
## Base pairing in DNA

DNA is made up of two polynucleotide chains running **anti-parallel** to each other and joined by H bonds between their organic bases..

- The purine adenine binds to the pyrimidine thymine
- The purine guanine binds to the pyrimidine cytosine

A and T, C and G are called **complementary base pairs**

*Notes*



## Reading the code

The base sequence on DNA is the **genetic code**. It is read in triplets, each triplet coding for a specific amino acid. A **gene** is a section of DNA containing the code for one protein.

But the DNA code is locked in the nucleus while amino acids are assembled into proteins on **ribosomes**. This is the process called **protein synthesis**.

The gene code is first copied (**transcribed**) onto messenger RNA, then **translated** into protein at the ribosome

## DNA replication

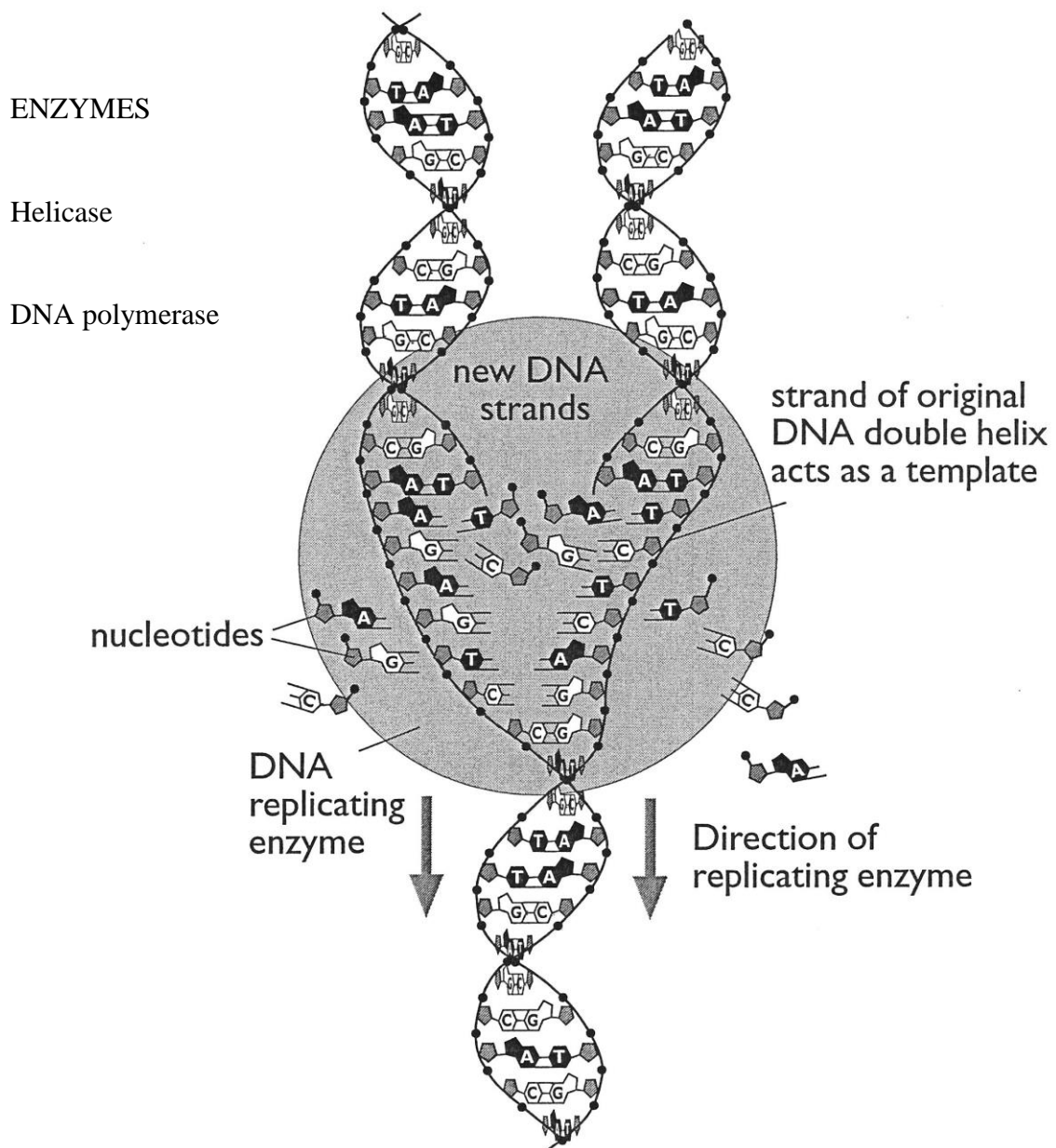
Remember: this process occurs during the S stage of interphase in the cell cycle.

Every new cell requires an exact copy of the entire genetic code.

This process involves

- an enzyme, DNA polymerase
- a supply of nucleotides (these are made in the nucleolus)
- H bonding of bases
- Covalent bonding of sugar phosphate backbone

It is called **semi – conservative replication** because .....



### **Evidence for semi-conservative replication**

Exp. Using nitrogen sources for nucleotide manufacture of 2 types

- Lighter  $^{14}\text{N}$
- Heavier  $^{15}\text{N}$

Bacterial grown on medium containing these two incorporated them into their DNA.

1. grow bacterial colony on  $^{15}\text{N}$
2. transfer for one generation to  $^{14}\text{N}$
3. repeat after 2 and 3 generations
4. extract DNA from each generation and centrifuge it

Sketch results below:

### **Evidence that DNA is the hereditary material**

Expt. with mice and a bacterium causing pneumonia which occurs in 2 forms

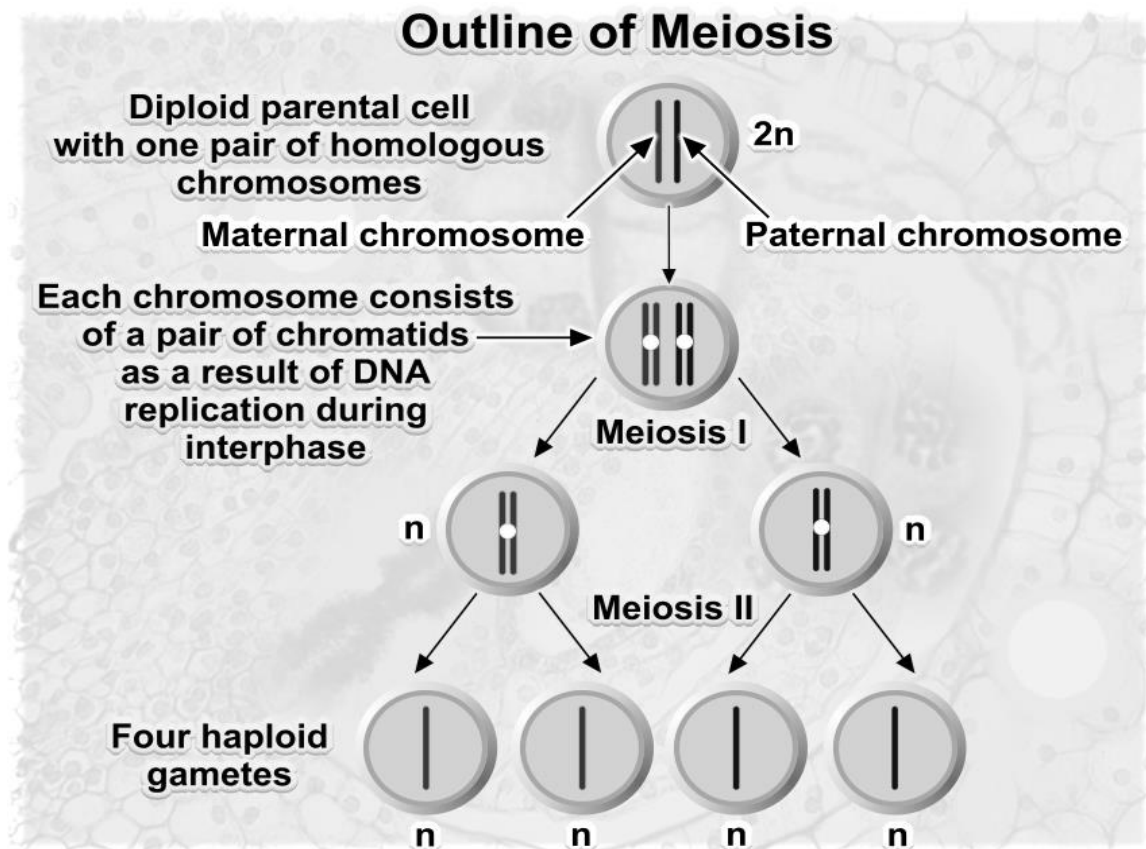
- Safe form (the R – strain)
- Harmful form (the S – strain)

Groups of mice injected with live R strain or dead S strain are fine but if injected with both at the same time, they develop pneumonia and the harmful live S strain is isolated from them.

Why?

## MEIOSIS

A special form of cell division which occurs in sex organs and results in sex cells (**gametes**) with half the chromosome number. 4 haploid gametes are produced. They are not genetically identical. They each have a copy of every gene but the alleles may vary.



Make a table below to compare mitosis with meiosis

Genetic variation is increased by

- Independent assortment of chromosomes
  
- Crossing over (draw diagram to illustrate)

**MUTATION:** chance mistakes occur during cell division to produce new alleles. A mutation may involve just one triplet code (e.g. cystic fibrosis) but the consequences may be severe or fatal.

Explain why this is

## **Selection of particular alleles**

**Artificial selection** - selection of particular alleles and their expressed characteristics by man, deliberate (e.g. dogs) or accidental (e.g. MRSA). (*see questions on the topic of antibiotic resistance*)

**Natural selection** - selection of particular alleles and their expressed characteristics by environmental factors e.g. predators, disease, climatic change, food shortage.

**The founder effect** - The first group of organisms to colonise a new habitat are not necessarily typical of the population as a whole and pass on their particular alleles to succeeding generations.

**Genetic drift** - Random inheritable mutations occur over time in separated populations leading to changes in the characteristics which have no particular significance for survival (e.g. blue eyes). These characteristics may be subjected to sexual selection.

**Genetic bottleneck** - small isolated breeding groups have a limited gene pool.



## Genes and alleles

**GENE** is a section of DNA / RNA containing the specific base sequence for making ONE protein. E.g. a gene controls the basic eye colour

**ALLELE** is an altered (mutated) form of the gene. E.g. blue eyes (the original gene would have been for brown eyes).

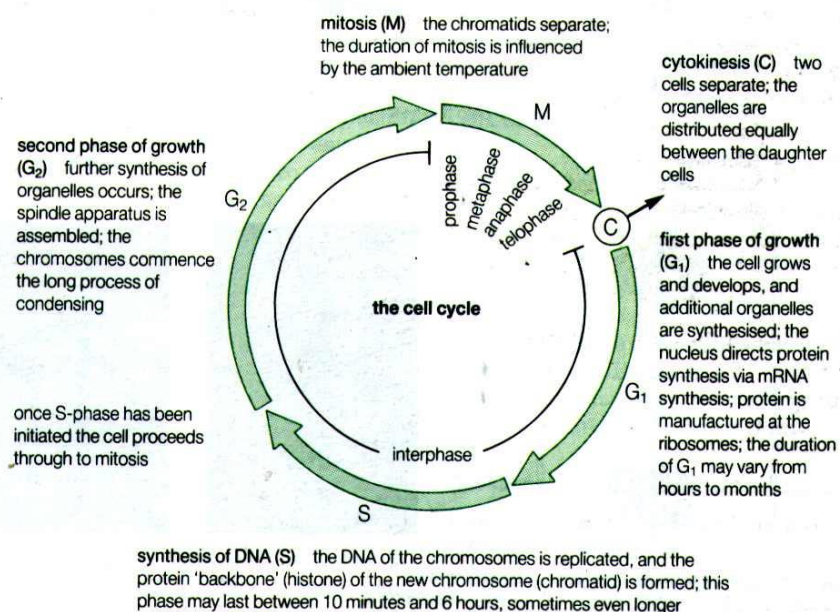
- Alleles are located at fixed points (loci) on chromosomes
- One allele for each gene is inherited from the mother and one from the father

**MUTATION** is a change in the base sequence of a gene to produce a new allele.

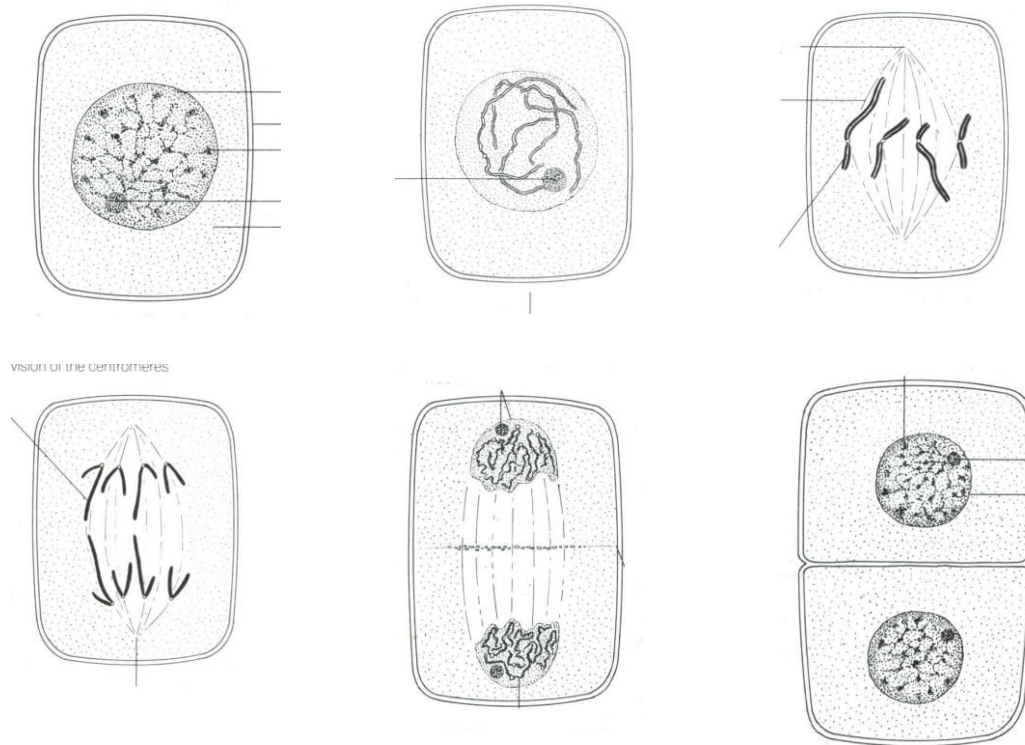
**JUNK DNA** is non-functional DNA inherited over thousands of generations. It includes **INTRONS**, bits of code with no function inside gene sequences

**The cell cycle** - a repeating series of cell divisions e.g. in stem cells

Figure 9.2 The cell cycle



Stages of mitosis



Summary of mitosis

Stage	Description of events
PROPHASE	
METAPHASE	
ANAPHASE	
TELOPHASE	
CYTOKINESIS	

*Some confusing words: Distinguish between the following*

1. Chromosome, chromatid and chromatin
2. Centromere and centriole
3. Stem cell and meristem
4. Mitosis and meiosis

	Mitosis	meiosis
Chromosome number		
Variation in daughter Cells		
Number of daughter Cells		
Purpose		

Asexual reproduction - cloning

Advantages?

Disadvantages?

Examples:

Binary fission

Budding

Vegetative propagation

Cell specialization = **DIFFERENTIATION**

Cell type	Specialised features
Red blood Cell	
Sperm cell	
Ciliated Epithelium	
Squamous Epithelium	
Palisade Cell	
Guard cell	
Root hair Cell	

TISSUE =

ORGAN =

ORGAN SYSTEM =