PSY236 - Biopsychology and Learning

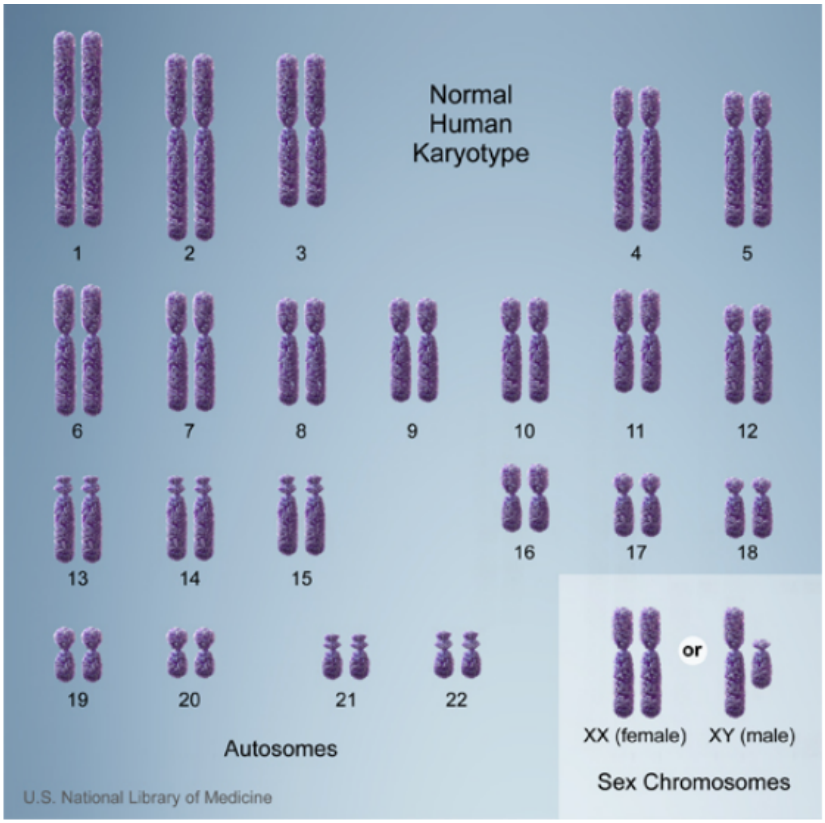
1. Behavioural Neuroscience: Genetics

Behaviour is the response of an individual, group or species to a stimulus/trigger in the environment. Individuals and species respond differently to a similar stimulus because of:

- Genetic makeup (nature). Evolution of physical traits cause different behavioural responses e.g. the evolution of wings allows birds to fly whereas humans run in a dangerous situation. Parental traits contribute to factors such as skin colour, height, intelligence and physical capability that influence behaviour.
- Environmental factors (nurture). Individual state of mind, emotion, previous learning experience, culture and background all contribute to producing unique behavioural responses.

Genetics

- Chromosomes are found in the nucleus of every cell in the body. They are made up of DNA that contains our genetic material (genes), which drives cell function and manufactures proteins.
- Single chromosomes are usually not depicted. Chromosomes are more commonly represented in pairs of identical chromosomes, where a single chromosome has duplicated and now exists as a sister chromatid, joined at the centromere.
- Every cell in the human body contains 46 chromosomes that come in 23 pairs. Of each pair, one chromosome comes from the biological mother and the other from the biological father.



*Karyotype – the number and visual appearance of chromosomes in the cell nuclei of an organism.

*Autosome – any chromosome that is not a sex chromosome. In the human body, 22 pairs of chromosomes are autosomes.

*One pair is the sex chromosomes, which determines the sex of the person. The pair consists of either XX (female) or XY (male) chromosomes. Since females only have X chromosomes, they always contribute an X chromosome to offspring. Males contribute either an X or Y chromosome, determining the sex of offspring.

- DNA (deoxyribonucleic acid) are double strands of nucleotide base pairs. Chromosomes are made up of long strands of DNA.
- Genes are short regions or sequences of DNA. They are the units of hereditary information – information that is passed down from one generation to another.
- Chromosomes > DNA > genes are contained within the nucleus of cells. Genetic information promotes survival of the cell and hence the organism.

The Making of Proteins

- DNA is essential for life because it programs the manufacture of different proteins for use in the body. Proteins are made up of amino acids, which form the building blocks of life.
- Twenty amino acids are used to make proteins, **nine** of which are essential to survival:

1. Histidine	2. Isoleucine	3. Leucine	4. Lysine	5. Methionine
6. Phenylalanine	7. Threonine	8. Tryptophan	9. Valine	

- The sequence of amino acids to make a protein is determined by an intermediate ribonucleic acid (RNA).
- DNA is a self-replicating molecule that consists of **double strands** of base pairs. These double strands can split to form a single strand - RNA is the copy of one strand of DNA. The process of splitting and copying strands of DNA is known as transcription.

- Every **triplet** sequence of bases determines the formation of a **single** type of amino acid. Chains of amino acids are known as peptides, which combine to form a protein. This process of protein formation is known as translation.

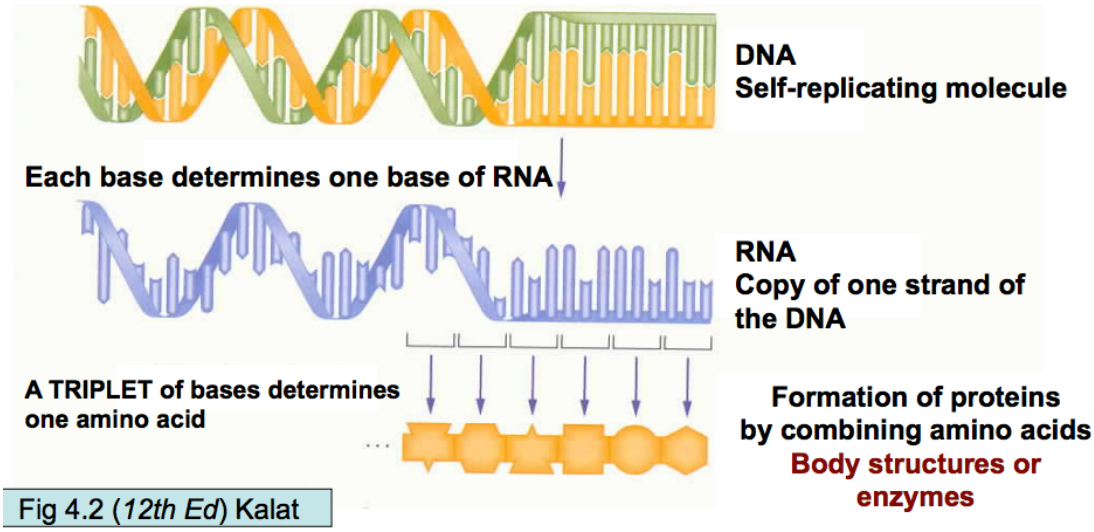
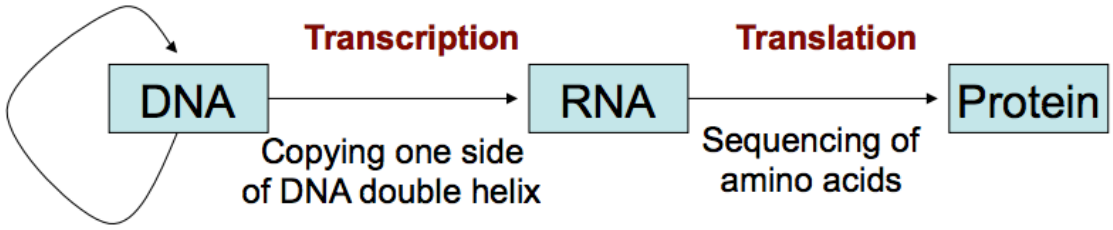


Fig 4.2 (*12th Ed*) Kalat

- The **order** of the base pairs in DNA determines the function of each gene. This genetic information is translated into the types of amino acids formed and the proteins created.
- Proteins are used in the body as
  - Biological tissue/cells, which make up the body parts of an organism.
  - Enzymes, which are catalysts of chemical reactions that allow our bodies to function normally. e.g. the enzyme called amylase in saliva facilitates the breakdown of sugar in food.

Genetic Life Cycle:



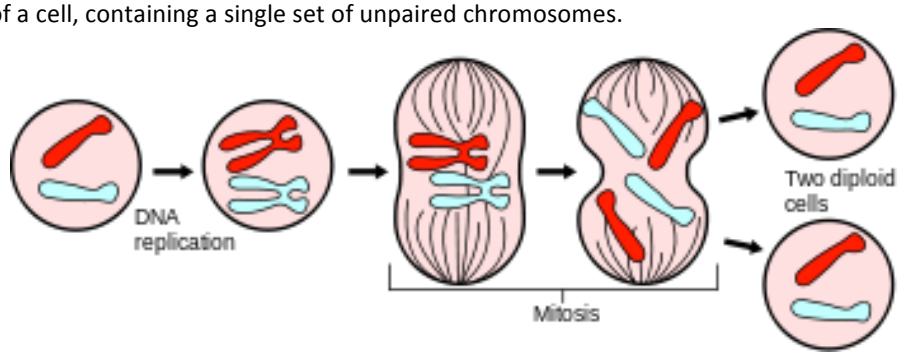
Replication - essential in cell division when making **new** cells

Cell Replication

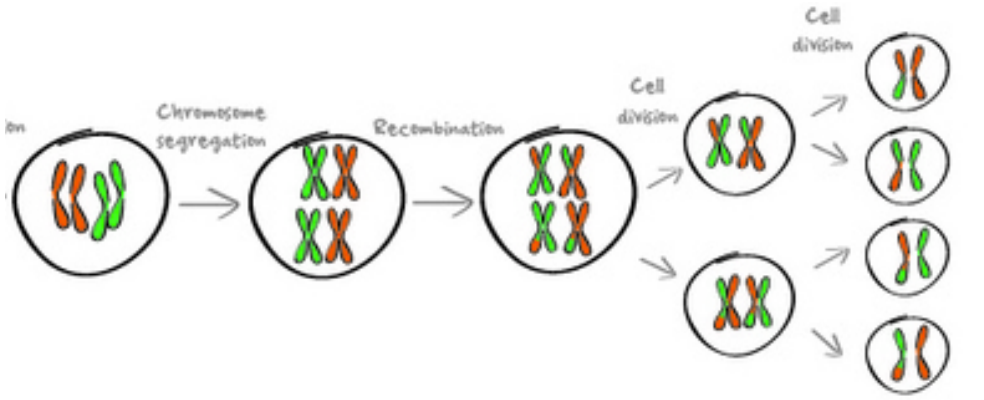
Mitosis is the duplication of a cell to produce two diploid cells, containing **identical** genetic information.

*Diploid – of a cell, containing two complete sets of chromosomes, one from each parent.

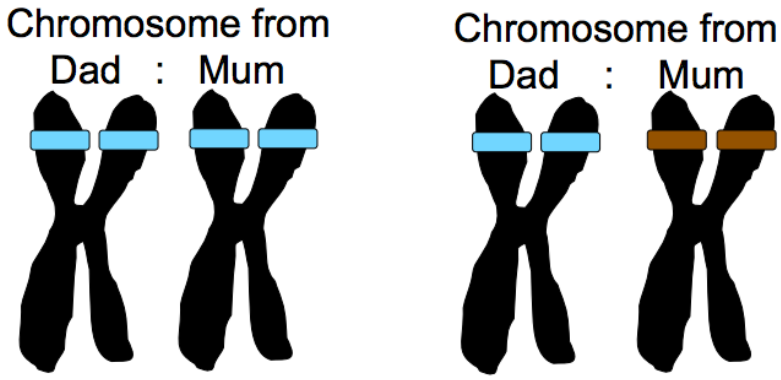
*Haploid – of a cell, containing a single set of unpaired chromosomes.



Meiosis is a two-stage process of cell division that results in four haploid cells, each with half the number of chromosomes as the original parent cell. These mature into reproductive cells (gametes), which fuse during sexual reproduction to produce a complete cell containing both maternal and paternal chromosomes. This results in genetic diversity in a population.
Meiosis occurs in the organs of the reproductive system. In males, the process is known as spermatogenesis and occurs in the testes, resulting in four sperm cells. In females, oogenesis results in one ovum and three polar bodies (which deteriorate in the body).
Reproduction combines a haploid male sperm cell with a haploid female ovum, producing a diploid zygote cell.

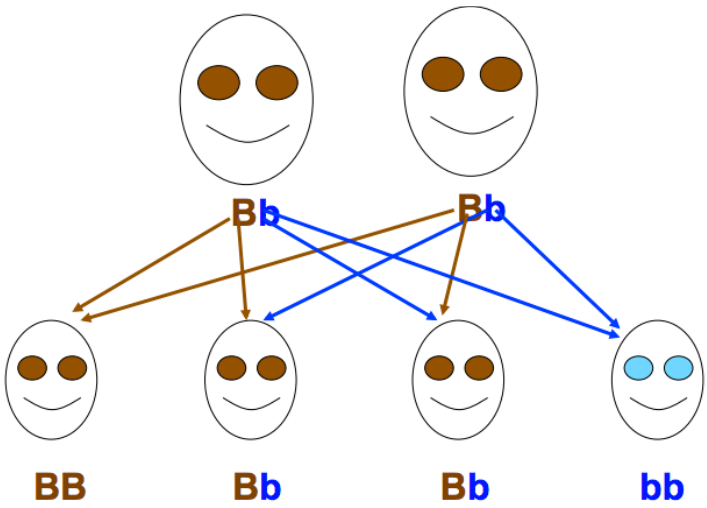


Recombination of genes allows for the biological expression of different physical or psychological characteristics.
If both chromosomes in a pair contain **identical** genes responsible for a single characteristic, the person is homozygous for that gene. If the chromosome pair contains two **different** genes responsible for a characteristic, the person is heterozygous for that gene.



The expression of a characteristic depends on whether the gene is dominant or recessive.
Dominant genes require only **one** gene present in the chromosome pair to produce the characteristic.
Recessive genes require **both** genes to be present in the chromosome pair (homozygous) to express the characteristic.

Example: chromosome 15 holds the genes responsible for eye colour. Brown (B) is a dominant trait, while blue (b) is recessive. If both parents are heterozygous (carry the recessive blue gene), four combinations are possible - they may have blue-eyed children who are homozygous for blue eyes.
(This diagram is useful but freaky af)



Genetic Mutations

Alterations or deletions of DNA sequence can be either beneficial or detrimental:

- Down's syndrome results from having three chromosomes instead of the usual two at chromosome 21.
- Mutations that resulted in some of the usually light-winged peppered moths to have black wings were beneficial during the Industrial Revolution – it was easier for the black moths to hide from predators. The higher rate of survival ensured continuation of the peppered moth species, now evolved such that dark-winged specimens are more common.

New therapies aim to turn on/off important genes. For example, micro RNA alters gene expression at the translation level to help prevent symptoms of autism.

Epigenetics is the influence of environmental factors on our genetic activity. Some factors 'close' a gene to prevent manufacture of a certain protein, others open up a gene sequence to encourage protein manufacture. For example, when worker bee larvae were fed with royal jelly, they matured to become queen bees – their diet suppressed the worker bee gene.

Heritability

The way we behave is predicted by our genetic makeup and shaped by our environment. If a behaviour has high heritability, it is largely determined by genes; conversely if a behaviour has low heritability, it is largely determined by the environment.

Genetic traits that promote survival and reproductive advantages in a species will be passed down, causing the evolution of behaviour. The traits that are advantageous may change over time with changes in the environment e.g. an animal that has evolved to survive in a warm climate will find its traits disadvantageous in an ice age – an animal of the same species but with different, more advantageous traits, is more likely to survive and hence pass down different traits.