Life Sciences

Key Points

June 2025

Basic technical points when answering the question paper

- Question 1, 2 and 3 must start on a new page
- After each sub question draw a line
- Graphs, Tables and drawings have a caption/heading
- Use a ruler or protractor and compass when drawing graphs

JUNE P2 – 60 MARKS

DNA: THE CODE OF LIFE	Term 1	2 weeks

- Functions of DNA:
- DNA makes up genes which carry hereditary information
- DNA contains coded information for protein synthesis

- Role of DNA in transcription
- One Strand of a DNA ✓-molecule act as a template on which a complimentary mRNA is formed that carries the coded message for proteinsynthesis

Differences between DNA and RNA

- Structural differences
- Differences in monomers

DNA	RNA
Sugar is deoxyribose ✓	Sugar is ribose ✓
Pairing of bases ✓	No pairing of bases ✓
Has weak hydrogen bond ✓	No weak hydrogen bond ✓
Long chain ✓	Short chain ✓
Double-stranded molecule ✓	Single-stranded molecule ✓
Nitrogen base thymine ✓ / ATCG	Nitrogen base uracil ✓ / AUGC

DNA
Deoxyribose sugar
Nitrogenous basis Thymine

RNA
Ribose sugar
Nitrogenous basic Uracil

DNA Replication – What we need to know !

- ? When in the cell cycle it takes place
- ? Where in the cell it takes place
- ? How DNA replication takes place (names of enzymes not required)
- ? The significance of DNA replication
-

DNA replication- there is a specific way and sequence in answering

- The double helix DNA unwinds
- Unzip/hydrogen bonds between the two strands break
- To form two separate strands
- Both DNA strands serve as template
- To build a complementary DNA/ (A=T, G=C)
- Using free DNA nucleotides
- Results in to two identical DNA molecules

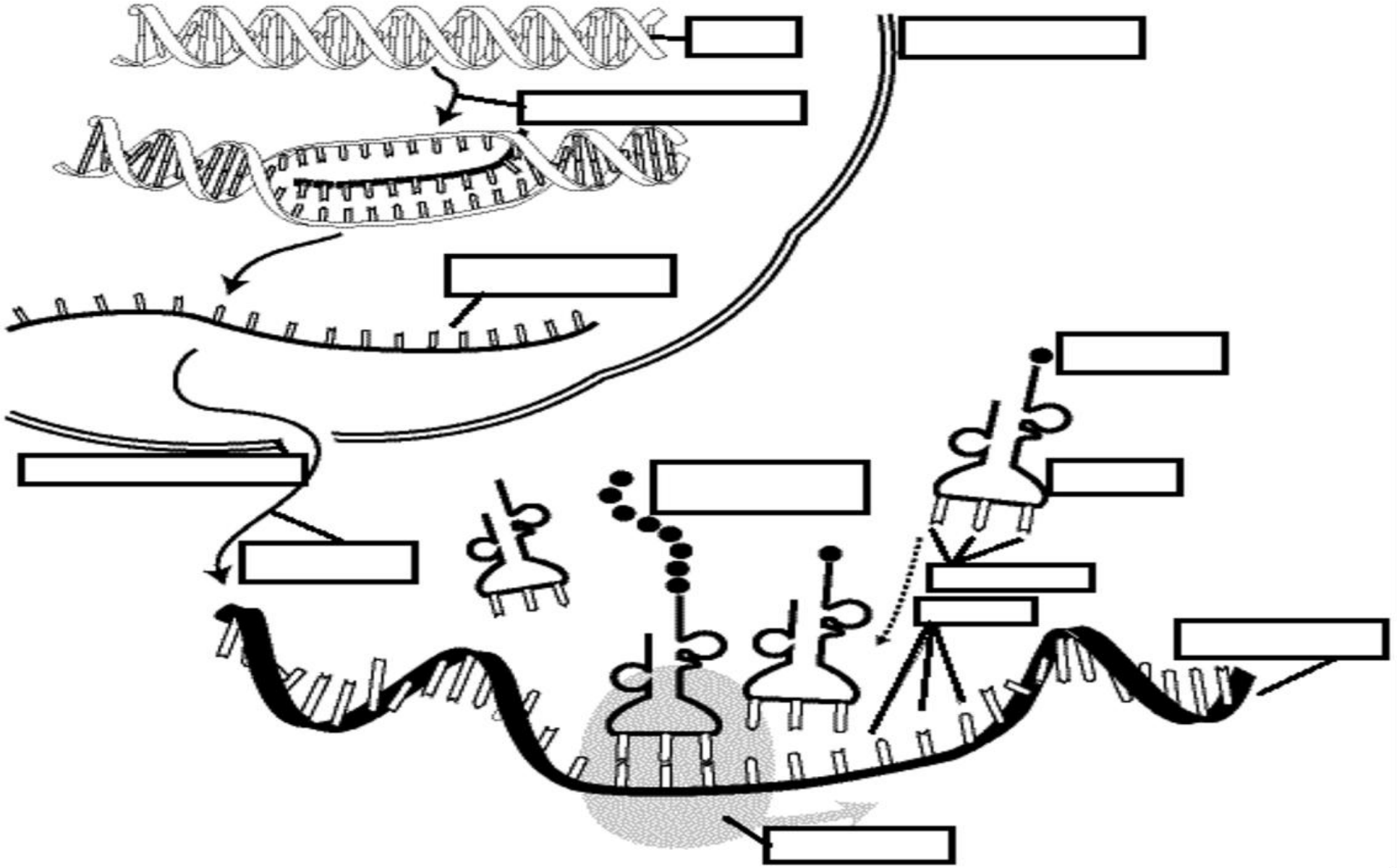
Transcription – look at the key words

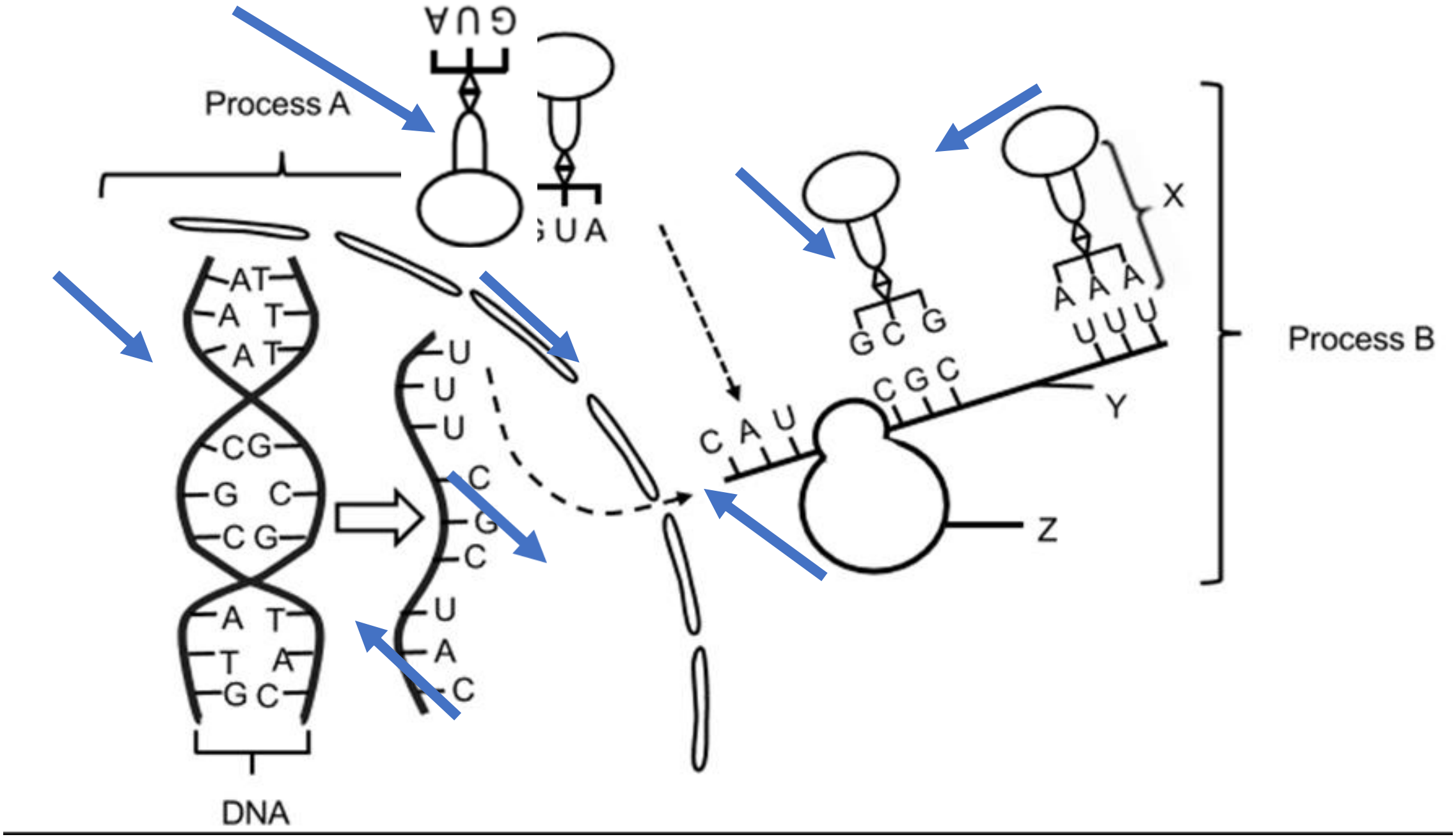
- The double helix DNA unwinds.
- The double-stranded DNA unzips/weak hydrogen bonds break to form two separate strands.
- One strand is used as a template
- to form mRNA
- using free RNA nucleotides from the nucleoplasm.
- The mRNA is complementary to the DNA.
- mRNA now has the coded message for protein synthesis

Translation

- Each tRNA carries a specific amino acid.
- When the anticodon on the tRNA
- matches the codon on the mRNA
- then tRNA brings the required amino acid to the ribosome.
- (Names of specific codons, anticodons and their amino acids are not to be memorised.)
- Amino acids become attached to each other by peptide bonds
- to form the required protein

DIAGRAMS – PROTEIN SYNTHESIS




Process A
DNA
Process B
X
Y
Z

DNA basis/ Codon/Anticodon /Amino acids/Mutations

Haemoglobin is a protein found in blood that carries oxygen to all the cells of the body. A portion of this protein is called a beta chain. If the sequence of amino acids in this chain changes, then a different form of haemoglobin, called haemoglobin S, is formed. Haemoglobin S cannot transport oxygen as efficiently as normal haemoglobin.

Position of amino acids in the beta chain	1	2	3	4	5	6	7
Normal haemoglobin	Val	His	Leu	Thr	Pro	Glu	Glu
Haemoglobin S	Val	His	Leu	Thr	Pro	Val	Glu

The table below shows the DNA base triplets coding for some amino acids.

DNA BASE TRIPLET	AMINO ACID
CAC	Val
GTG	His
GAC	Leu
TGA	Thr
GGA	Pro
CTC	Glu

Give the:
DNA base triplet for amino acid 3 - **GAC**
mRNA codon for amino acid 4 - **ACU**

What is a change in the sequence of DNA base triplets called? – Gene mutation

Use the information in the tables to explain how a change in the sequence of the DNA base triplets results in the formation of haemoglobin S, rather than normal haemoglobin.

-The DNA base triplet change from CTC to CAC
Therefore, because there is no indication of mRNA we go to the amino acids
-The Amino acid sequence change
-because a different amino acid bind VAL instead of GLU
-A a new/ different protein will be formed.

How to answer gene mutation (change in nitrogenous bases)

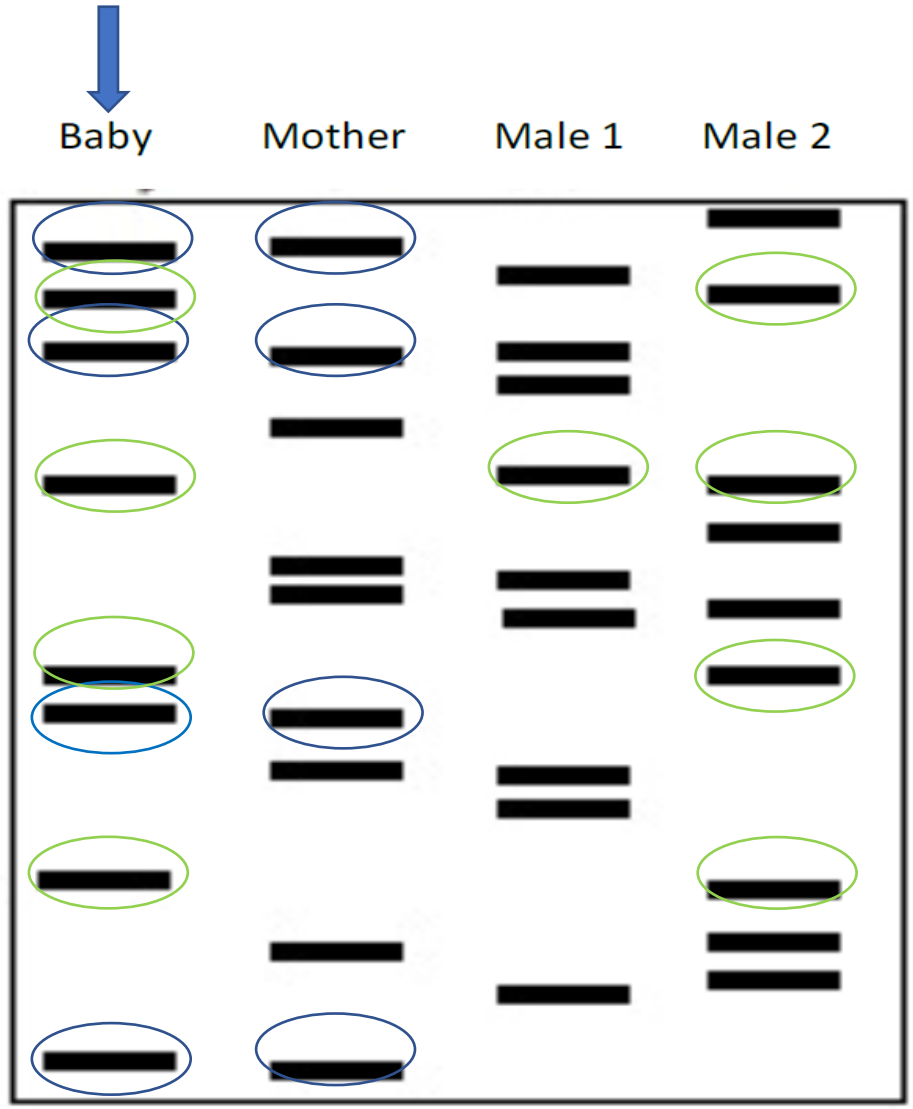
Nitrogenous bases	Before	After
DNA – Base triplet	TCG	TCC
mRNA – Codon	AGC	AGG
tRNA – Anti-codon	UCG	UCC
Amino Acid	Proline	Valine
Protein	Different protein formed	

DNA profiling

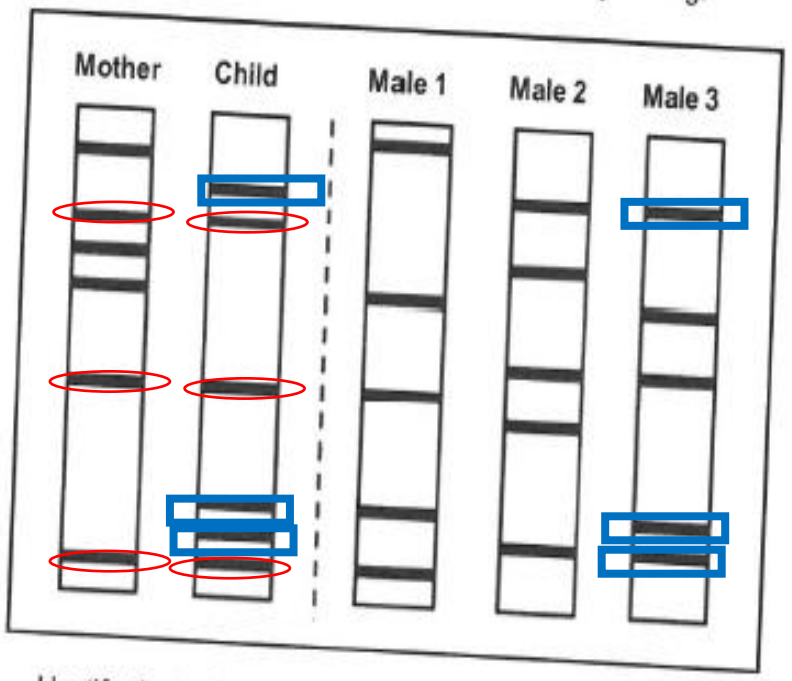
1) Look at the DNA bands of the baby

2) Identify all DNA bands that are common with that of the mother.

3) If all the remaining DNA bands of the baby correspond with that of one of the males, then that male is the father.



3.3 The diagram below shows a technique used in paternity testing. (6)



3.3.1 Identify the technique shown above. (1)

3.3.2 Which male is the biological father of the child? (1)

3.3.3 Explain your answer to QUESTION 3.3.2. (3)

3.3.4 State TWO other uses of this technique. (2)
(7)

3.3 3.3.1 DNA profiling✓ (DNA fingerprinting)

3.3.2 Male 3✓

3.3.3
- The bands of the child's DNA is a combination of the DNA from each parent ✓
- Three bands are identical to that of the mother✓
- The remaining (three) bands correspond with that of male 3✓

3.3.4
- To investigate crimes✓/resolve disputes
- To identify organisms from their remains✓
- To identify missing persons✓
- To identify family relationships other than paternity✓ e.g. siblings or cousins
- To test for the presence of specific alleles✓/genes that cause a genetic disorder
- To establish matching tissues for organ transplants✓ Any 2

(Mark first TWO only)

Meiosis- 30 Marks

- The events of the following phases of Meiosis 1 and 2, using diagrams:
- □ Prophase
- □ Metaphase
- □ Anaphase
- □ Telophase
-

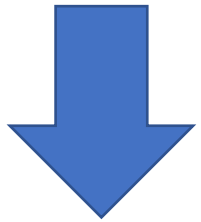
Meiosis

- The importance of meiosis:
- Production of haploid gametes

The halving effect of meiosis overcomes the doubling effect of fertilisation, thus maintaining a constant chromosome number from one generation to the next

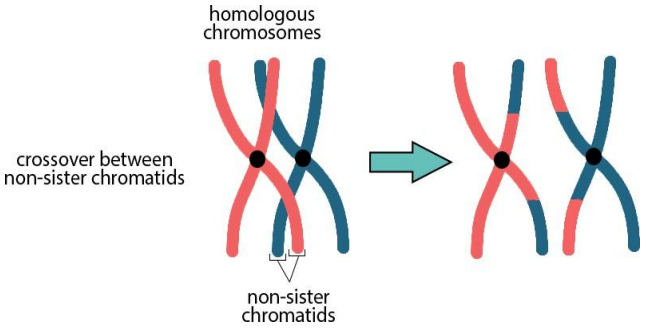
- Introduce genetic variation – Crossing over

  - random arrangement of chromosomes



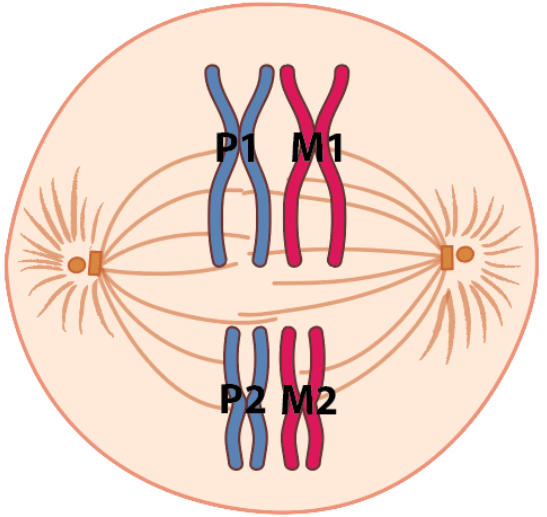
Meiosis and Genetic variation

Crossing over



- occurs during prophase I ✓
- Homologous chromosomes ✓
- non-sister – chromatids/adjacent chromotids overlap ✓
- at points called chiasma ✓/chiasmata
- Genetic material is exchanged ✓
- resulting in new combinations of genetic material ✓ from both parents

The random arrangement of chromosomes at the equator

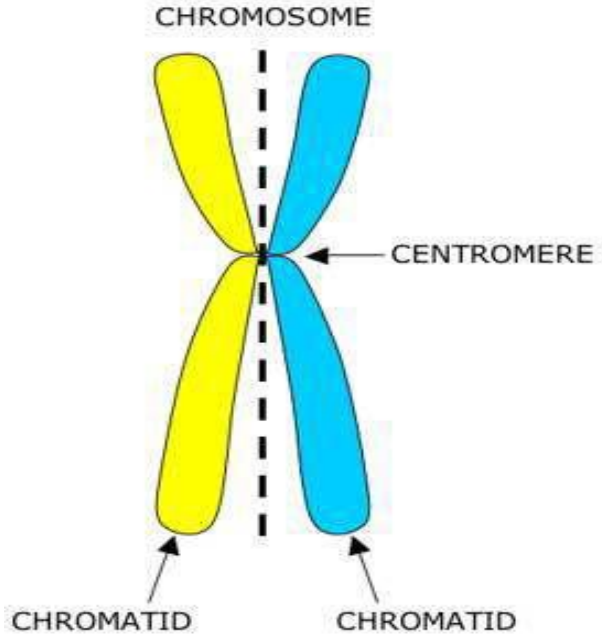


- Homologues chromosomes arrange randomly om the equator
- This result into genetic different gametes

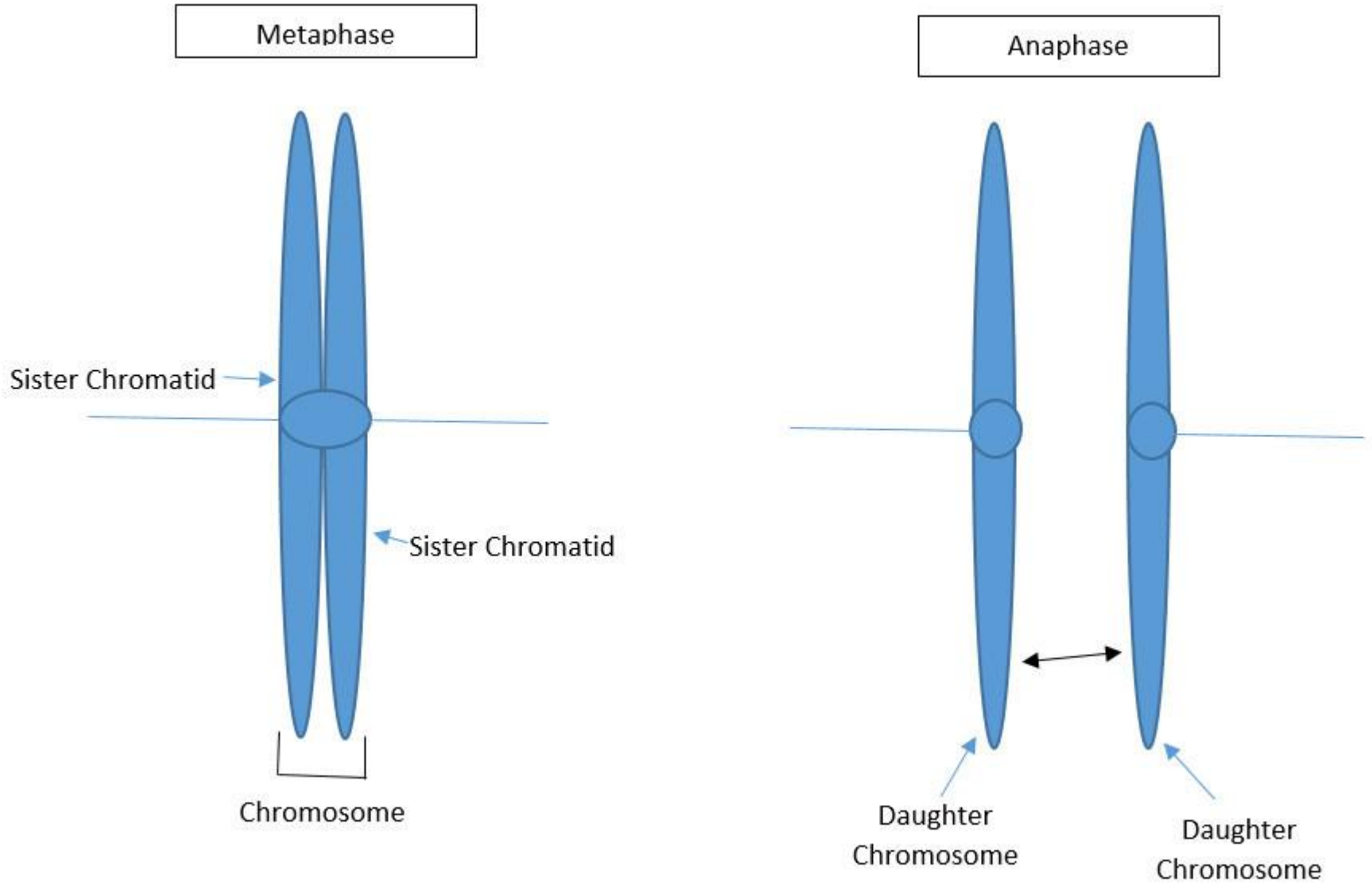
What we need to know about chromosomes

- Chromosomes consist of DNA (which makes up genes) and protein
- The number of chromosomes in a cell is a characteristic of an organism (e.g., humans have 46 chromosomes) It can be haploid or diploid (Know the difference)
- Chromosomes which are single threads become double (two chromatids joined by a centromere) as a result of DNA replication

Daughter chromosome/Chromosome



Chromosomes/ Sister chromatid / Daughter chromosome



DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

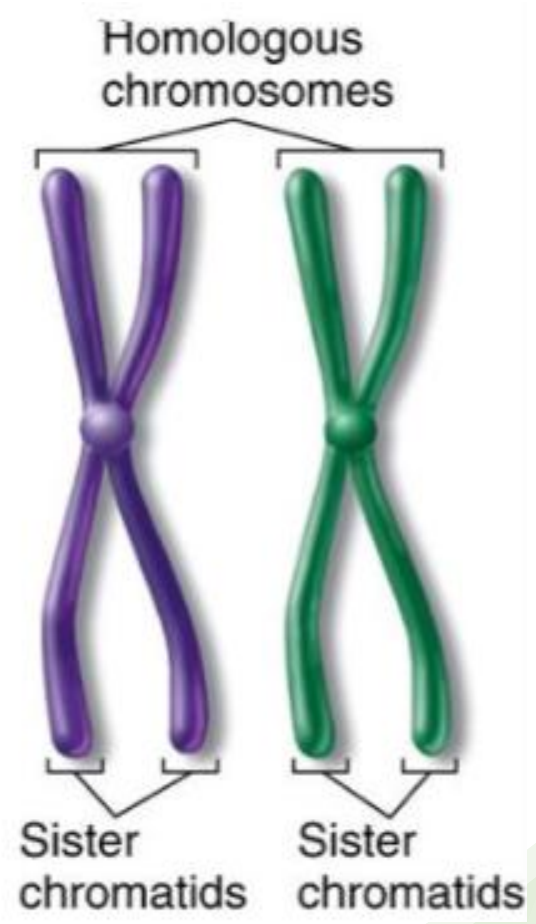
MEIOSIS	MITOSIS
• Meiosis involves 2 cell divisions	• Mitosis involves 1 cell division
• Meiosis gives rise to sex cells	• Gives rise to somatic cells
• Cells produced are haploid	• Cells produced are diploid
• Differs according to gender	• Has no gender specification
• 2 phases	• 1 phase
• 4 daughter cells formed	• 2 daughter cells
• Half the number of chromosomes to the parent cell	• Same number of chromosomes formed as in parent cell
• All cells formed are genetically different to each other and parent cell	• Genetically identical to each other and parent cell
• Cells responsible for genetic variation in reproduction (gametes)	• Cells responsible for growth and repair (somatic cells)

Differentiate between

Haploid (n)	Diploid (2n)
The condition where cells have half the number of chromosomes during meiosis. These cells are called gametes (sex cells).	The condition where cells have the full set of chromosomes. These cells are called body cells (somatic cells).

What we need to know about Homologous Chromosomes?

- - Shape – NOT SAME STRUCTURE
- - Size/length
- - Position of genes/alleles
- - Genes coding for same characteristic
- - Location of centromere

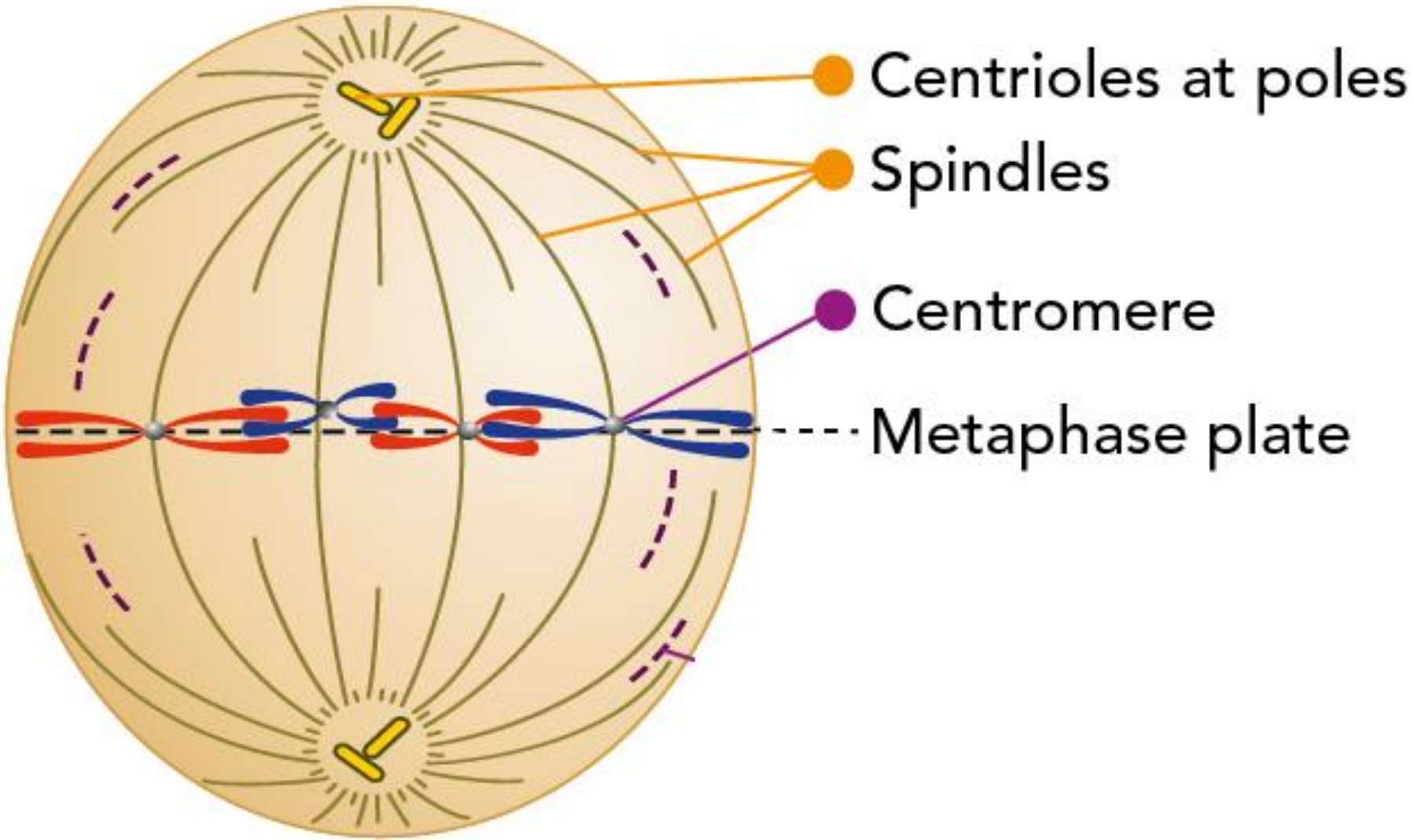


Meiosis

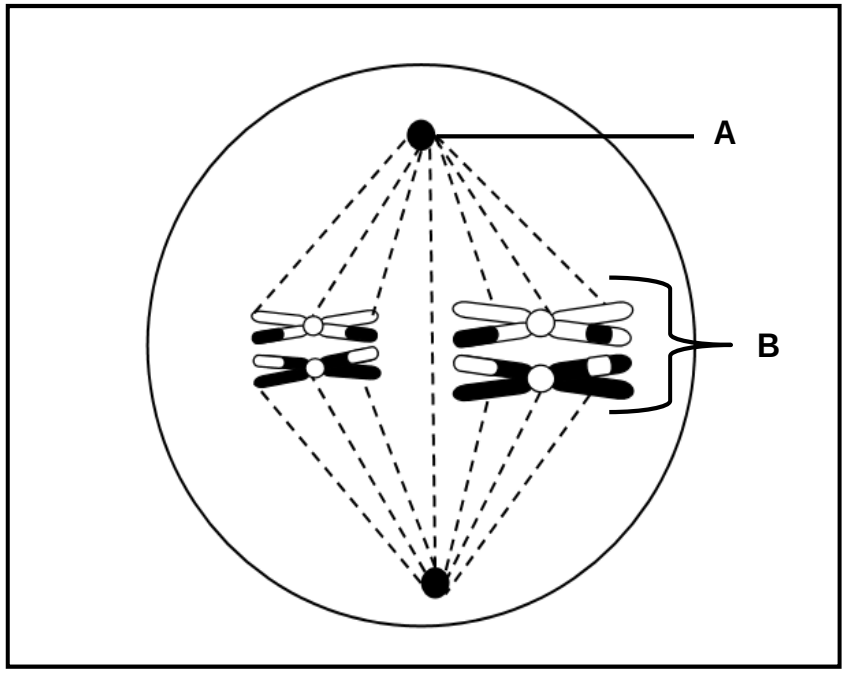
BEHAVIOUR OF THE **CHROMOSOMES DURING** THE DIFFERENT PHASES OF MEIOSIS I

- **During prophase I**
- chromosomes pair up/homologous pairs /bivalents form
- Crossing over exchange of genetic material occurs
- between chromatids/adjacent chromosome pairs
- **During metaphase I of meiosis**
- homologous chromosomes metaphase I/chromosome in metaphase 2 are arranged
- at the equator of the cell in pair
- in a random way
- with the chromosome attached to the spindle fibre
- **During anaphase I**
- chromosome pairs separate (I)/chromatids (II) move to opposite poles
- During telophase I
- the chromosomes/ daughter chromosomes reach the poles of the cell

Meiosis- Labels and Functions



2.3 The diagram below shows a cell during a phase of meiosis.



2.3.1 Give labels for:

(a) **A**

(b) **B**

2.3.2 Identify the phase in the diagram.

2.3.3 Give a reason for your answer to QUESTION 2.3.2.

2.3.4 Explain why this is a diploid cell.

2.3.5 How many chromosomes will there be in each of the gametes produced by this cell?

2.3 2.3.1 (a) centriole✓

(b) homologous chromosomes ✓ / bivalent

2.3.2 Metaphase I ✓

2.3.3 Homologous chromosomes present✓
Homologous Chromosomes are lined at the equator ✓

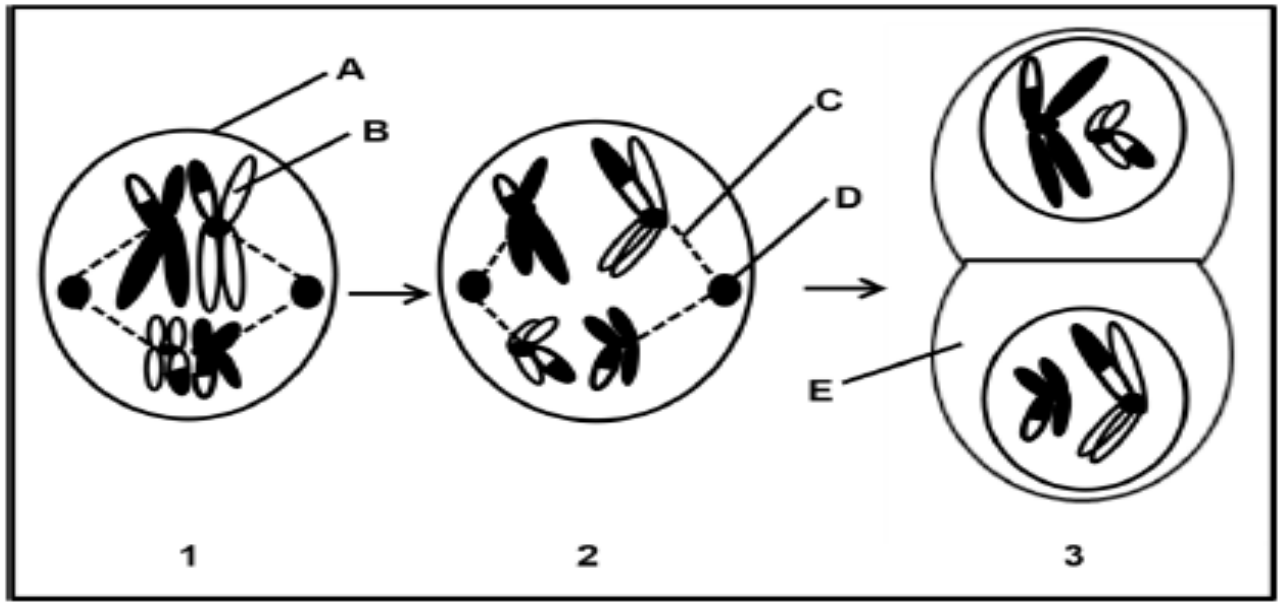
2.3.4 Because homologous / paired chromosomes present ✓✓

2.3.5 2 / Two ✓

Homologous chromosomes arrange in pairs on the equator. Not homologous pairs arrange on the equator

NB

Nucleic acids : DNA and RNA



Name the phases 1 -3

1- Metaphase 1
2- Anaphase 1
3 – Telophase 1

Label A to E

A- Cell membrane
B_ Chromatid
C- Spindle fibres
D- Centriole
E - Cytoplasma

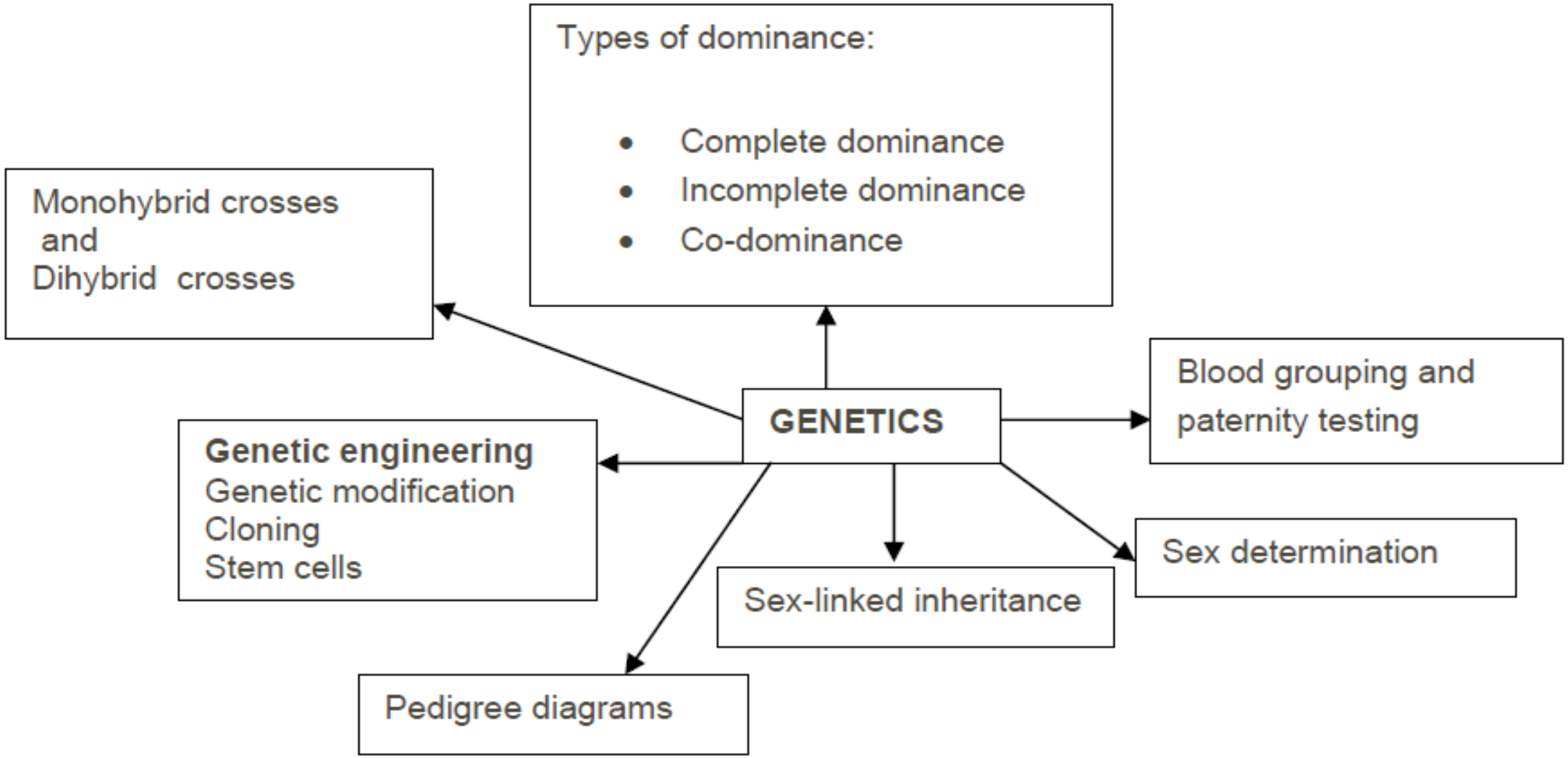
Difference between Anaphase 1 and 2

Chromosomes are pulled to the poles – Anaphase 1

Chromatids are pulled to the poles – Anaphase 2

GENETICS AND INHERITANCE

60 MARKS P 2 JUNE



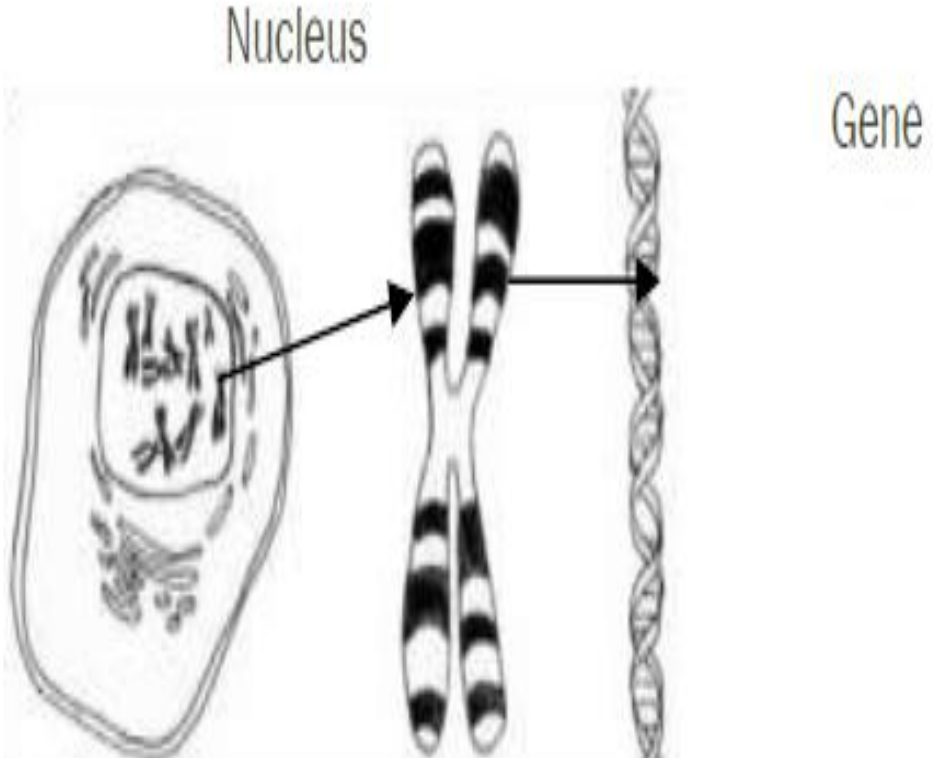
Biological terms in Genetics

- Chromatin and chromosomes
- Genes and alleles
- Phenotype and genotype
- Dominant and recessive alleles
- Homozygous (pure breeding) and heterozygous (hybrid)
- Monohybrid cross and dihybrid cross

Term	Explanation
Gene	A small portion of DNA coding for a particular characteristic.
Alleles	Different forms of a gene which occur at the same locus (position) on homologous chromosomes.
Genotype	Genetic composition (make-up) of an organism.
Phenotype	The physical appearance of an organism determined by the genotype, e.g. tall, short.

Dominant allele	An allele that is expressed (shown) in the phenotype when found in the heterozygous (Tt) and homozygous (TT) condition.
Recessive allele	An allele that is masked (not shown) in the phenotype when found in the heterozygous (Tt) condition. It is only expressed in the homozygous (tt) condition.
Heterozygous	Two different alleles for a particular characteristic, e.g. Tt.
Homozygous	Two identical alleles for a particular characteristic, e.g. TT or tt.

The relationships between: Chromosomes- DNA – GENE -GENOME

Term	Explanation	Diagram/Additional notes
Gene	A small portion of DNA coding for a particular characteristic.	

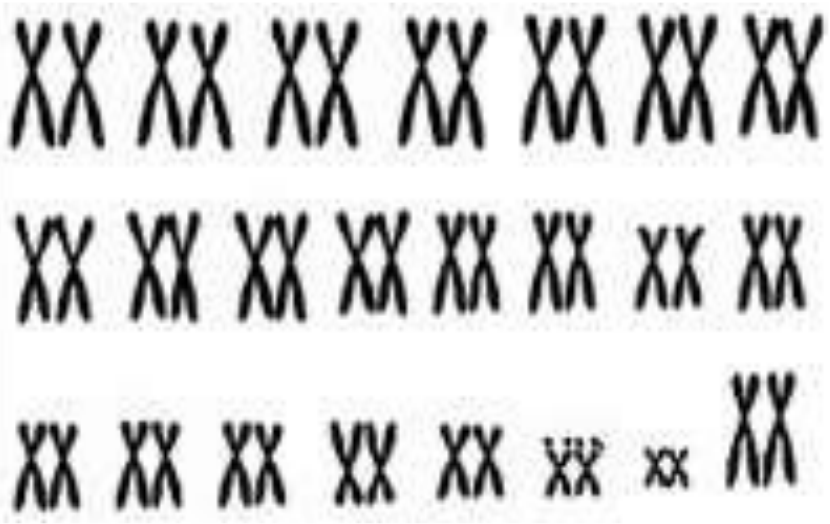
Genome vs karyotype

- The mapping of the exact
- position of all the genes in all
- the chromosomes of a human.

Example: Gene number 3 on chromosome number 4 is

responsible for a particular characteristic.

- The number, shape and
- arrangement of all the
- chromosomes in the nucleus of
- a somatic cell.



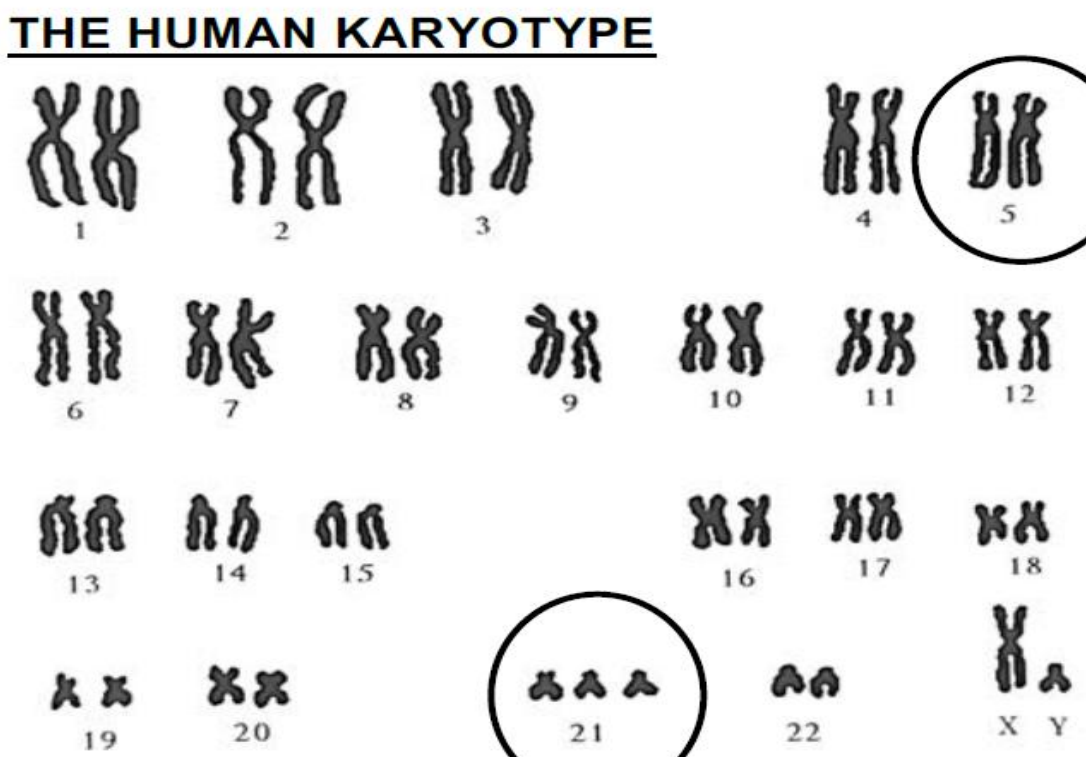
Do not forget about

- Multiple alleles

More than two alternative forms of a gene at the same locus

Example: Blood groups are controlled by three allelesi.

Autosomes vs Gonosomes



Homologous chromosome pair

- one from each parent
- one into each gamete

Trisomy 21

Autosomes:

- Chromosome pairs 1 to 22

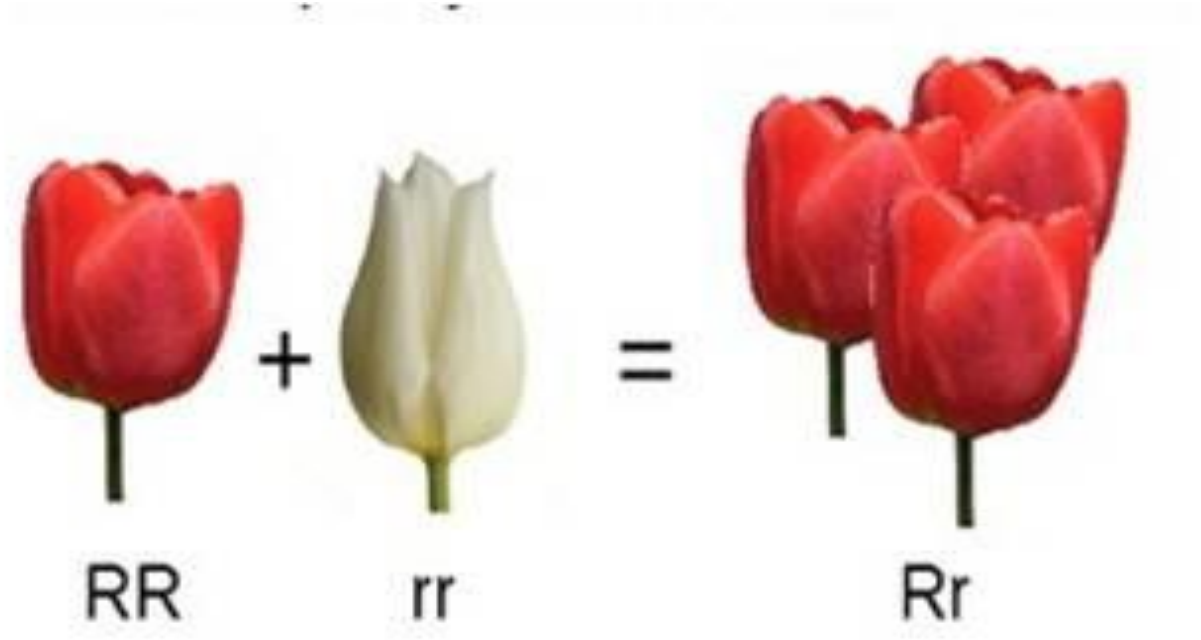
Gonosomes:

- Chromosome pair 23
- XX for female and XY for male

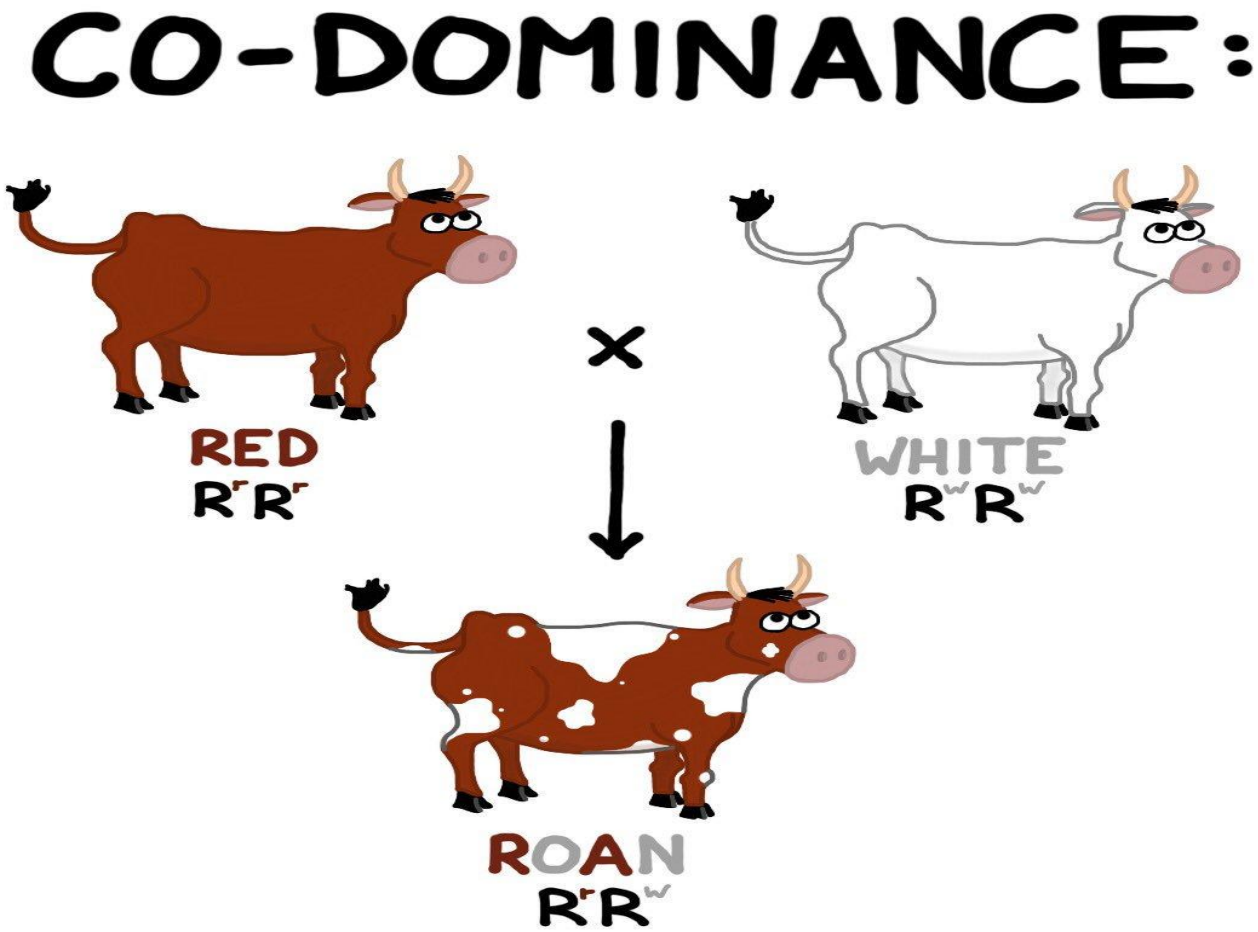
Types of Dominance

New definition in exam guidelines

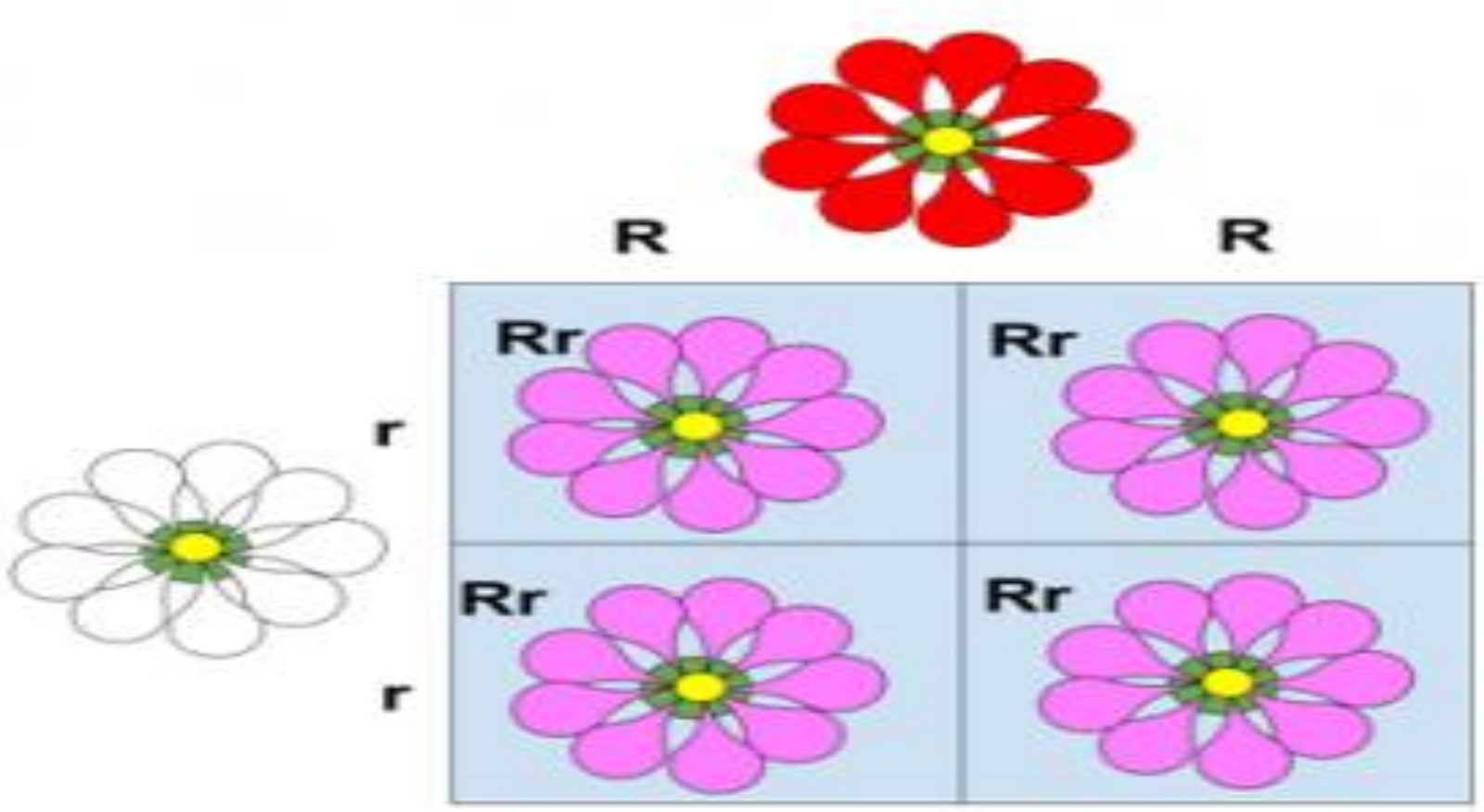
- 1. Complete dominance – Red allele is dominant and White is recessive, such that the effect of the white allele is masked by the dominant allele in the heterozygous condition (Rr)



2. Co-dominance – both Red and White alleles of a gene are equally dominant whereby both red and white alleles express themselves in the phenotype in the heterozygous condition

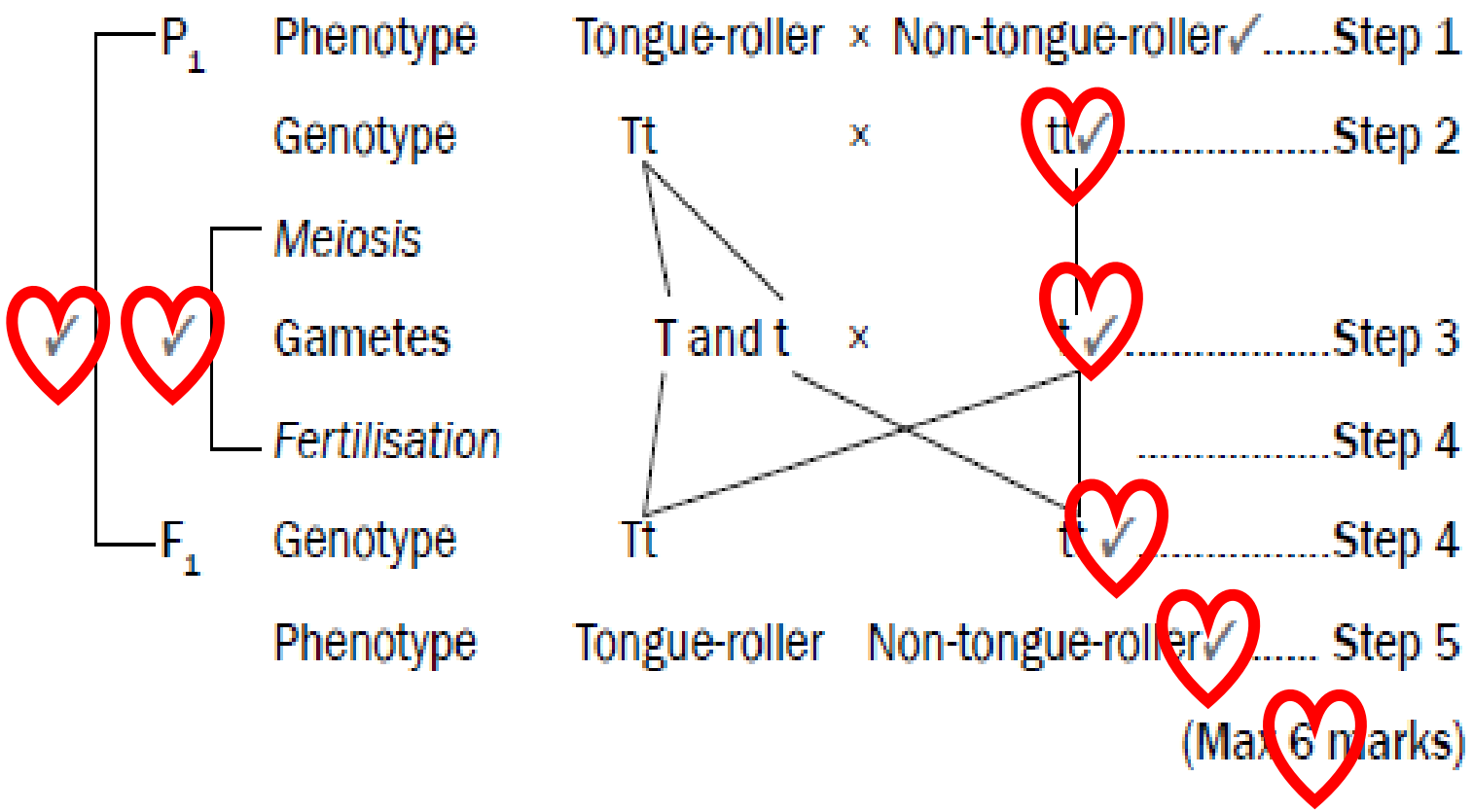


3. Incomplete dominance – neither one of red and white alleles of a gene is dominant over the other, resulting in pink phenotype in the heterozygous condition



Key point Q. Paper 2- Genetics

- Format for representing a genetics cross
-



Dihybrid crossing

In a certain species of plant, the gene for stem colour assorts independently to the gene for plant height.

The symbols for the alleles of the two genes are shown below.

Plant Height	**Stem colour**
T: tall	**B**: black
t: short	**b**: red

Plant **1** is short and has a black stem. Plant **1** has a parent that is tall and has a red stem. Plant **2** is tall and has a black stem.

The Punnett diagram below illustrates the cross between plants **1** and **2**.

Gametes	TB	Tb	**(i)**	tb
tB	TtBB	TtBb	ttBB	ttBb
tb	TtBb	Ttbb	ttBb	ttbb
tB	TtBB	**(ii)**	ttBB	ttBb
tb	**(iii)**	Ttbb	ttBb	ttbb

TtBb/TTBB/ttBb

NOT TBtB

TTBB

State the following:

1.4.1 Gamete at **(i)** (1)

1.4.2 Genotype at **(ii)** (1)

1.4.3 Phenotype at **(iii)** (2)

1.4.4 Genotype of the **parent** of plant **1** (2)

(6)

Gametes of Ttbb

Tb Tb tb tb

Different Laws

This is poorly answer and understand by all learners

NB

- The Law of Dominance-

When two homozygous organisms with contrasting characteristics are crossed, all the individuals of the F1 generation will display the dominant trait

An individual that is heterozygous for a particular characteristic will have the dominant trait as the phenotype.

- Mendel's Principle of Segregation-

NB!!

an organism possesses two 'factors' which separate or segregate so that each gamete contains only one of these 'factors'

- Mendel's Principle of Independent Assortment –

The various 'factors' controlling the different characteristics are separate entities, not influencing each other in any way, and sorting themselves out independently during gamete formation

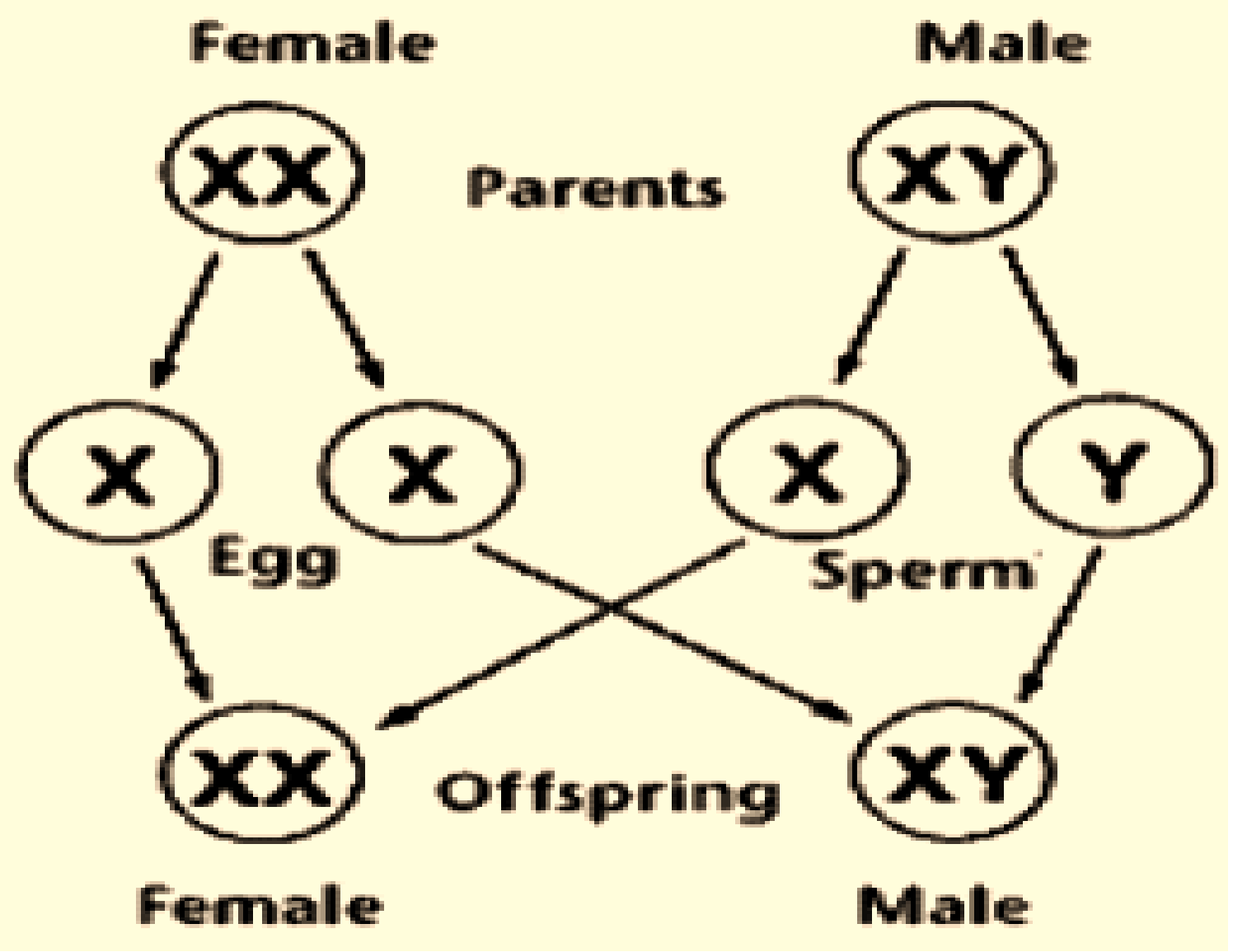
Do not forget about

- Multiple alleles

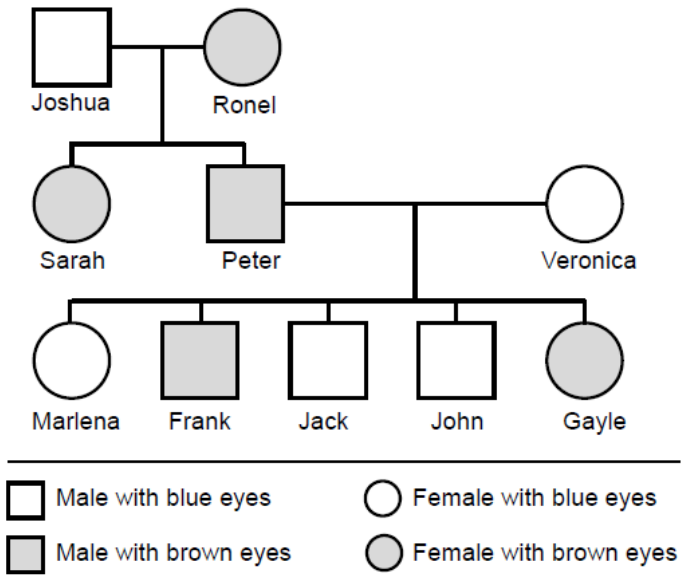
More than two alternative forms of a gene at the same locus

Example: Blood groups are controlled by three allelesi.

How sex is determined in humans



Interpretation of pedigree diagrams



Step 1: Study any key and opening statement/s and look for dominant and recessive characteristics and phenotypes.

Step 2: Write in the phenotypes of all the individuals as given in the problem.

Step 3: Fill in the genotype of all the individuals with the recessive condition it must have two recessive alleles (two lower case letters, e.g. **bb**)

Step 4: For every individual in the diagram that has the recessive condition, it means that each allele was obtained from each of the parents. Work backwards and fill in one recessive allele for each parent

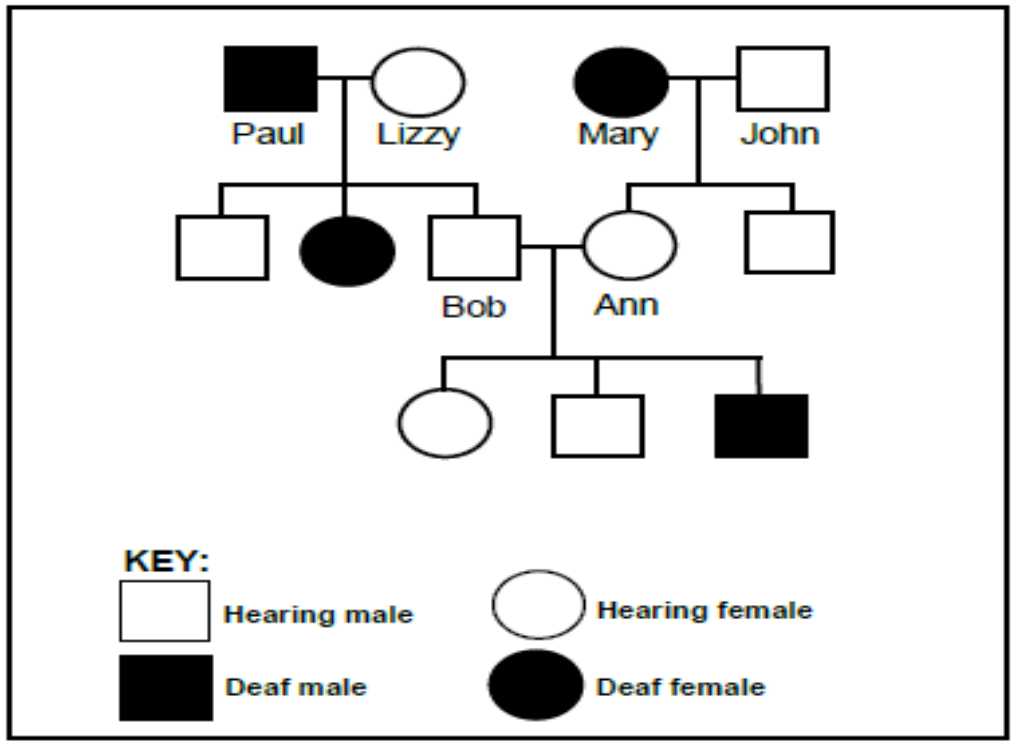
Step 5: If the parents showed the dominant characteristic, fill in the second letter which represents the dominant allele (a capital letter, e.g. **B**).

The genotype of Peter is 'Bb' – working backwards from the offspring Marlena or Jack or John who are homozygous recessive. This means that one of the recessive alleles of Marlena, Jack and John, i.e. 'b', must have come from parent Peter and the other one from parent Veronica

Step 6: Any other individual showing the dominant characteristic will most likely be homozygous dominant (**BB**) or heterozygous dominant (**Bb**).

Ronel could be homozygous dominant (BB) or heterozygous dominant (Bb)

One type of deafness in humans is carried on a single allele. The diagram below shows the inheritance of deafness in a family.



2.4.1 How many:

(a) Generations are represented in this pedigree diagram (1)

(b) Children of Paul and Lizzy are able to hear (1)

2.4.2 Which phenotype is dominant? (1)

2.4.3 Use the offspring of Bob and Ann to explain your answer to QUESTION 2.4.2. (4)

2.4.4 Use the letter **'A'** to represent the dominant allele and the letter **'a'** for the recessive allele to give ALL the possible genotypes for a hearing individual. (2)

1 Give the gonosome of Ann

XX

2. How many males are effected

2

Sex – link disorders

WHY FEMALES HAVE A SMALLER CHANCE OF SUFFERING FROM HAEMOPHILIA

- Haemophilia is caused by a recessive allele✓
- Carried on the X chromosome✓
- Females have two X chromosomes✓/ Males only have one X chromosome
- Females must inherit two copies of the recessive allele✓ females who inherit only one of the recessive alleles are still non-haemophiliac✓

WHY ARE THERE MORE MALES THAN FEMALES WITH COLOUR-BLINDNESS

- Males only have one X-chromosome✓
- If this chromosome carries the recessive allele✓/X_b
- the male will be colour-blind✓
- the Y-chromosome in males, does not carry any allele to mask the effect of the colour-blind allele✓
- Females have 2 X-chromosomes✓
- They need to have two recessive alleles✓/X_b X_b to be affected
- A dominant allele on the other X-chromosome will mask the effect✓ of the recessive trait.

Mutations

- Definition -Sudden change in the genetic composition of an organise in the genetic composition of an organism

- Gene Mutation – a change in the sequence of nitrogenous bases or nucleotides of DNA

- Chromosomal mutation – a change in the normal structure or number of chromosomes

Stem cell Research

- What are Stem Cells? – Undifferentiated cells which has the potential to differentiate to form any tissue or organ on the body

Sources	Uses
• Bone marrow	• Replace dead cells in the heart after a heart attack
• Placenta	• Used to grow skin tissues to treat burnt victims
• Embryo	• To grow nerve cells to treat spinal cord injuries and Parkinson's disease
• Blood in the umbilical cord	

Genetic engineering

Biotechnology is the manipulation of biological processes to satisfy human needs.

Genetic engineering is an aspect of biotechnology and includes:

- Stem cell research – sources and uses of stem cells
- Genetic modified organisms – brief outline of process (names of enzymes involved are not required) and benefits of genetic modification
- Cloning – brief outline of process and benefits of cloning

Paternity testing

The use of each of the following in paternity testing:

- Blood grouping
- DNA profiles

Paternity testing (Why are blood groups not conclusive)

- Blood groups can tell who is not the father
- Blood groups cannot tell who the actual father is
- Because many man share/have the same blood group
- Therefor DNA profiling is more conclusive
- Since DNA contains hereditary information