GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

Matthew Goniwe
SCHOOL OF LEADERSHIP & GOVERNANCE

SSIP – April/May 2020

SUBJECT: LIFE SCIENCES

Participant's Guide

© COPYRIGHT

Table of contents

A. FOREWORD

This Just in Time teacher training workshop is organized at the start of term 2. Topics to be covered in term 2 by the gr.12 teacher will be mediated to enable teachers to unlock the content for the learners. The dates for the workshops were announced in 2019 at a joint meeting with Matthew Goniwe School of Leadership and Governance (MGSLG) and Teacher Development (TD). The topics chosen for special attention in the workshop were implicated in the diagnostic reports on the NSC 2019 November examinations as well as the analytical report compiled by the province, as problematic topics. Teachers have also expressed the need for content and pedagogical training in these topics.

Therefore, not only content, but also hands-on activities on how to teach Genetics and Heredity, The nervous system, The eye, The ear and The human endocrine system will be part of the workshop content. The formal SBA task to be done in term 2 will also be performed to ensure common understanding. Typical exam questions on these topics will also be unpacked. ICT integration will be demonstrated by the facilitators and practiced by the teachers. The dissection of the eye will be done in groups to encourage teachers to include practical work in their daily teaching and learning.

B. PURPOSE

Training Course Goals: Professional development for teachers from schools at risk to improve the quality of teaching and learning in the targeted schools.

C. OVERALL SSIP AIMS/GOALS

The SSIP programme aims at professional development for Grade 10-12 teachers in the application of effective teaching and reflective practice to improve learner performance on the identified Grade 12 examinable topics. The overall goal for SSIP is to provide teachers with professional expertise, tools and skills to spot student learning difficulties and decide on the course of action.

SSIP came about as a result of the diagnostic needs that are identified through the end of the year NSC examination student learning data. In response to this, design and development of teaching resources will lead to the training of teachers on learners' needs identified.

The four interconnected outcomes that drive the professional development activities for SSIP are:

1. Enhancing Teachers' knowledge: deep understanding of subject matter knowledge and students' ideas on the content.
2. Enhancing quality teaching and assessment for learning: effective instructional approaches that teachers may use to ensure improved understanding by most learners.
3. Developing ICT integration skills: Use of ICT to improve teaching and learning.
4. Building professional learning communities: allow teachers to start collaborating and form professional networks in non-formal settings in context of their schools.

D. PROGRAMME OUTCOMES

Professional development to improve learner outcomes in the identified term 2 LifeSciences topics.

E. LEARNING ASSUMED TO BE IN PLACE

Teachers who are qualified to teach Life Sciences in grade 10 – 12 (FET Phase)

F. TARGET AUDIENCE

Grade 12 teachers who have obtained below 70% in the 2019 NSC results and grade 12 novice teachers.

G. NOTIONAL HOURS

The time required to successful completion has been allocated as follows:

Contact face to face session	16 hours
Pre Test	½ hour
Day 2 : Content Practice and Demonstration	9¼ hours
Day 3: Content Practice and Demonstration	5½ hours
Post Test	½ hour

H. COURSE DESIGN AND ASSESSMENT STRATEGY

The course will focus on content, teaching and learning approaches and assessment and it will use both pre-post tests and activities to monitor participants' progress and understanding of the term 2 topics for Life Sciences.

COURSE OUTLINE/ MAP

Module 1 :Genetics & Heredity	**Module 2 : The human nervous system**
Objectives/Outcomes	**Objectives/Outcomes**
When you complete this module, you will be able to: • Use diagrams from past question papers and modify them for your own use • Solve monohybrid crosses for complete, incomplete, co-dominance, sex-linked diseases and blood groups. • Calculate ratios and percentages of the genotype and phenotype of the F_1 and F_2 generations. • Solve dihybrid crosses. • Read and solve pedigree diagrams • Classify questions on the different levels of Bloom's taxonomy. • Administer and assess the gr.12 SBA task on genetics. • Answer questions on mutations and genetic engineering. • Introduce genetics as a topic in a fun way to learners.	**When you complete this module, you will be able to:** • Identify the different parts of the nervous system • Identify the different structures of the brain. • Describe the functions of the different parts. • Draw and label the parts of the reflex arc. • Briefly explain the events occurring during a reflex action. • Carry out an investigation on reaction time.

Module 3 : The human eye	**Module 4 The human ear**
Objectives/Outcomes	**Objectives/outcomes**
When you complete this module, you will be able to: • Draw and label the parts of the eye. • Describe the functions of the different parts. • Briefly explain the changes occurring in the eye	**When you complete this module, you will be able to:** • Draw and label the parts of the ear. • Describe the functions of the different parts. • Briefly describe the path of sound as it travels

during accommodation and pupillary reflex. • Identify and describe the various defects of the eye. • Illustrate the existence of the blind spot. • Illustrate the role of binocular vision in depth perception. • Dissect the eye and be able to identify the different parts of the eye. • Set questions on the different levels of Bloom's taxonomy.	through the ear. • Briefly describe the functioning of the maculae and cristae and their role in balance. • Briefly describe the defects of the ear.

Module: 5 : Endocrine system
Objectives/outcomes
When you complete this module, you will be able to: • Differentiate between endocrine and exocrine glands. • Discuss the differences between the nervous system and the endocrine system. • Identify the different endocrine glands and the hormones they secrete. • Discuss the different negative feedback mechanisms. • Define homeostasis.

ICONS USED IN THIS MODULE

1. Discussion	
2. Group Activity	
3. Individual Activity	
4. Study/Teaching Tips	
5. Notes	
6. Assessment	

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

Matthew Goniwe
SCHOOL OF LEADERSHIP & GOVERNANCE

ANNUAL TEACHING PLAN (ATP) – Gr.12 2020

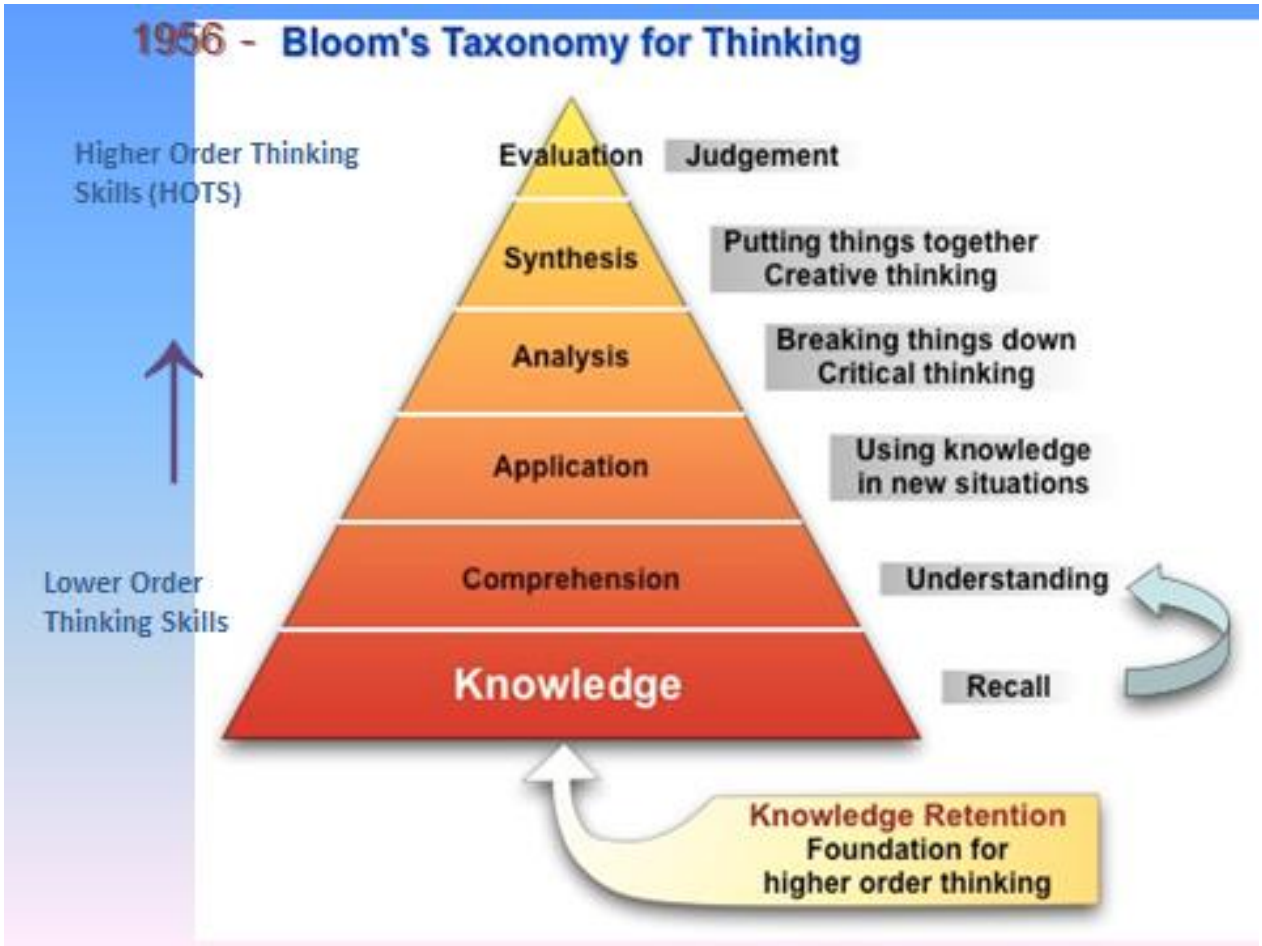
WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	WEEK 9	WEEK 10	WEEK 11
15 – 17 Jan	20 – 24 Jan	27/01 –31/01	03/02– 7/02	10 – 14 Feb	17 – 21 Feb	24/02 - 28/02	02/03 – 06/03	9 – 13 Mar	16 – 20 Mar	31/03 – 03/04
DNA, RNA and meiosis					**Reproduction**			**Genetics**		
• Revision of the structure of the cell (4%)	• DNA (8%)	RNA • Transcription • Translation **SBA Practical task 1** (12%)	• Mitosis (Revision) • Chromosomes (16%)	• Meiosis I • Meiosis II • Non-disjunction (20%)	• Reproduction in Vertebrates • Structure and function of the ♀ and ♂reproductive systems (24%)	• Gametogenesis • Structure of an ovum and sperm • Menstrual Cycle • Ovarian cycle • Uterine cycle (28%)	• Fertilisation • Implantation • Gestation (32%)	• Genetics • Monohybrid crosses (36%)	• Sex determination • Sex-linked Inheritance • Blood groups **Test term 1** (40%)	• Dihybrid crosses • Genetic pedigree (44%)

WEEK 12	WEEK 13	WEEK 14	WEEK 15	WEEK 16	WEEK 17	WEEK 18	WEEK 19	WEEK 20	WEEK 21	WEEK 22
6 - 9 Apr	14 – 17 Apr	20 - 24 Apr	28 – 30 Apr	4 - 8 May	11 - 15 May	18 May – 12 June				7 – 10 Jul
Genetics	**Human nervous system**									
• Mutations • Genetic Engineering • Paternity testing • Genetic Links **SBA Practical task 2** (48%)	• Human nervous system (52%)	• Reflex arch • Disorders of CNS (56%)	• The eye • Accommodation • Pupillary mechanism (60%)	• The ear • Balance **Assignment** (64%)	• Human endocrine system • Negative feedback mechanism **Test term 2** (68%)	**Midyear examination**				• Homeostasis In Humans (72%)

WEEK 23	WEEK 24	WEEK 25	WEEK 26	WEEK 27	WEEK 28	WEEK 29	WEEK 30	WEEK 31	WEEK 32	WEEK 33
13 – 17 Jul	20 – 24 Jul	27/07– 31/07	3 - 7 Aug	11 – 14 Aug	17– 21 Aug	24 – 28 Aug	31/8 – 4/9	7 – 11 Sep	14 – 18 Sep	29/9 – 2/10
Evolution			**Gr.11 content**							
• Plant hormones • Plant defense mechanisms • Introduction to Evolution • Variation (78%)	• Lamarckism • Darwinism • Punctuated equilibrium • Natural Selection (84%)	• Artificial selection • Speciation • Mechanisms of reproductive isolation • Evolution in present times **SBA Practical task 3** (90%)	• Human Evolution • Out of Africa hypothesis (96%)	• Revision of Human impact on the environment **Test term 3** (100%)	**PRELIM EXAMINATION**					Revision

WEEK 34	WEEK 35	WEEK 36	WEEK 37	WEEK 38	WEEK 39	WEEK 40	WEEK 41	WEEK 42
5 – 9 Oct	12 – 16 Oct	19 Oct – 2 Dec						
REVISON	**REVISION**	**FINAL EXAMINATION**						

COGNITIVE DEMAND LEVELS IN LIFE SCIENCES



In Life Sciences the last three levels are combined so that a FOUR level of cognitive demand is used:

Knowing science	Understanding science	Applying scientific knowledge	Evaluating, analysing and synthesising scientific knowledge
40%	25%	20%	15%
To **recall** or **recognise explicit** information, details, facts, formulas, terms, definitions, procedures, representations **from memory or from material provided**.	To **communicate understanding** of a Life Sciences concept, idea, explanation, model, or theory, for example to: **Interpret**: change from one form of representation to another (e.g. pictures to words; words to pictures; numbers to words, words to numbers, pictures to numbers) **Exemplify**: Find a specific example or illustration of a concept or principle **Classify**: Determine that something belongs to a category. **Summarize**: Abstract a general theme or major points. **Infer**: Draw a logical conclusion from presented information. **Compare**: Detect similarities and differences between two objects or concepts. **Explain why**: create a cause-and-effect model of a system or concept.	To use, **perform** or follow **a basic/** standard/ routine **procedure**/rule/method/ operation. To use/**apply understanding** of Life Sciences concepts, facts or details from a known context to an unfamiliar context.	**Analyse complex information** To adapt a variety of appropriate strategies to **solve** novel/ **non-routine**/complex/ open-ended **problems**. To **apply multi-step procedures.** **Evaluate** To evaluate or make critical **judgement** (for example, on qualities of accuracy, consistency, acceptability, desirability, worth or probability) using background knowledge of the subject. Judge, critique **Create a new product** To **integrate** life sciences concepts, principles, ideas and information, make connections and relate parts of material, ideas, information or operations to one another and to an overall structure or purpose.

The instructional verbs used in examination/test questions

Verb	Explanation
Analyse	Separate, examine and interpret
Calculate	This means a numerical answer is required – in general, you should show your working, especially where two or more steps are involved
Classify	Group things based on common characteristics
Compare	Point out or show both similarities and differences between things, concepts or phenomena
Contrast	Compare two or more things to show the differences between them
Define	Give a clear meaning
Describe	State in words (using diagrams where appropriate) the main points of a structure/process/phenomenon/investigation
Determine	To calculate something, or to discover the answer by examining evidence
Differentiate	Use differences to qualify categories
Discuss	Consider all information and reach a conclusion
Explain	Express your answer in cause-effect or statement and reason sequence
Identify	Name the essential characteristics
Label	Identify on a diagram or drawing
List	Write a list of items, with no additional detail
Mention	Refer to relevant points
Name	Give the name (proper noun) of something
State	Write down information without discussion
Suggest	Offer an explanation or a solution
Tabulate	Draw a table and indicate the answers as direct pairs

DEGREES OF DIFFICULTY

To judge the level of difficulty of each examination/test question, you need to consider both the demands that each question makes on the cognitive schema of an average learner and the intrinsic difficulty of the question or task. To make this judgment, you need to identify where the difficulty or ease in a particular question resides.

The framework ***for thinking about question or item difficulty*** comprises the following four general categories of difficulty:

- Content (topic/concept) difficulty;
- Stimulus (question and source material) difficulty;
- Task (process) difficulty; and
- Expected response (memo) difficulty.

FRAMEWORK FOR THINKING ABOUT QUESTION DIFFICULTY:

Content/concept difficulty	Stimulus difficulty	Task difficulty	Expected response difficulty
Content/concept difficulty indexes the difficulty in the **subject matter, topic or conceptual knowledge** assessed or required. In this judgment of the item/question, difficulty exists in the **academic and conceptual demands** that questions make and/or the **grade level** boundaries of the various 'elements' of domain/subject knowledge (topics, facts, concepts, principles and procedures associated with the subject).	**Stimulus difficulty** refers to the difficulty of the linguistic **features of the question** (**linguistic** complexity) and the challenge that candidates face when they attempt to read, interpret and understand the words and phrases in the question AND when they attempt to read and understand the **information or 'text' or source material (diagrams, tables and graphs, pictures, cartoons, passages, etc.) that accompanies the question.**	**Task difficulty** refers to the **difficulty that candidates confront when they try to formulate or produce an answer**.	**Expected response difficulty** refers to difficulty imposed by examiners in a **mark scheme and memorandum**. This location of difficulty is more applicable to 'constructed' response questions, as opposed to 'selected' response questions (such as multiple choice, matching/true-false).

Examiners should analyse the items in their papers to ensure the paper is **not too easy** or **too difficult** even if the cognitive demand of the paper is according to the standard.

COURSE TIMETABLE

DAY ONE			
SESSION	**TIME ALLOCATION**	**ACTIVITY**	**RESOURCES**
SESSION ONE	16:30 – 17:00	Plenary	
	17:00 – 18:00	Registration of participants	Registration forms
	18:00 – 18:30	Self-assessment – Pre-Test Feedback on self-assessment	MCQ
	18:30 -19:00	Administration and logistical arrangements	
	19:00 – 21:00	DINNER	

DAY TWO			
SESSION	**TIME ALLOCATION**	**ACTIVITY**	**RESOURCES**
SESSION ONE	08:00 – 10:30	Module 1: Unit 1: How do we take images from past papers and use it in our own worksheets and/or question papers? Activity 1.1 Module 1: Unit 2 How do we teach the different kinds of monohybrid crosses Activity 1.2, 1.3 and 1.4	Course material and video clip Power Point Presentation
	10:30 – 10:45	TEA BREAK	
SESSION TWO	10:45 – 13:00	Module 1: Unit 3: What are sex linked diseases and how do we determine sex? Activity 1.5 Unit 4: What are the different blood groups and the genetics behind it? Activity 1.6	Course material Power Point Presentation Video clip
	13:00 – 14:00	LUNCH BREAK	
SESSION THREE	14:00 – 16:15	Module 1: Unit 5: What are dihybrid crosses and how do we solve it? Activity 1.7	Course material Power Point

		Module 1: Unit 6: What are pedigree diagrams and how do we solve it? Activity 1.8 Activity 1.9 (SBA task) Module 1: Unit 7: What are mutations and genetic engineering and what are the applications of this? Activity 1.10	Presentation
	16:15 – 17:00	TEA BREAK	
SESSION FOUR	17:00 – 19:00	Module 2: Unit 1: Responding to the environment and coordination of activities in the body Activity 2.1 Unit 2: Structure of the Nervous System Unit 3: Structure of the Central Nervous System Activity 2.2 Unit 4: Location and functions of the Peripheral Nervous System Unit 5: Location and functions of the Autonomic Nervous System Unit 6: Structure and functioning of a nerve Unit 7: Structure and function of a simple reflex arc Activity 2.3 Unit 8: Disorders of the CNS	Course material Power Point Presentation Video clip
	19:00 – 21:00	DINNER	

DAY THREE

SESSION	TIME ALLOCATION	ACTIVITY	RESOURCES
SESSION ONE	08:00 – 10:30	Module 3: Unit 1: Structure and functions of the parts of the human eye, using a diagram. Unit 2: Binocular vision and its importance. Unit 3: Changes that occur in the human eye during accommodation and pupillary reflex, using diagrams. Unit 4: The nature and treatment of visual	Course material Power point Video clips

		defects, using diagrams. Activity 3.1 – 3.6 Module 4 Unit 1: Structure of the human ear and the functions of the different parts, using a diagram. Unit 2: Functioning of the human ear in hearing and balance. Unit 3: The nature and treatment of hearing defects. Activity 4.1 – 4.3	
	10:30 – 10:45	TEA BREAK	
SESSION TWO	11:00 -13:30	Module 5: Unit 1: What is the endocrine system? Unit2: What is a negative feedback mechanism? Activity 5.1	Course material Power point Video clip
		Self-evaluation – Post Test Completion of evaluation forms Graphically presented Feedback on Pre and Post test	Post test
		Closing	
	13:30	Plenary followed by Lunch	

MODULE 1 – GENETICS AND HEREDITY

INTRODUCTION

Genetics is the **science of inheritance** and studies the principles of heredity and variation. The hereditary instruction carried within the DNA ensures that offspring resemble their parents and ensures that **genetic variation** can take place, resulting in survival of the fittest.

During sexual reproduction, offspring are produced that resemble the parents. **Two haploid** gametes are the result of the process of **meiosis**. The gametes fuse during reproduction and the result is a **diploid zygote**, containing a double set of chromosomes. One set of the chromosomes came from the male gamete, which contains the DNA from the father. One set of chromosomes came from the female gamete and contains the DNA from the mother. The child therefore contains DNA from both parents.

At this point in time, you as the grade 12 teacher, have already finished the introduction to genetics, monohybrid crosses, sex determinations, sex linked inheritance and blood grouping. You are left with dihybrid crosses, genetic pedigree diagrams, mutations, genetic engineering, paternity testing, genetic links and the SBA practical task. We have decided to include the first topics to help you with revision activities if some of the topics were not clear when you first explained it. You will also notice that we have included terminology lists as these are crucial for good performance. Please ensure that your learners do regular terminology activities and tests.

OVERVIEW

This module deals with genetics and heredity. The module starts with notes and important "tips" for learners. There is a detailed terminology list, followed by monohybrid crosses, sex determination, blood grouping, dihybrid crosses, pedigree diagrams, mutations, genetic engineering and paternity testing.

SPECIFIC OBJECTIVES

By the end of this session, participants will be able to:

- Cut a diagram from a pdf document and modify it in the paint program before we paste it into another document.
- Solve monohybrid crosses for complete, incomplete, co-dominance, sex-linked diseases and blood groups.
- Calculate ratios and percentages of the genotype and phenotype of the F_1 and F_2 generations.
- Solve dihybrid crosses.
- Read and solve pedigree diagrams
- Administer and assess the gr.12 SBA task on genetics.
- Answer questions on mutations and genetic engineering.
- Introduce genetics as a topic in a fun way to learners.

CONTENT

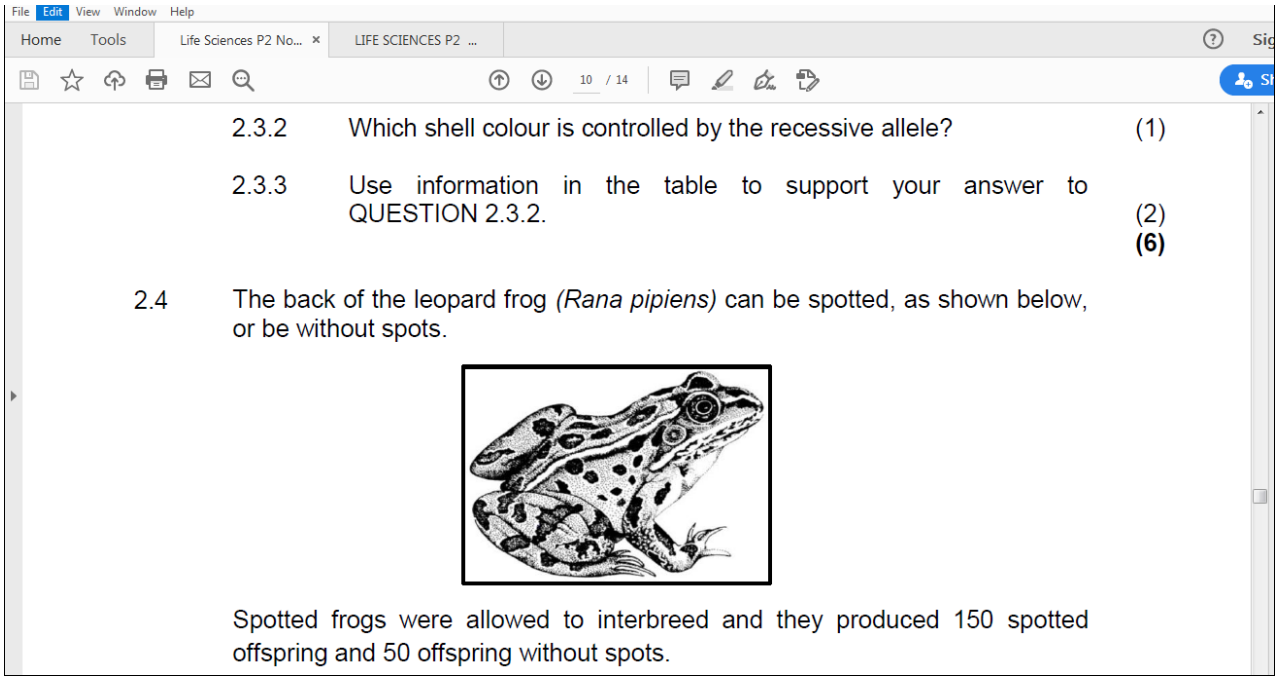
You will study this module through the following units:

Unit 1: How do we take images from past papers and use it in our own worksheets and/or question papers?
Unit 2: How do we teach the different kinds of monohybrid crosses?
Unit 3: What is sex linked diseases and how do we determine sex?
Unit 4: What are the different blood groups and the genetics behind it?
Unit 5: What are dihybrid crosses and how do we solve it?
Unit 6: What are pedigree diagrams and how do we solve it?
Unit 7: What are mutations and genetic engineering and what are the applications of this?

UNIT 1 - How do we take images from past papers and use it in our own worksheets and/or question papers?

Step 1: Open question paper in PDF format

Step 2: Go to toolbar on top, click on edit



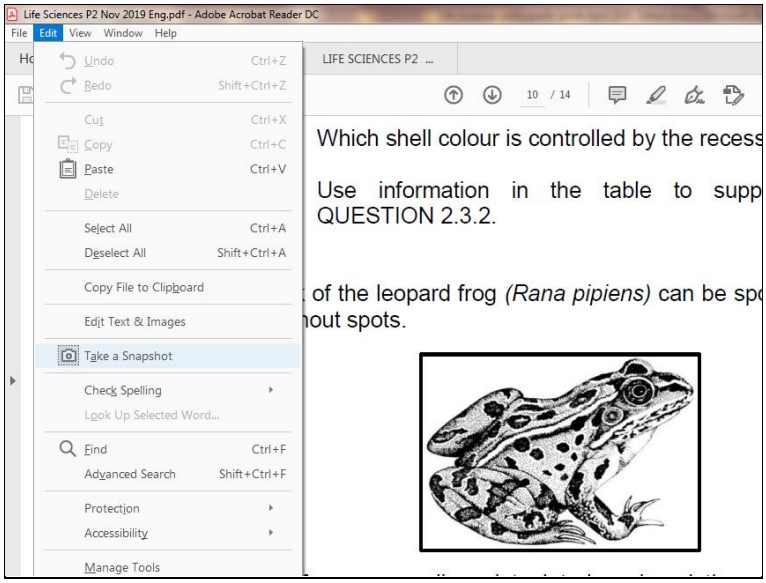
2.3.2 Which shell colour is controlled by the recessive allele? (1)

2.3.3 Use information in the table to support your answer to QUESTION 2.3.2. (2)
(6)

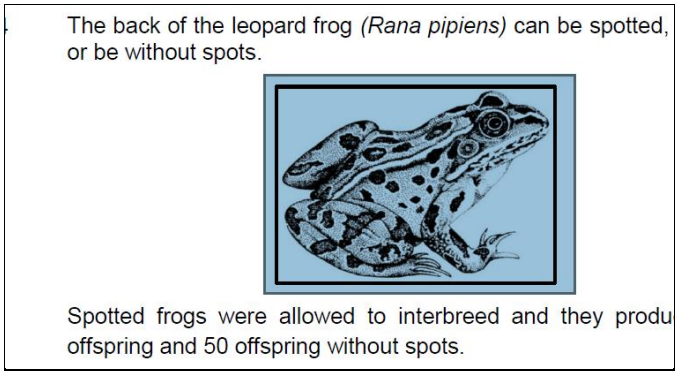
2.4 The back of the leopard frog *(Rana pipiens)* can be spotted, as shown below, or be without spots.

Spotted frogs were allowed to interbreed and they produced 150 spotted offspring and 50 offspring without spots.

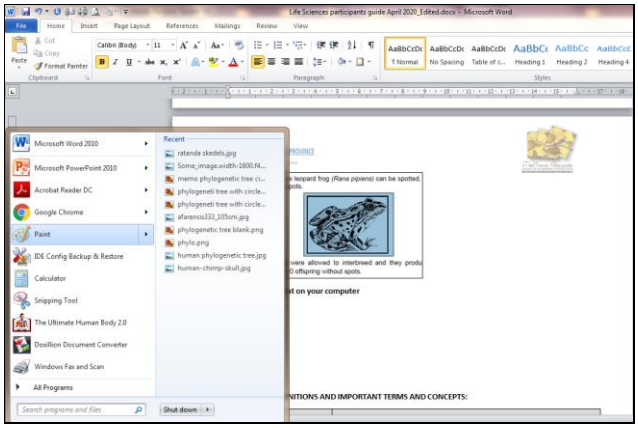
Step 3: Click on snapshot

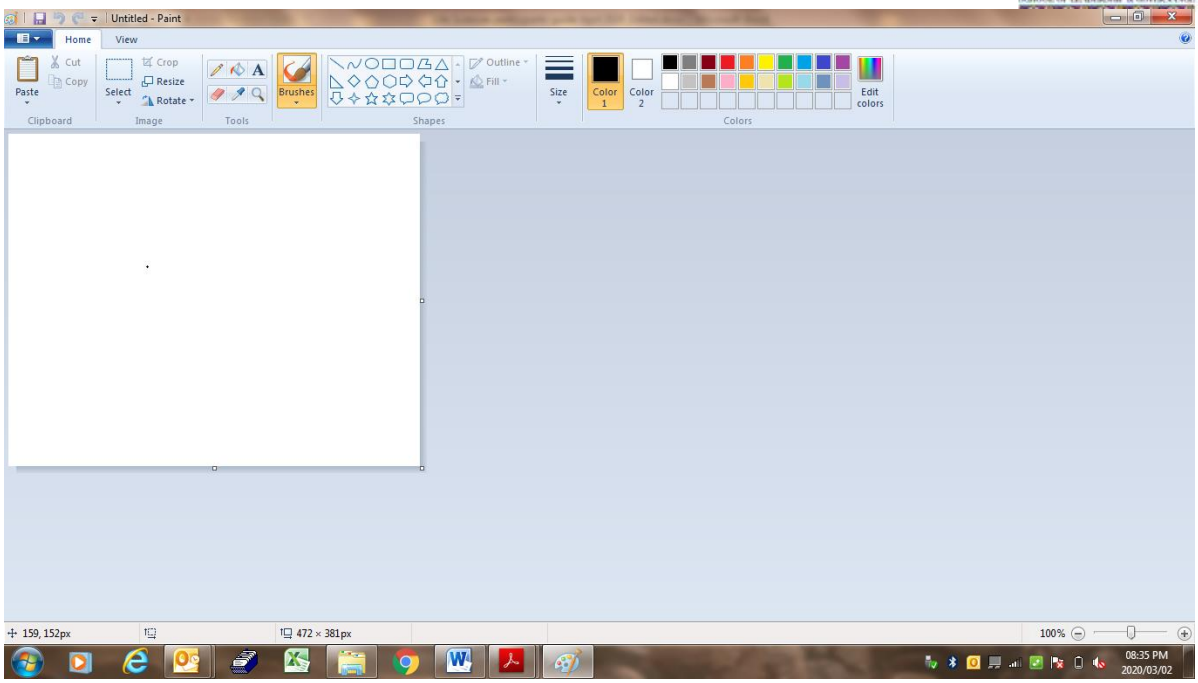


Step 4: Highlight the diagram



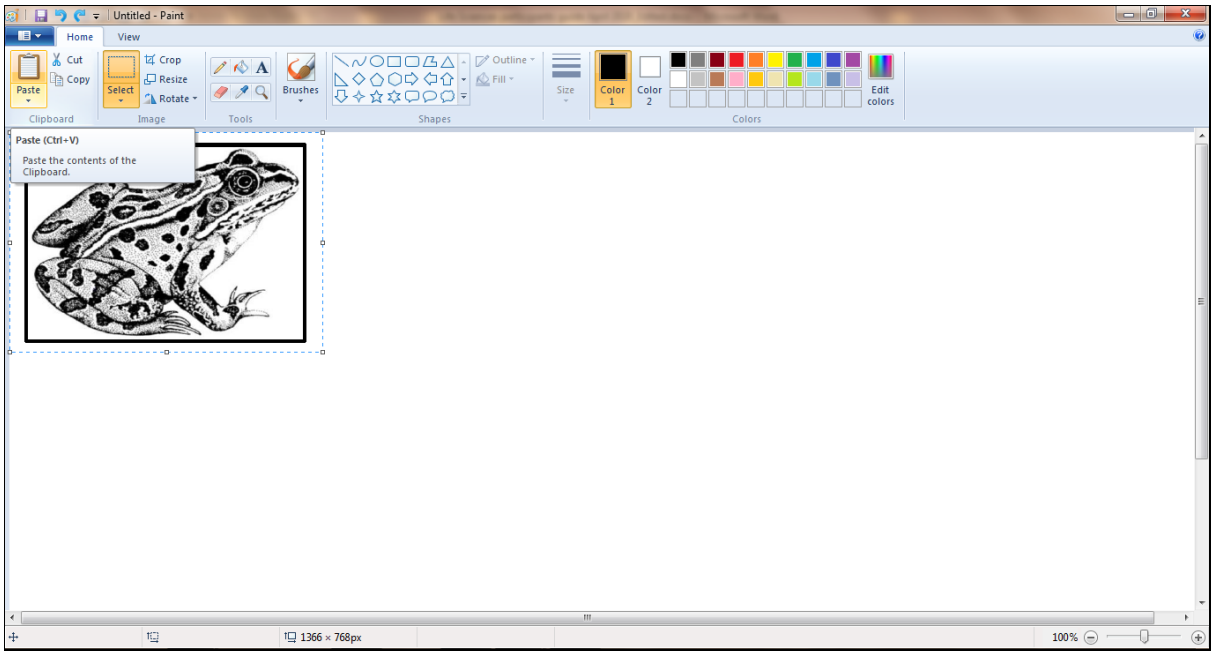
Step 5: Open Paint on your computer





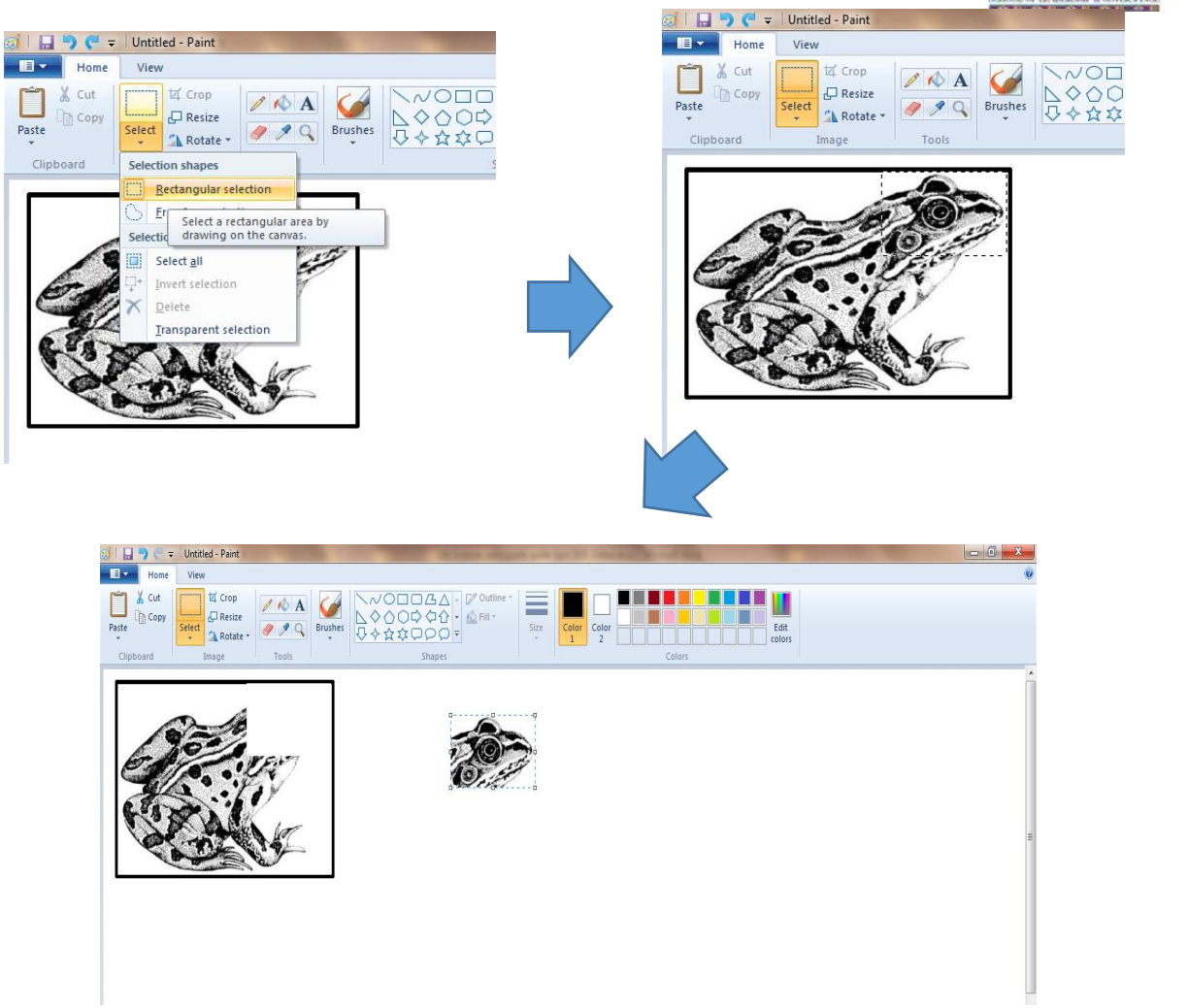
Step 6: Click on Paste

You can do many things with this program. you can add a shape, colour in certain parts. You could rotate it and type in labels and add label lines. All you have to do is click on the icon in the toolbar.

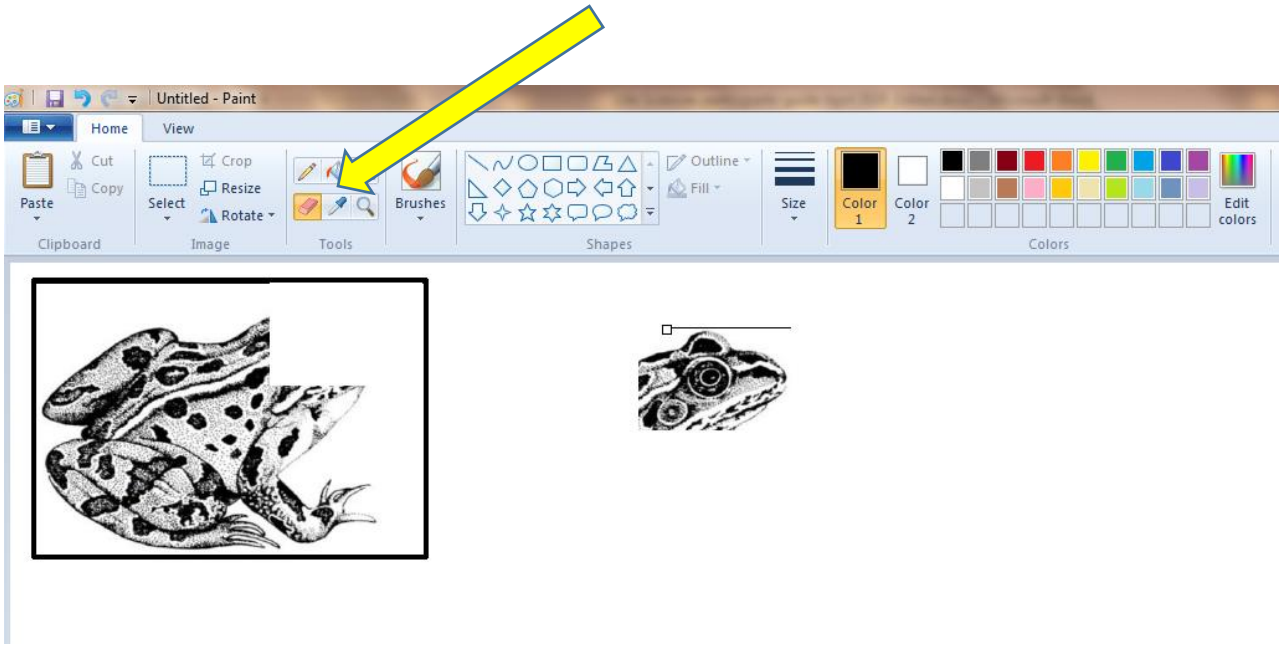


Step 7: Now you can make the desired changes.

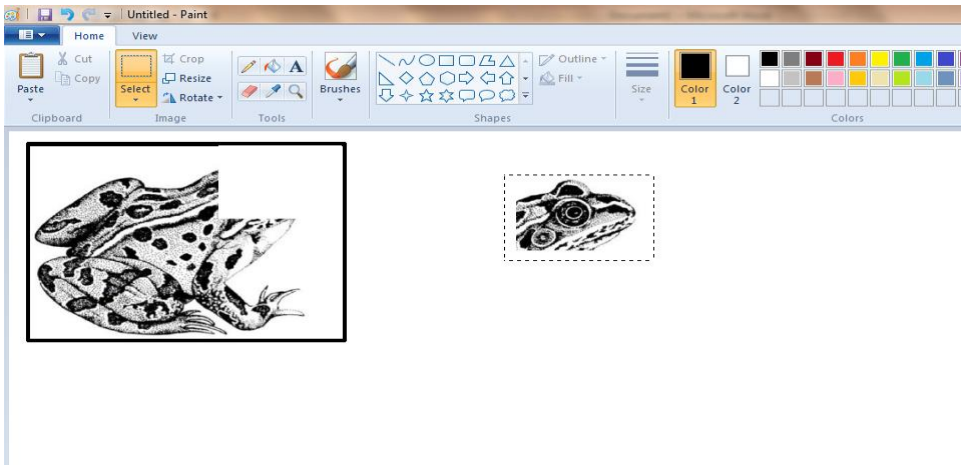
Say for example we are only interested in the head of the frog. Click select, rectangular selection and highlight the head. Then move the selection to the side.



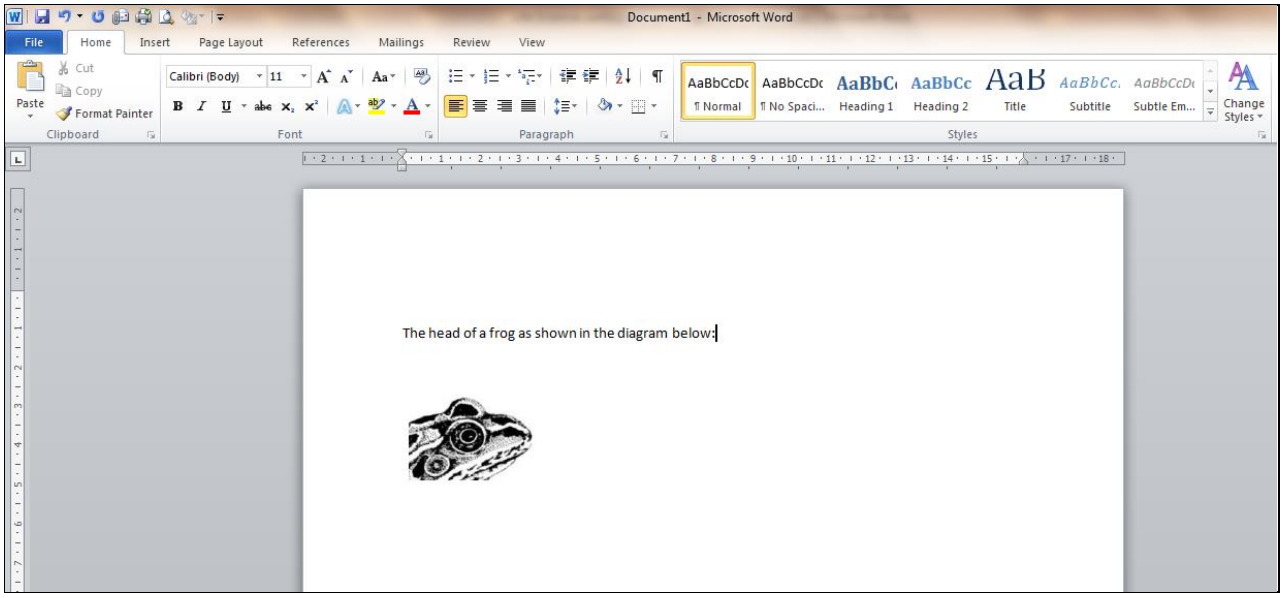
Step 8: There is a line, erase the line with the rubber. Select the rubber and erase the line.



Step 9: Select the head and click on copy



Step 10: Go to the document where you want to insert the diagram (head) and paste it in the position where you want it



ACTIVITY 1.1

AIM: To practice working with the paint program

Method:

Select a diagram or graph from a question paper on your computer. Insert it into paint. Make any changes on the diagram and paste it back into the question paper.

UNIT 2 - How do we teach the different kinds of monohybrid crosses?

- *Learners MUST understand the link between meiosis and genetics.*
- *During the crossing over in prophase I of meiosis, chromosomes share information and then during metaphase I, separate* ***randomly.***
- *This determines the combination of chromosomes and genes that you have as an individual. Genetics determines individual variation (to be different) and survival of the fittest.*
- *Learners MUST have a clear understanding of the genetic terminology in order to study genetics and answer genetic problems.*
- *Mendel's Laws are very important - understand the concepts of dominance and how this plays a role in monohybrid crosses (mono = one = one characteristic or trait).*
- *Be aware of confusing the word 'cross/ crossing' with 'crossing over' in Meiosis. You cross individuals and calculate the chances of a characteristic or trait being in the offspring. Learners must be clear of the difference between these two terms.*
- *Questions on blood group inheritance and sex determination are often asked. The more examples of genetic crosses that they do, the better they will do.*
- *Pedigree diagrams are a popular way to express family history and are often asked in exams. Make sure they know how to answer them.*
- *There are basically* ***FOUR types of monohybrid crosses*** :

    - **Homozygous Dominant x Homozygous recessive HH x hh;**
    - **Heterozygous x Heterozygous Hh x Hh;**
    - **Heterozygous x Homo recessive Hh x hh;**
    - **Heterozygous x Homo dominant Hh x HH**

- In the notation of the genotype the **dominant allele** represented by a **CAPITAL LETTER** must always be written first e.g. Gg and **NOT** gG.

DEFINITIONS AND IMPORTANT TERMS AND CONCEPTS:

Biological term	Description
Albinism	The condition that results from the absence of skin pigmentation
Alleles	Two alternative forms of a gene at the same locus
Artificial selection/selective breading	The breeding of organisms over many generations in order to achieve a desirable phenotype
Biotechnology	The use of biological processes, organisms or systems to improve the quality of human life
Clone	A copy of an organism that is genetically identical to the original organism
Cloning	The process by which genetically identical organisms are formed using biotechnology
Co-dominance	The type of inheritance where both alleles are equally dominant and both express themselves equally in the phenotype. E.g. A white cow crossed with a black bull will produce a calf with black and white patches
Complete dominance	The type of inheritance where the dominant allele masks the expression of the recessive allele in the heterozygous condition
Chromatin network:	Visible as thread-like structures in the nucleus of an inactive cell
Chromosome:	A structure made up of two chromatids joined by a centromere that carries the hereditary characteristics within the DNA
Dihybrid cross	A genetic cross involving two different characteristics e.g. shape and colour of seeds
Dominant allele:	An allele that masks or suppresses the expression of the allele partner on the chromosome pair and the dominant characteristic is seen in the homozygous (e.g.: TT) and heterozygous state (e.g.: Tt) in the phenotype.
Gene	A segment of DNA/a chromosome that codes for a particular characteristic
Gene mutation:	A change of one or more N- bases in the nuclear DNA of an organism.
Genetic variation:	This includes a variety of different genes that may differ from maternal and paternal genes resulting in new genotypes and phenotypes.
Genotype	This is the total **genetic composition** of an organism. It is the information present in the gene alleles, for example BB, Bb or bb.
Genome	The complete set of chromosomes in the cell of an organism
Haemophilia	A sex-linked genetic disorder characterised by the absence of a blood-clotting factor
Heterozygous	An individual having two non-identical alleles for a characteristic

Homologous structures	Similar structures on different organisms that suggest they have a common ancestor
Homozygous:	When two alleles that control a single trait (on the same locus) are **identical**.
Hypothesis	A tentative explanation of a phenomenon that can be tested and may be accepted or rejected
Incomplete dominance	The type of inheritance where both alleles express themselves in such a way that an intermediate phenotype is formed. E.g. A white flowering plant crossed with a red flowering plant will produce a pink flowering plant.
Locus:	The exact position or location of a gene on a chromosome.
Mendel's Law of Dominance	When two individuals with contrasting pure breeding characteristics are crossed, the individuals of the first generation (F_1) will **ALL** resemble the parent with the dominant characteristic.
Mendel's Law of Independent Assortment	Alleles of a gene for one characteristic segregate independently of the alleles of a gene of another characteristic. The alleles for the two different genes will therefore come together randomly during gamete formation. This is also known as random assortment.
Mendel's Principle of Segregation	During gametogenesis the two alleles of a gene separate so that each gamete will receive one allele of a gene for a specific characteristic/trait.
Monohybrid cross	A genetic cross involving one characteristic e.g. colour of seeds
Mutation	A sudden change in the sequence/order of nitrogenous bases of a nucleic acid
Multiple alleles:	When there are more than two possible alleles for one gene locus. e.g. blood groups
Phenotype:	This is the external, **physical appearance** of an organism. The phenotype is determined by the genotype. **(**phenotype, when both recessive gene alleles are present e.g.: bb)
Pedigree diagram	A diagram showing the inheritance of genetic disorders over many generations
Population	A group of organisms of the same species living in the same habitat at the same time
Recessive allele:	An allele that is suppressed when the allele partner is dominant. The recessive trait will only be expressed/seen if both alleles for the trait are homozygous recessive e.g.: tt
Stem cells/meristematic cells	Undifferentiated cells that can develop into any cell type
Theory	Explanation of an observation that is supported by facts, models and laws

STRATEGIES TO TEACH TERMINOLOGY:

1. In every lesson identify new terms/concepts and write it on the board.
2. Learners will take down terms/concepts at the back of their notebooks noting the correct spelling.
3. Learners must define/write down the meaning of these words from listening to the educator' lesson/finding meaning from the dictionary or textbook.
4. Break down the concept/term where possible- give the meaning of the prefix and suffix e.g. photo (light) synthesis (to build up).

5. Use the concept in a sentence.
6. Educators must check that learners have done the above, on a daily basis e.g. asks any learner to define a concept.
7. By the end of the year ALL learners have a comprehensive GLOSSARY of ALL terms /concepts.
8. ASSESSMENT: Biological terms to be included in all daily assessment tasks. Develop crossword puzzles. (Use various websites from internet e.g. eclipse)
9. Learning terminology also helps in answering MCQs and matching questions, etc.

GENETICS AND INHERITANCE:

The Principles of Heredity:

If a tall plant (dominant trait) is crossed with a short plant (recessive trait) a genetic cross could be written as follow:

P_1 Phenotype: Tall plants x short plants

Genotype: TT x tt

Meiosis

Gametes: T , T x t , t **(Mendel's principle of segregation)**

Fertilization

	T	**T**
t	Tt	Tt
t	Tt	Tt

F_1

Genotype: 100 % Tt (heterozygous tall)

Phenotype: 100% Tall **(Mendel's Law of Dominance)**

Note : that the F_1 offspring have characteristics from both parents but in the phenotype, all display the dominant characteristic.

The offspring of the F_1 (Tt) grow and mature to become P_2. The offspring of **P_2** are known as F_2.

P_2 **Phenotype:** Tall plants x Tall plants

Genotype: T t x T t

Meiosis

Gametes: T , t x T , t

Fertilization

	T	**t**
T	TT	Tt
t	Tt	tt

F_2 Genotype: **1 TT : 2 Tt : 1 tt**

homozygous tall : heterozygous Tall : homozygous short

Phenotype: **75% tall : 25% short**

1. TYPES OF DOMINANCE:

1.1 EXAMPLES OF MONOHYBRID CROSSES:

There are basically **FOUR types of crosses**.

We will use one general trait e.g. hair colour:

B = brown hair colour (dominant trait)

b = blonde hair colour (recessive trait)

CROSS EXAMPLE 1: (Homozygous dominant x Homozygous recessive)

P_1 (first parent generation)

Phenotype: Brown x blonde

Genotype: BB x bb

Meiosis

Gametes: B , B x b , b

Fertilization

	B	**B**
b	Bb	Bb

b	Bb	Bb

F_1 (first filial generation = first offspring)

Genotype: Bb

Phenotype: 100% brown

CROSS EXAMPLE 2: (Heterozygous x Heterozygous)

P_1 **Phenotype:** Brown x Brown

Genotype: Bb x Bb

Meiosis

Gametes: B , b x B , b

Fertilization

	B	**b**
B	BB	Bb
b	Bb	bb

F_1 **Genotype:** BB : Bb Bb : bb

1 : 2 : 1

Phenotype: 75% brown and 25% blonde

CROSS EXAMPLE 3: **(Homozygous dominant x Heterozygous)**

P_1 **Phenotype:** Brown x Brown

Genotype: BB x Bb

Meiosis

Gametes: B , B x B, b

Fertilization

	B	**B**
B	BB	BB
b	Bb	Bb

F_1 **Genotype:** BB BB : Bb Bb

1 : 1

Phenotype: 100% brown

CROSS EXAMPLE 4: (Homozygous recessive x Heterozygous)

P_1 **Phenotype:** Blonde x Brown

Genotype: bb x Bb

Meiosis

Gametes: b, b x B , b

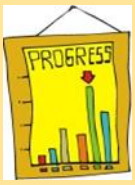
Fertilisation

	b	**b**
B	Bb	Bb
b	bb	bb

F_1 **Genotype:** Bb Bb : bb bb

1 : 1

Phenotype: 50% brown and 50% blonde



Activity 1.2

AIM: To enable participants to draw a basic monohybrid genetic cross.

Method: Draw a genetic cross using the information below:
In humans, the ability to roll the tongue is because of a dominant gene. Use the letters (R) to represent rolling and (r) for non-rolling and show diagrammatically, by means of a genetic cross, how a man who is a roller, who marries a woman who is also a roller, may have a girl who cannot roll her tongue.

1.2. Incomplete dominance

In this kind of dominance none of the two alleles of a gene are dominant over one another resulting in an intermediate phenotype in the heterozygous condition. In flowers this type of dominance could be viewed in flower colours.

For example a red flower is crossed with a white flower and the alleles are incomplete dominant. The cross for this type of dominance will be as follow:

Colour key: **R** (red) **W** (white)

P_1 **Phenotype**: red x white

Genotype: RR x WW

Meiosis

Gametes R ,R, x W, W

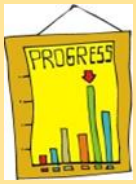
Fertilisation

F_1 **Genotype**: 4:4 RW

Phenotype: 100% pink

Another example could be found in humans:

Curly hair (**CC**) x Straight hair (**SS**) = Wavy hair (**CS)**



Activity 1.3

AIM: To enable participants to complete a genetic cross on a trait that exhibit incomplete dominance.

Method: Complete the following questions:
SpongeBob loves growing flowers for his pal Sandy! Her favourite flowers, Poofkins, are found in red, blue and purple. Use the information provided and your knowledge of incomplete dominance to complete each section below.

1. Write the correct genotype for each colour if R represents a red gene and B represents a blue gene.

   Red: _____ Blue: _____ Purple: _____

2. Draw a genetic cross to indicate what the genotypes of the resulting flowers if SpongeBob crossed a Poofkin with red flowers with a Poofkin with blue flowers.

1.3. Co-dominance

In this kind of dominance both alleles of a gene are equally dominant whereby both alleles express themselves in the phenotype in the heterozygous condition

For example a red flower is crossed with a white flower and the alleles are co-dominant. The cross for this type of dominance will be as follow:

Colour key: **R** (red) **W** (white)

P_1 **Phenotype**: red x white

Genotype: RR x WW

Meiosis

Gametes R ,R, x W, W

Fertilisation

F_1 **Genotype**: 4:4 RW

Phenotype: 100% Red with white markings/ white with red markings

Another example in humans is: Blood groups.

Activity 1.4

AIM: To enable participants to complete a genetic cross on a trait that exhibit co-dominance.

Method: Complete the following questions:

In certain marine invertebrates the colour of the shell is under the control of one gene with three alleles. In different combinations, the three alleles produce four phenotypes: orange, yellow, orange-yellow and black.

The table below shows the results of the offspring produced from crosses involving parents of different phenotypes.

CROSS	PHENOTYPES OF SHELLS	
	PARENTS	OFFSPRING
1	Yellow x yellow	27 yellow: 9 black
2	Black x black	All black
3	Orange x orange	30 orange: 10 black
4	Orange x yellow	All orange- yellow

1. Name and describe the type of dominance shown by cross 4. (3)
2. Which shell colour is controlled by the recessive allele? (1)
3. Use information in the table to support your answer to QUESTION 2. (2)

UNIT 3 - What is sex linked diseases and how do we determine sex?

Sex determination in humans

There are 22 pairs of autosomes and one pair of sex chromosomes (gonosomes) in the human karyotype. Females have XX **sex chromosomes** while males have **XY sex chromosomes**. Each time fertilisation occurs, there is a 50% chance of the zygote being male and a 50% chance of the zygote being female, **X + X = XX** and **X + Y = XY**.

An example of a genetic cross to show the inheritance of sex:

P_1 Phenotype: male x female

Genotype: XY x XX

Meiosis

Gametes: X , Y x X , X

Fertilization

	X	**X**
X	XX	XX
Y	XY	XY

F_1 Genotype: XX XX : XY XY

1 : 1

Phenotype: 50% females : 50% males

Sex-linked alleles

Some characteristics or traits are carried on the sex chromosomes.

HAEMOPHILIA and COLOUR BLINDNESS are two sex linked disorders that forms part of our curriculum. This is taught, if learners see this they should immediately know that it is sex linked and they should use this method. Any other sex-linked disorder will be specified as a sex-linked disorder in the question.

Haemophilia is **a** sex-linked condition where blood fails to clot properly. This recessive allele is found only on the X chromosome of the sex chromosomes. Males have only **one X chromosome** The **Y chromosome** has no gene for blood clotting. This means that the condition of haemophilia is seen in males with only one recessive allele present. A female with one recessive allele will be a carrier because the other X chromosome will carry the normal dominant gene. A female will only be haemophilic if she has both homozygous recessive alleles.

EXAMPLES OF HAEMOPHILIA GENETIC CROSSES:

EXAMPLE 1: For a normal male and female carrier (heterozygous) cross:

P_1 Phenotype: unaffected normal male x female carrier

Genotype: X^HY x X^HX^h

Meiosis

Gametes: X^H, Y x X^H , X^h

Fertilization

	X^H	Y
X^H	X^H X^H	X^H Y
X^h	X^H X^h	X^hY

F_1 Genotype: **1** $X^H X^H$: **1** $X^H X^h$ **1** $X^H Y$ **1** $X^h Y$

normal female : female carrier : unaffected male : haemophilic male

25% : 25% : 25% : 25%

Phenotype : 50% unaffected females : 25% unaffected males : 25% haemophilic males

EXAMPLE 2: An affected male with an unaffected female.

P_1 Phenotype: affected male x unaffected female

Genotype: $X^h Y$ x $X^H X^H$

Meiosis

Gametes: X^h , Y x X^H , X^H

Fertilization

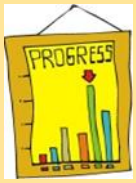
	X^h	Y
X^H	X^HX^h	X^HY
X^H	$X^H X^h$	X^HY

F_1 **Genotype:** X^HX^h X^HX^h X^HY X^HY

50% of **F_1** is female carriers : 50% of **F_1** is normal males

1 **:** **1**

Phenotype : **100% normal**



Activity 1.5

Aim: to enable participants to explain sex linked illnesses as well as to do a genetic cross on these illnesses.

Method: Answer the following questions:

1. Haemophilia is a genetic disorder caused by a recessive allele on the X chromosome. A haemophiliac female marries a normal male. Explain why all their sons will be haemophiliacs.

2. Colour blindness is a genetic disorder caused by a recessive allele on the X chromosome. A colour blind man marries non-carrier women. Do a genetic cross to show the possible genotypes of their children.

UNIT 4 - What are the different blood groups and the genetics behind it?

Blood grouping

Humans have different blood groups and this is a result of multiple alleles. The alleles namely I^A, I^B and i in different combinations result in four different blood groups. Learners are expected to solve genetic crosses regarding the different blood groups.

The phenotype will be the blood type and the genotype has to indicate the two different alleles present. Blood group O has two recessive alleles namely i. Blood group A and B has co-dominant alleles.

The following table indicates the phenotype, genotype of each blood group:

Phenotype/Blood type	Genotype
A	$I^A I^A$
A	$I^A i$
B	$I^B I^B$
B	$I^B i$
AB	$I^A I^B$
O	i i

Co-dominance in humans:

Homozygous dominant = $I^A I^A$ (blood group A)

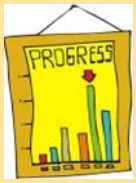
Homozygous dominant = $I^B I^B$ (blood group B)

Heterozygous = $I^A I^B$ (blood group AB)

Homozygous recessive = **ii** (blood group O)

1-2-3-4 Rule

- **You can only have one blood group**
- **You can only have two alleles for a blood group**
- **But there are three different alleles**
- **And there are four blood groups**



Activity 1. 6

AIM: To enable participants to answer questions on blood group alleles, to do a genetic cross on blood groups as well as to calculate ratios.
Method: Answer the following questions:

1. Human blood groups are controlled by multiple alleles.
a) How many alleles control blood groups?
b) Which TWO alleles are co-dominant in the inheritance of blood groups?
c) A man is heterozygous for blood group A and marries a woman who has blood group O. Use a genetic cross to show the phenotypic ratio of their offspring.

2. A baby was kidnapped from a hospital immediately after she was born. Fifteen years later it was discovered that Mr and Mrs Thomas, who were raising her, were not her biological parents. Mr and Mrs George, whose baby was born around the same time, claimed that she was their child. The blood groups of both families are shown in the table below.

INDIVIDUAL	**BLOOD GROUPS**
Child	O
Mr Thomas	O
Mrs Thomas	AB
Mr George	B
Mrs George	A

2.1 How many genes control the inheritance of blood groups?
2.2 Name the individual whose blood group shows co-dominance.
2.3 Explain why Mr and Mrs George could possibly be the parents of this child.

UNIT 5 - What are dihybrid crosses and how do we solve it?

DIHYBRID CROSSES

- A dihybrid cross involves the inheritance of two characteristics.
- According to the **Law of Independent Assortment**, alleles of a gene for one characteristic segregate independently of the alleles of a gene for another characteristic. The alleles for the two genes will therefore come together randomly during gamete formation.
- This means that the two characteristics are transmitted to the offspring independently of one another.
- The above law only applies if the genes for the two characteristics are not on the same chromosome.

Steps you should follow in working out a dihybrid cross:

Example: In hamsters, the allele for black coat colour (B) is dominant over the allele for white coat colour (b). The allele for rough coat (R) is dominant over the allele for smooth coat (r). If you cross a hamster that is heterozygous black and homozygous rough, with one that is heterozygous black and heterozygous rough, what will be the phenotypes and genotypes of the offspring?

STEP	What to do generally	What to do in this problem
Step 1	Identify the phenotypes of the two hamsters for each of the two characteristics.	According to the statement of the problem, both parents are **black** and have **rough coats.**
Step 2	Choose letters to represent the alleles for the gene responsible for each characteristic.	Use the letters, e.g. **B** for black, **b** for white, **R** for rough, and **r** for smooth as provided in the question.
Step 3	Write the genotypes of each parent.	According to the statement of the problem, both parents are heterozygous black, while the one is homozygous rough and the other one heterozygous rough for coat texture. Their genotype will therefore be **BbRR** and **BbRr**
Step 4	• Determine the possible gametes that each parent can produce. • Remember that each parent will have two alleles for each gene. • The gametes of each parent will have only one allele for each gene because of segregation during meiosis. • Remember that because of the principle of independent assortment an allele for one gene could appear in the same gamete with any of the	• The genotype of the parents are: **BbRR** and **BbRr** • If we represent the alleles for each gene in the following format, then we can see how these alleles could come together randomly (principle of independent assortment) to form the different types of **gametes**: **BbRR:** **BbRr**

	alleles for the other gene.	Alleles	B	b		Alleles	B	b
		R	**BR**	**bR**		R	**BR**	**bR**
		R	**BR**	**bR**		r	**Br**	**br**
Step 5	Enter the possible gametes at the top and side of a Punnett square.	Please refer to the solution that follows.						
Step 6	• Because of random fertilisation, gametes from both parents could fuse in different combinations to form the offspring. • In the punnet square, write down the genotypes of the offspring that will result from each possible combination of gametes	Please refer to the solution that follows.						
Step 7	Determine the phenotypes of the offspring from the genotypes obtained in the punnet square.	Please refer to the solution that follows.						

Solution to the problem

P_1 Phenotype Black,Rough x Black, Rough……**Step 1**

Genotype BbRR x BbRr ……**Step 2,3**

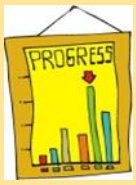
Meiosis and Fertilisation

Gametes	BR	BR	bR	bR
BR	BBRR	BBRR	BbRR	BbRR
Br	BBRr	BBRr	BbRr	BbRr
bR	BbRR	BbRR	bbRR	bbRR
br	BbRr	BbRr	bbRr	bbRr

Steps 4-6

F_1 Genotype 6 different genotypes, as in the table above

Phenotype 12 Black, rough; 4 White, rough…… ……**Step 7**



Activity 1.7

AIM: to enable participants to do a dihybrid cross

Method: Answer the following questions regarding a dihybrid cross.

A certain plant species has the following alleles for each characteristic:

Number of seeds per pod

P: one seed

p: three seeds

Leaf shape

L: normal shape

l: wrinkled shape

The table below shows the results of the offspring produced by a genetic cross between two plants of this species.

PHENOTYPE	NUMBER OF OFFSPRING
One seed and wrinkled leaves	100
One seed and normal leaves	290
Three seeds and wrinkled leaves	32
Three seeds and normal leaves	96

1.1 How many genes of the plant are considered here? (1)

1.2 Name the dominant phenotypes of the plant. (2)

1.3

Give the:

(a) Genotype of each parent (2)

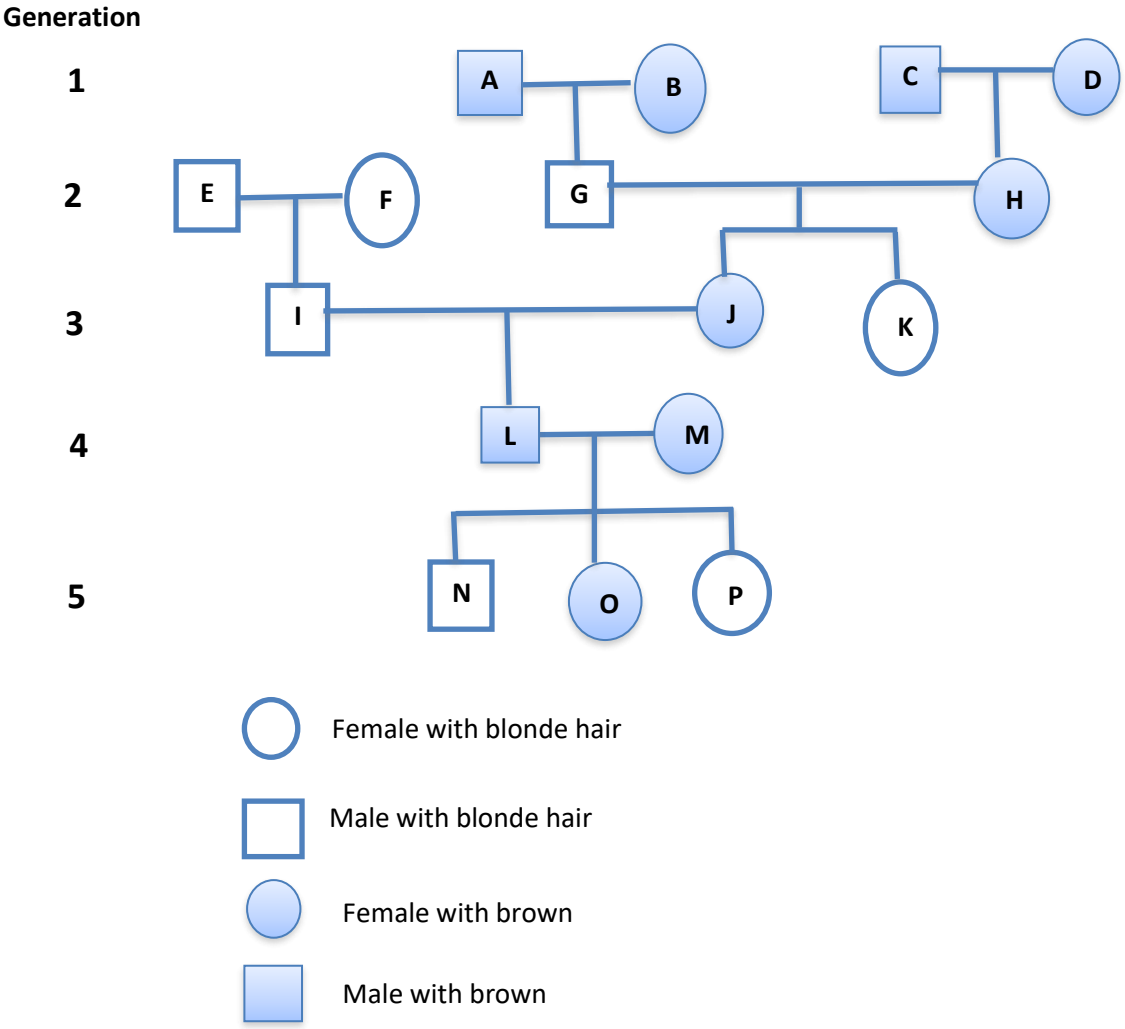
(b) Number of offspring that are homozygous recessive for both characteristics (1)

UNIT 6 - What are pedigree diagrams and how do we solve it?

Pedigree diagrams/genetic lineages

A genetic lineage/pedigree traces the inheritance of characteristics over many generations. Learners should be able to interpret pedigree diagrams.

How to approach answering pedigree diagram questions:



Analysing the genetic lineage in a pedigree diagram:

Step 1: Mark all the **homozygous recessive** individuals with blonde hair. This will be all the white shapes: E, F, G, I, K, N and P as **bb** on the pedigree chart.

Step 2: Work from the generation line 5 up towards the generation line 1 so that you start with the last offspring on the pedigree diagram. To produce an offspring with **bb**, BOTH parents must have at least one homozygous recessive gene (**b**).

If the parent is a white shape – then the parent is **bb** and already marked. If the parent is a shaded shape and produced a **bb** offspring, then the parent must be heterozygous **Bb**. Mark the **Bb** parents on the pedigree diagram.

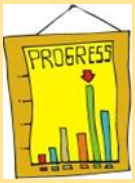
Step 3: Parents that are shaded shapes and produce only shaded shape offspring, can be homozygous **BB** or heterozygous **Bb**. Look to the next generation and then work backwards. Mark the parents on the pedigree diagram.

Step 4: Answer the questions that relate to the pedigree diagram.

Try to work out the genotype of A, B, C, D, H, J, L, M and O on your own first.

Let us see if you were right:

- A and B are **Bb** because they produce G (**bb**)
- If C is **BB** then D must be **Bb** or C is **Bb** then D is **BB** because H must be **Bb** to produce K (**bb**)
- J is **Bb** because G is **bb** and H is **Bb** (produced sister K - **bb**)
- L and M are both **Bb** because parent J is **Bb** and I is **bb** so they cannot be homozygous BB AND L and M produce a son (N) and daughter (P) that are both homozygous **bb**
- Offspring O can be either **BB** or **Bb** because both parents are heterozygous **Bb**

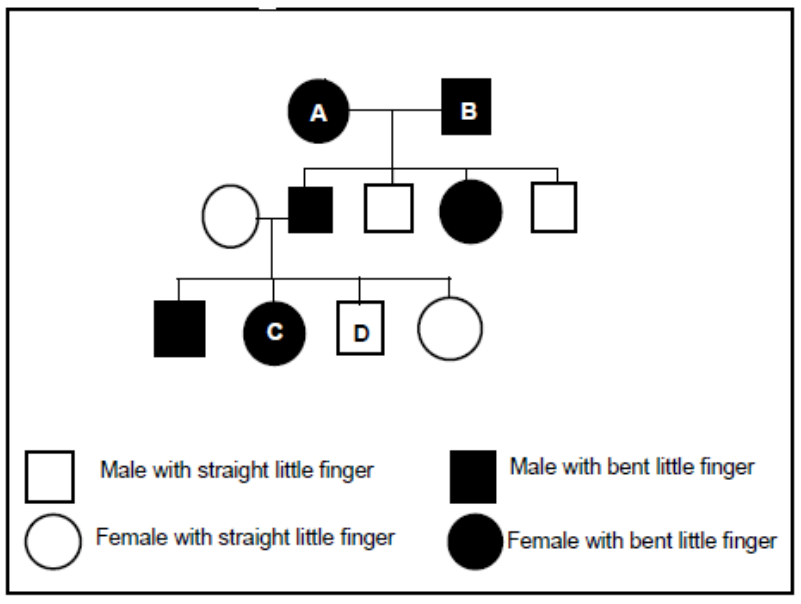


Activity 1.8

AIM: To enable participants to answer analyse pedigree diagrams.
To enable participants to classify questions according to Bloom's taxonomy.

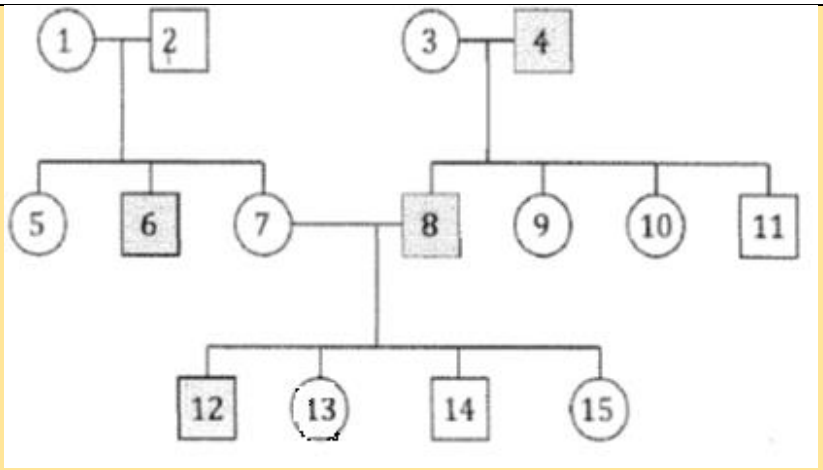
Method: Answer the following questions regarding pedigree diagrams.

1. A dominant allele causes the last joint of the little finger to bend inwards towards the fourth finger (**B**) and is called 'bent little finger'. The recessive allele (**b**) causes the little finger to be straight.
   The pedigree diagram below shows the inheritance of a 'bent little finger' in a family.



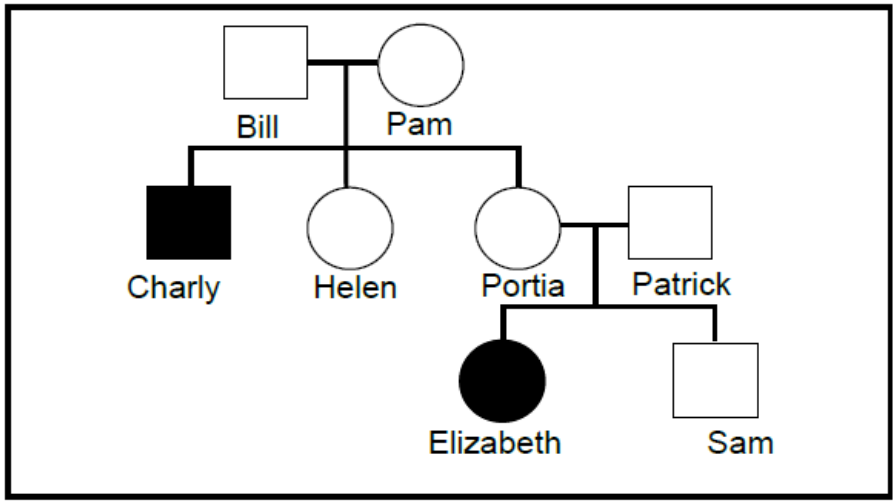
1.1. Explain why individuals A and B are definitely heterozygous for this trait.
1.2 Individual C has a child with a partner that has straight little fingers.
Use a genetic diagram to show the possible genotypes and phenotypes of the child.

2. The following pedigree diagram is for colour blindness. Determine the possible genotypes for number 1-15. Colour blindness is a sex linked condition. Use X^b to indicate the affected allele and X^B to indicate the normal allele.



3. Tay-Sachs disease is caused by an autosomal recessive allele (n). Children with Tay-Sachs disease lose motor skills and mental functions. Over time, the children become blind, deaf, mentally retarded and paralysed. Tay-Sachs children die by the age of five.

The pedigree diagram below shows the inheritance of Tay-Sachs disease in a family.



[Source: www.tay-sachs.org]

3.1. Give:
(a) Charly's phenotype
(b) Portia's genotype
(c) Bill's genotype

3.2 Explain why Patrick is normal, but a carrier of Tay-Sachs disease.

3.3 Classify each question above according to Bloom's taxonomy. (Refer to pages 10 and 11).
Give a reason for your classification.

3.4 Will you classify any of the questions to be difficult or very difficult?
Give a reason for your classification.

Activity 1.9

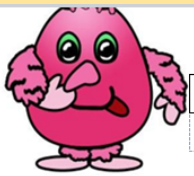
AIM: To enable participants to administer and assess the grade 12 SBA on genetics successfully
Method: Follow the instructions.

LIFE SCIENCES Grade 12

Practical Task Term 2: Genetics and Heredity

Date: _____

Name: _____



Total	
	30

Duration: 1 hour

SECTION A

QUESTION 1

INSTRUCTIONS TO LEARNERS – THIS IS AN INDIVIDUAL TASK. THE TASK MUST BE DONE IN CLASS UNDER CONTROLLED CONDITIONS.

Background

Every family has observable characteristics, or traits, that are passed on from parents to their children. We can categorize these traits in two different ways: as genotype and phenotype. A person's **genotype** is the set of genes that he/she carries (what their DNA 'says'). The **phenotype is** the observable characteristics (what we can see). Different versions of the same gene are called **alleles**. To keep things simple, we give the genotype a two-letter code. You will be given codes to use in this exercise.

Each letter of the two-letter code is an allele. Remember that you get two copies of each gene: one from mom and one from dad.

Materials for each group

- 2 alien 'parents'
- Pen or pencil
- Scissors
- Beaker
- Glue or tape
- Crayons or pencil crayons

Procedure

1. Meet your partner at your station. Receive two pictures of "aliens" from the teacher. Assign one alien to be the "mom" and the other the "dad" to each one of you. You will be "crossing" these two aliens to create a beaker baby.
2. Based on phenotypes (what we see), figure out the genotypes (what the DNA really says) of your alien. Do this by circling the appropriate phenotype for each trait in **Table 1**. The corresponding genotype is listed. Write this code in the genotype column. *See the example here:*

What we see				Genotype (case sensitive)
B. Hair Colour	Red = HH	Pink = Hh	White = hh	Hh
C. Hair Curl	Curly = MM	Wavy = Mm	Straight = mm	MM

3. Write the corresponding alleles for each trait (one letter per box) in **Table 2.** Each letter represents an allele version of that gene. The information for the "mom" should go on one colour and the "dad" information on the other colour. *See the example here:*

Trait	Genotype	
	Allele 1	Allele 2
B. Hair colour	H	h
C. Hair Curl	M	M

4. From **Table 2** cut out each allele and place all of the alleles for the "mom" and for the "dad" into the beaker.
5. **Shake the beaker to mix all of the versions!** Randomly draw out different colours for each trait from the beaker so that you create complete genotypes for each trait. Remember: Each trait needs a version of the gene from "mom" and a version of the gene from "dad".
6. As you draw out versions, write them in the "what the DNA says" columns in **Table 3 (*Child's Genetic Make-Up)***.
7. Go back to the **Table 1** and determine the traits of the offspring and put the information in the "what we see" column of **Table 3**.
8. Draw a **detailed picture** of your offspring with the appropriate traits based on their genotype. Clearly label all 8 traits of your offspring.

Table 1 - Traits and Genotypes of your "Alien"

Is it "mom" or "dad"? _____

Circle what you see and write the genotype for your alien in the last box.

Trait What you See	Phenotypes			Genotype (case sensitive)
B. Body colour	Orange = BB	Pink = Bb	Blue = bb	
H. Hair colour	Red = HH	Pink = Hh	White = hh	
M. Hair curl	Curly = MM	Wavy = Mm	Straight = mm	
A. Antenna	2 = AA	1 = Aa	None = aa	
E. Eye colour	Brown = EE	Green = Ee	Blue = ee	
N. Nose	Trunk = NN	Parrot = Nn	Button = nn	
L. Hairy arms and feet	Very hairy = LL	Some hair = Ll	No hair = ll	
R. Tongue roll	Roller = RR	(Rr = Roller)	Non-Roller = rr	

***note:** If your alien is a tongue roller, you chose whether their genoype is RR or Rr.*

Transfer the information to **Table 2** for cutting

Table 2 - Personal traits – Versions of the gene separated for your "alien"

Write the corresponding alleles for each trait in (one letter per box) below. Each letter represents an allele version of that gene. The information for the girl should go on one colour and the boy information on the other colour.

Trait	What the DNA says Allele 1	Alelle 2
B. Body colour		
H. Hair colour		
M. Hair curl		
A. Antenna		
E. Eye colour		
N. Nose		
L. Hairy arms and feet		
R. Tongue roll		

****When you finish filling out the table, cut along the dashed lines***

Table 3 - The Child's Genetic Make-Up

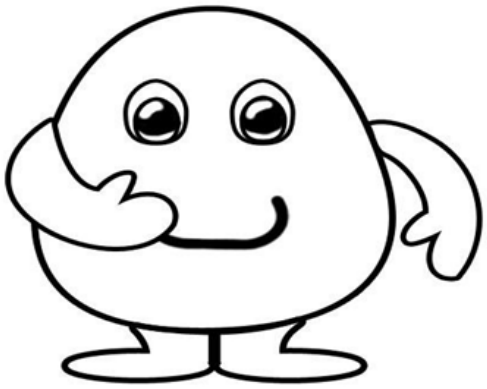
Shake the beaker to mix all of the versions! Randomly draw out different colours for each trait from the beaker so that you create complete genotypes for each trait. Remember: Each trait needs a version of the gene from "mom" and a version of the gene from "dad". As you draw out versions, write them in the "what the DNA says" columns.

Trait	What the DNA says		What we see
	allele from "mom" alien	*allele from "dad" alien*	
B. Body colour			
H. Hair colour			
M. Hair curl			
A. Antenna			
E. Eye colour			
N. Nose			
L. Hairy arms and feet			
R. Tongue roll			

Go back to **Table 1** and determine the traits of the offspring and put the information in the "what we see" column.

QUESTION 1

Draw and colour a **detailed picture** of your offspring with the appropriate traits based on his or her genotype. Clearly label all 8 traits of your offspring.



Genotype (8)

Body colour	Hair colour	Hair curl	Antenna	Eye colour	Nose	Hairy arms and feet	Tongue roll

QUESTION 2

If you were to repeat this activity, would the offspring be exactly alike? Explain your answer. (2)

[10]

SECTION B

QUESTION 3

In cats the gene for coat colour is sex-linked. **Calico cats** are domestic cats with a spotted or particoloured coat that is predominantly white, with patches of two other colours (often, the two other colours are orange and black). The genotype $X^B X^B$ is black, $X^b X^b$ is orange and $X^B X^b$ is tortoiseshell. The cat shown in the picture below is a typically 'calico cat'.

[https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQcxTIghYJmjhM0M2OT93R_4cmbg-zrcmhLXg0xBc5u6ptrJVgz]

3.1 A tortoiseshell female is mated with a black male. In a genetic diagram, work out the genotype and phenotype of the offspring of these two parents. (6)

3.2 What percentage of each type of offspring can be expected? (1)

3.3 Would one expect to find any tortoiseshell males? Explain. (3)

(10)

QUESTION 4

A learner investigated the frequency of certain dominant and recessive characteristics in his class.

His hypothesis was:

There will be more learners with dominant characteristics than learners with recessive ones.

He used 10 boys and 10 girls to investigate the following characteristics. He collected the data over a two week period.

Characteristic	Dominant	Recessive
Tongue rolling	roller	non roller
Number of fingers	five fingers	six fingers
Hair	curly hair	straight hair
Earlobe attachment	free earlobe	attached earlobe

The results of the investigation are shown in the table below:

Tongue rolling		Number of fingers		Hair		Earlobe attachment	
Roller	Non roller	6 Fingers	5 Fingers	Curly	Straight	Free earlobe	Attached earlobe
✓✓			✓✓✓		✓		
✓			✓		✓✓✓	✓✓✓	✓
✓✓✓	✓		✓✓	✓	✓	✓	
✓			✓✓✓✓		✓	✓✓✓	
✓✓	✓		✓		✓✓✓	✓✓✓	
✓✓✓			✓	✓✓	✓✓	✓	
✓	✓		✓✓✓✓✓		✓✓✓	✓✓✓	
✓	✓	✓	✓✓		✓	✓	
✓	✓			✓	✓	✓✓	✓✓

4.1 Process the results of the investigation and tabulate the findings neatly. (5)

4.2 Which TWO processes occur during meiosis to make it possible for a child to inherit different genes from his/her parents? (2)

4.3 Which characteristic shows the largest difference between dominant and recessive alleles? (1)

4.4 Explain if this learner's hypothesis can be accepted or rejected? (2)

(10)

[30]

UNIT 7 - What are mutations and genetic engineering and what are the applications of this?

❑ MUTATIONS

This is a sudden change in the genetic composition of an organism. it contributes to genetic variation.

➢ Gene mutation

A gene mutation is a **change** in the genetic material/DNA sequencing in the cell affecting only a few base pairs in just a single gene.

➢ Chromosomal mutation

Refer to changes in the normal structure or number of chromosomes.

➢ CAUSES OF MUTATIONS

- nuclear radiation, exposure to ultra violet light and x-rays ;

- viruses; unhealthy diet and alcohol

➢ EFFECTS OF MUTATIONS

Mutations assist the organism to **adapt** to its environment.

- **HARMFUL MUTATIONS** : causes changes in DNA that can cause errors in protein sequencing, that can result in partially or completely non- functional proteins.
- **HARMLESS MUTATIONS** : Have no effect on the structure or functioning of the organism.
- **USEFUL MUTATIONS**: Can be advantageous to the organism and they are passed on from parent to offspring.

➢ Examples of mutations to be studied:

Haemophilia, Colour-blindness and Down syndrome

❑ Genetic Engineering:

This is the process where scientists alter, swap or manipulate the genes on the DNA, to produce an organism with desirable characteristics. Genetic engineering uses biotechnology to satisfy human needs.
The following table shows the advantages and disadvantages of genetic engineering which is **no longer** in the **exam guidelines** but still useful to show learners.

Advantages of Genetic engineering	Disadvantages of Genetic engineering
• Production of medication/ resources cheaply • Control pests with specific genes inserted into a crop • Uses specific genes to increase crop yields/ food security • Selecting genes to increase shelf- life of plant products	• Expensive/ research money could be used for other needs • Interfering with nature or immoral • Potential health impacts • Unsure of long term effects

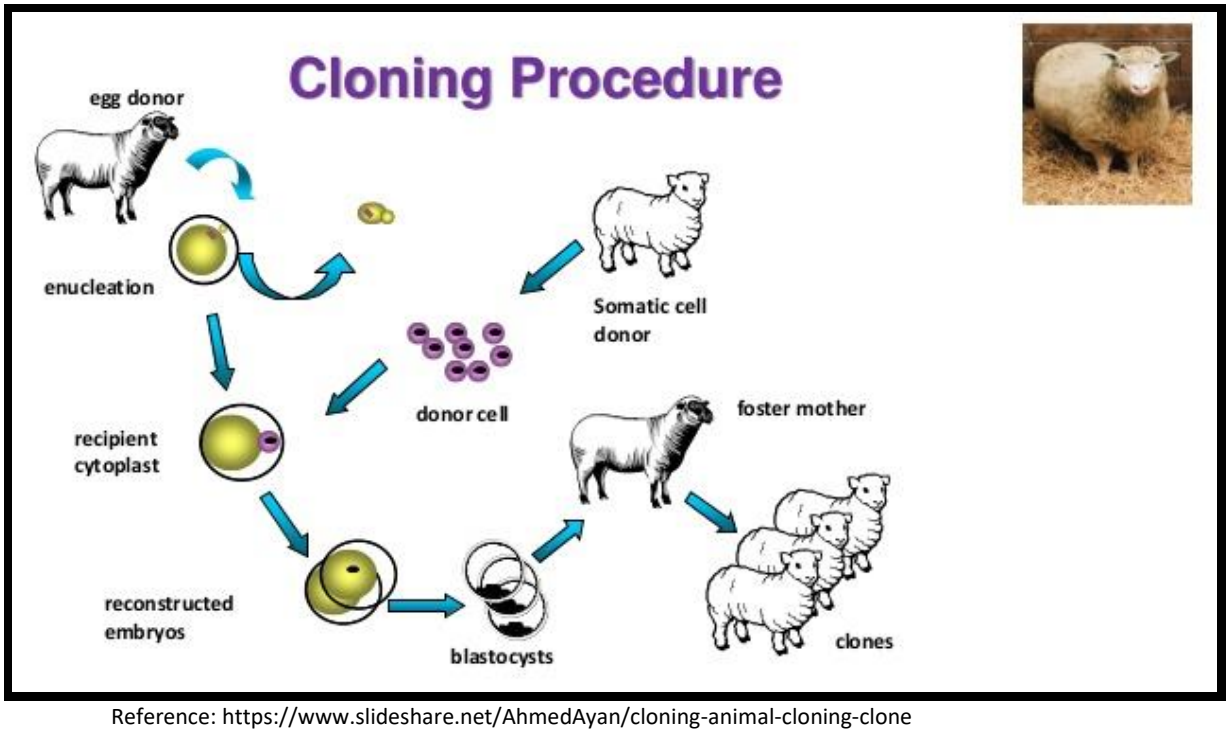
The examples of genetic engineering to be studied: ***Cloning***, ***stem cell research*** *and* ***genetically modified organisms.***

- **Cloning**

This is the process by which genetically identical organisms are produced using biotechnology.

Process:

- With cloning, the nucleus of a **somatic** cell (2n) of one organism is removed.
- An **ovum (n**) is taken from an ovary of **another organism**.
- The **nucleus** of the ovum is **destroyed.**
- The **somatic cell's nucleus** (2n) is then placed inside the ovum.
- The **ovum is put back into a uterus** where it is allowed to grow and differentiate into an embryo.
- When the new offspring is produced, it is identical to the original organism.
- A sheep called Dolly was cloned successfully in 1997.



Reference: https://www.slideshare.net/AhmedAyan/cloning-animal-cloning-clone

- **Stem Cell research:**

A stem cell is any cell in the body that can differentiate into any specialised type of tissue in the body.

- **SOURCES OF STEM CELLS**

Stem cells can be harvested from:

- umbilical cord blood (once a baby has been born),
- a foetal blastocyst and
- Bone marrow.

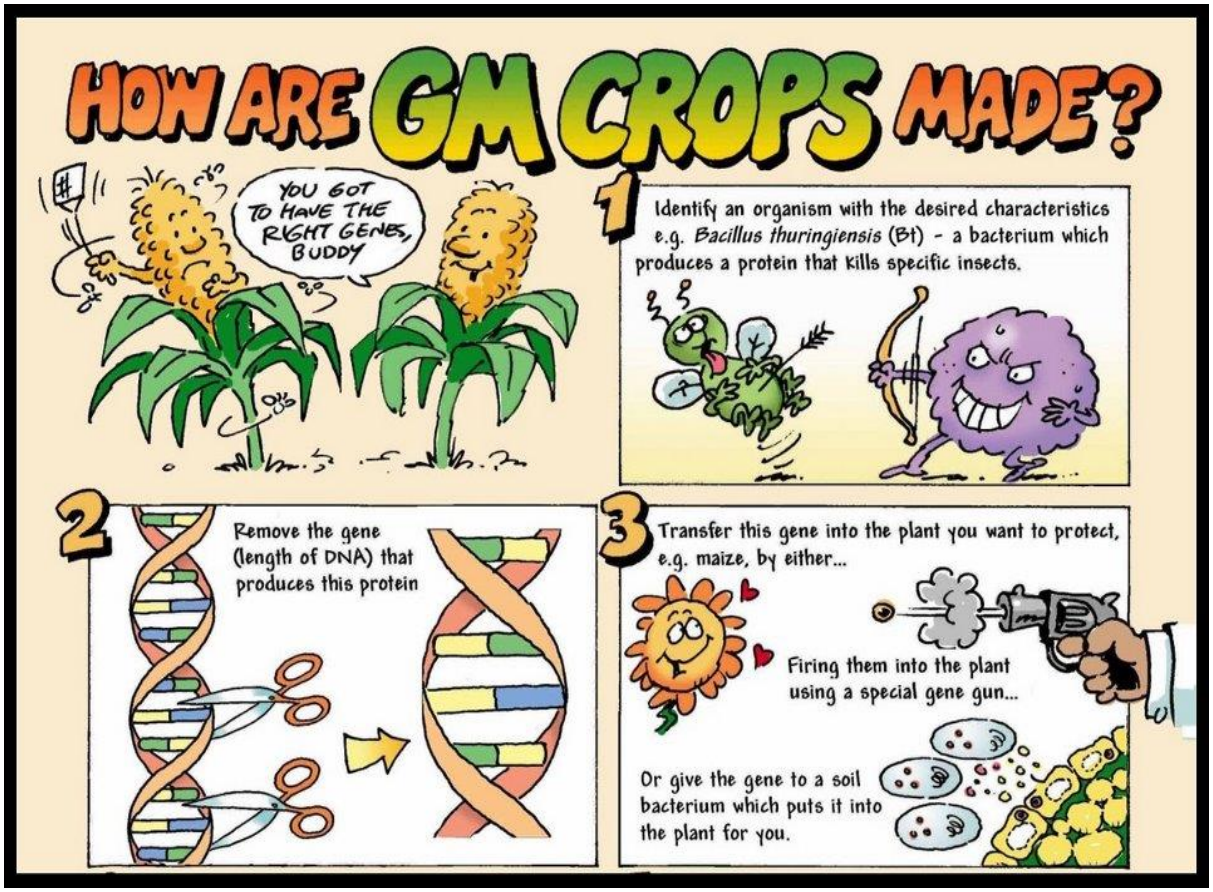
- **USES OF STEM CELL THERAPY**

To treat:

- cancers like Leukemia
- degenerative diseases like Multiple Sclerosis
- diabetes mellitus where the pancreas no longer produces insulin
- muscle damage
- organ damage and
- certain genetic diseases in conjunction with gene therapy

- **Genetically modified organisms**

PROCESS:



- **Benefits of genetic modification**

e.g. The Advantages of Genetically Modified Crops

- **Better for the environment**
  Since GMOs require much less chemicals to thrive, the impact on the environment is lessened. The pesticides and other chemicals commonly used on non GMO crops emit greenhouse gases and pollute the ground soil.
- **Resistance to disease**
  One of the modifications made to the crops is an added resistance to disease that would normally kill off the crops. This keeps the yields high and the prices for the consumers low.
- **Sustainability**
  GMOs provide a stable and efficient way to sustain enough crops to feed the ever growing population of people in the world. This was the main goal of GMO crops in the first place.
- **Increased flavour and nutrition**
  Along with resistances to insects and disease, the genes of the crops can also be altered to have a better flavor and increased nutritional value. This is good all around.
- **Longer shelf life**
  Genetically modified foods have a longer shelf life. This improves how long they last and stay fresh during transportation and storage.
- **Keeps it affordable**
  One of the biggest effects that the use of GMOs has had on our everyday life is the prices of produce and other foods. Since more crops can be yielded, the prices can be much lower.

- **PATERNITY TESTING**

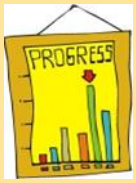
An analysis, usually of the **DNA** or **blood type** of a mother, child, and possible father, to estimate the probability that the man is the biological father of the child.

Blood grouping

- Genotypes of the mother and the suspected man's blood groups are compared with those of the child.
- If the genotypes for the blood groups of the man and the mother could not lead to the blood group of the child the man is not the father of the child.
- If the genotypes for the blood groups of the man and the mother could lead to the blood group of the child it cannot be said with certainty that the man is the father of the child because other males have the same blood group.

DNA profiles

- Every person except identical twins has her/his own unique DNA profile.
- It can be described as an arrangement of black bars representing DNA fragments of the person.
- It is used to:
- Identify paternity



Activity 1.10

AIM: to enable participants to describe and debate issues surrounding cloning and stem cell research

Method: Answer the following question:

Essay question:

Sometimes the paternity of a son or a daughter is disputed.

Describe sex determination in humans and explain how blood grouping and DNA profiling are used in paternity testing.

Activity 1. 11

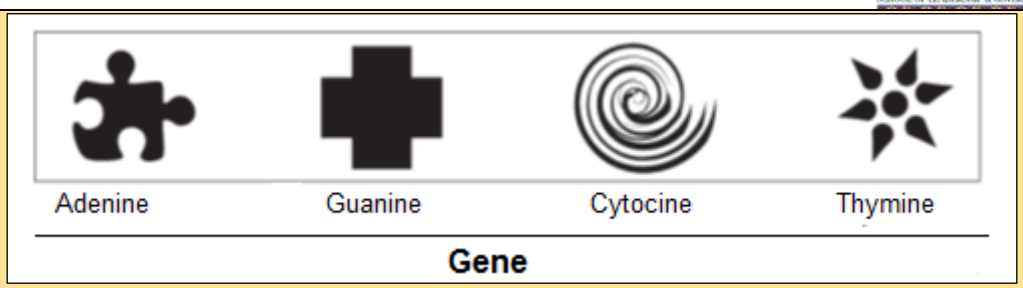
AIM: To enable participants to introduce the topic of genetics in a fun way to their learners.
Method: Participants create and decode a "DNA" recipe for man's best friend to observe how variations in DNA lead to the inheritance of different traits. Strips of paper (representing DNA) are randomly selected and used to assemble a DNA molecule. Participants read the DNA recipe to create a drawing of their pet, and compare it with others in the group to not similarities and differences.

CREATING A DOG

Follow the directions below to create a DNA recipe for a dog. Using the ***Dog Traits Key,*** read your DNA recipe and make a drawing of your dog showing all of its traits.

Directions:

1. Make sure you have an envelope containing "Dog DNA". It should contain 8 coloured strips: Each strip is a gene, and the symbols on the strip represents nitrogenous basis.

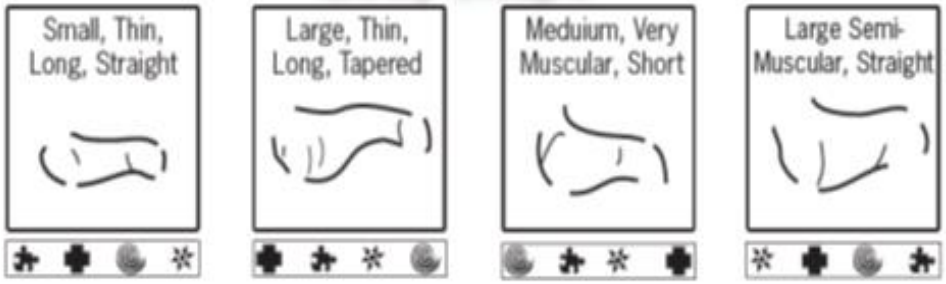


2. Leave the strips in the envelope.
3. Determine the first trait of your dog (body shape) by randomly picking a piece of dog DNA out of the envelope.
4. Look at the symbols on the DNA strip you have chosen. Match the pattern to one you see on the ***Dog Traits Key*** for body shape.
5. Circle the picture for body shape that matches the DNA piece that you picked.
6. Set the piece of DNA aside and repeat steps 3-5 for the next trait on the key.
7. After circling the matching picture, tape the second piece of DNA to the first to make one long strand. This will become the DNA recipe for your entire dog.
8. Repeat these steps for each of the traits listed on the ***Dog Traits Key***.
9. When you have finished, draw your dog with all of its traits (the traits you have circled on the ***Dog Traits Key***) on a separate piece of paper.
10. Hang up the picture of your dog along with its DNA recipe (the DNA pieces you chose attached in a long strand).

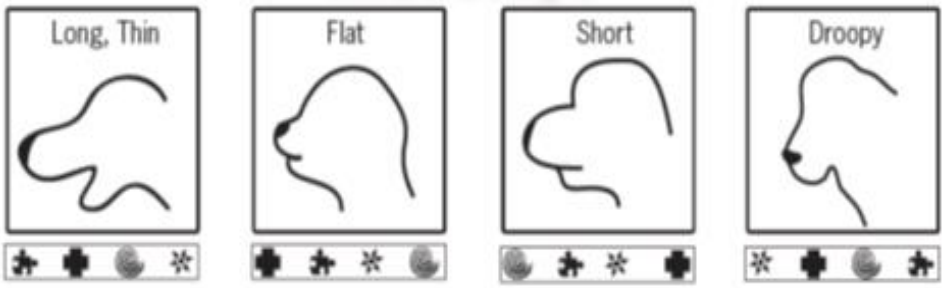
Is your dog different from or the same as the others in the group?

Dog Traits Key

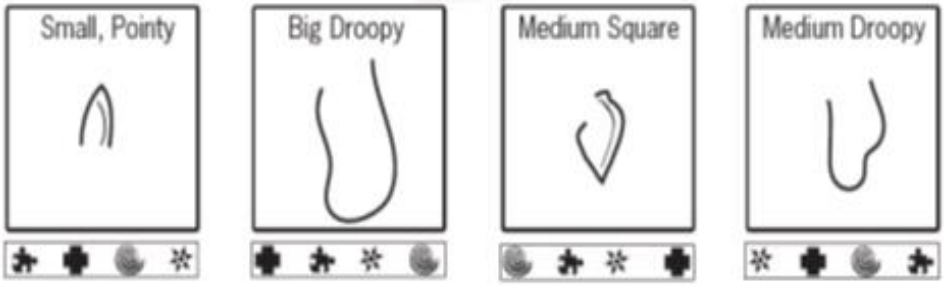
Body Shape



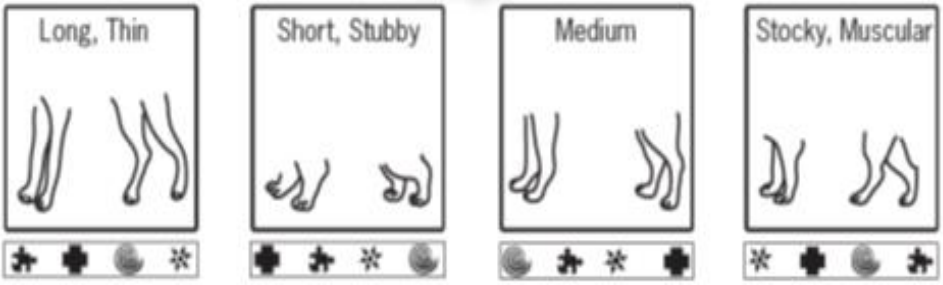
Head Shape

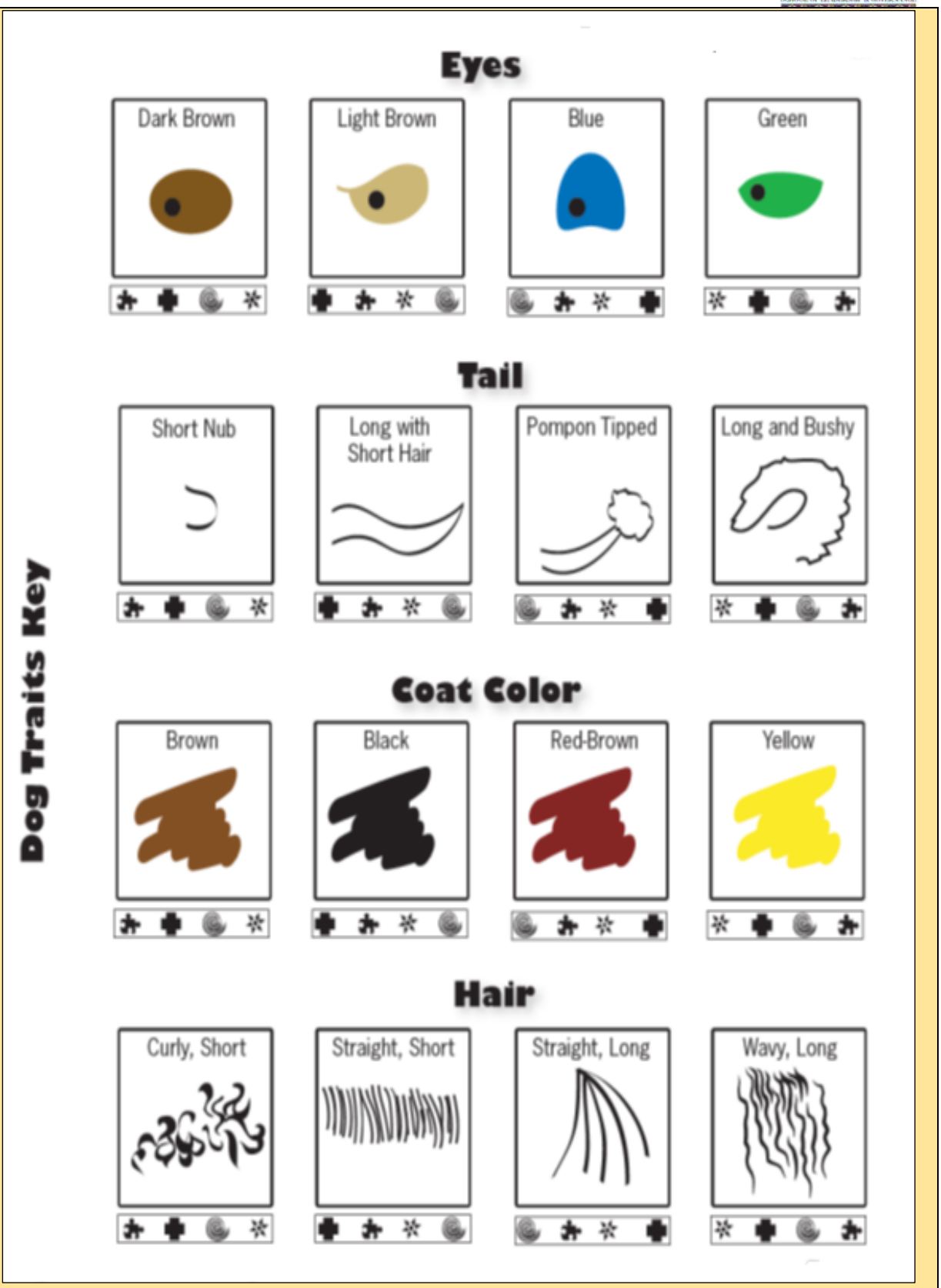


Ears



Legs




Dog Traits Key
Eyes
Dark Brown
Light Brown
Blue
Green
Tail
Short Nub
Long with Short Hair
Pompon Tipped
Long and Bushy
Coat Color
Brown
Black
Red-Brown
Yellow
Hair
Curly, Short
Straight, Short
Straight, Long
Wavy, Long

RESOURCE

https://wordmint.com/public_puzzles/200551

http://learn.genetics.utah.edu

https://bit.ly/2YbySBm

Download the free SCOP genetics app on Android from Wits University:

https://play.google.com/store/apps/details?id=scoping.genetics&hl=en

MODULE SUMMARY

Life exists in a variety of life forms and it is in the study of DNA, genetics and inherited characteristics that life at molecular level intersects with Strand 4: Diversity, Change and Continuity in the CAPS curriculum.
In order to understand species, speciation, biodiversity and change, it is **essential to understand how DNA and chromosomes enable continuity and** change. This module covers all the requirements for the DBE NSC exams w.r.t. the topic: Genetics and Heredity:

REFERENCES

- DBE Exam guidelines for learners
- GDE ATP
- 2015-2019 NSC past papers
- 2014-2019 national diagnostic report on learner performance
- Approved grade 12 national textbooks
- Internet
- Gauteng grade 12 Life Sciences Revision booklet

MODULE 2 – THE HUMAN NERVOUS SYSTEM

INTRODUCTION

To survive, all organisms need to be able to sense changes in their environment and to control their responses to these changes. The nervous system and the endocrine system are important communication systems that co-ordinate, intergrade and carry out the activity of body cells, tissues, organs and the organism. They maintain a constant internal balance, while reacting to the changes that occur in both the external and internal environment.

The nervous system is broken down into three parts: Central Nervous System (CNS), Peripheral Nervous System (PNS) and Autonomic Nervous System (ANS).

Nervous tissue consists of 3 types of neurons that have different functions: sensory, inter/connector and motor neurons

A simple reflex arc allows organisms to react to stimuli in the environment quickly as a protective mechanism.

Two weeks are allocated on the ATP for the teaching of the human nervous system. Because the structure and function of the central nervous system and reflex arc has to be taught, it is important to use diagrams for the teaching and learning of this topic. You will also notice that we have included terminology lists as these are crucial for good performance. Please ensure that your learners do regular terminology activities and tests.

There is practical work listed in CAPS that needs to be performed to enhance teaching and learning and video clips are also included.

OVERVIEW

This module deals with the human nervous system. There is a detailed terminology list, followed by the structure and functions of certain parts of the nervous system, neurons, reflex arc and the nature and treatment of diseases affecting the nervous system.

SPECIFIC OBJECTIVES

By the end of this session, participants will be able to:

- Identify the different parts of the nervous system
- Identify the different structures of the brain.
- Describe the functions of the different parts.
- Draw and label the parts of the reflex arc.
- Briefly explain the events occurring during a reflex action.
- Carryout an investigation on reaction time.

CONTENT

You will study this module through the following units:

Unit 1: Responding to the environment and coordination of activities in the body
Unit 2: Structure of the Nervous System
Unit 3: Structure of the Central Nervous System
Unit 4: Location and functions of the Peripheral Nervous System
Unit 5: Location and functions of the Autonomic Nervous System
Unit 6: Structure and functioning of a nerve
Unit 7: Structure and function of a simple reflex arc
Unit 8: Disorders of the CNS

UNIT 1 – Responding to the environment and coordination of activities in the body

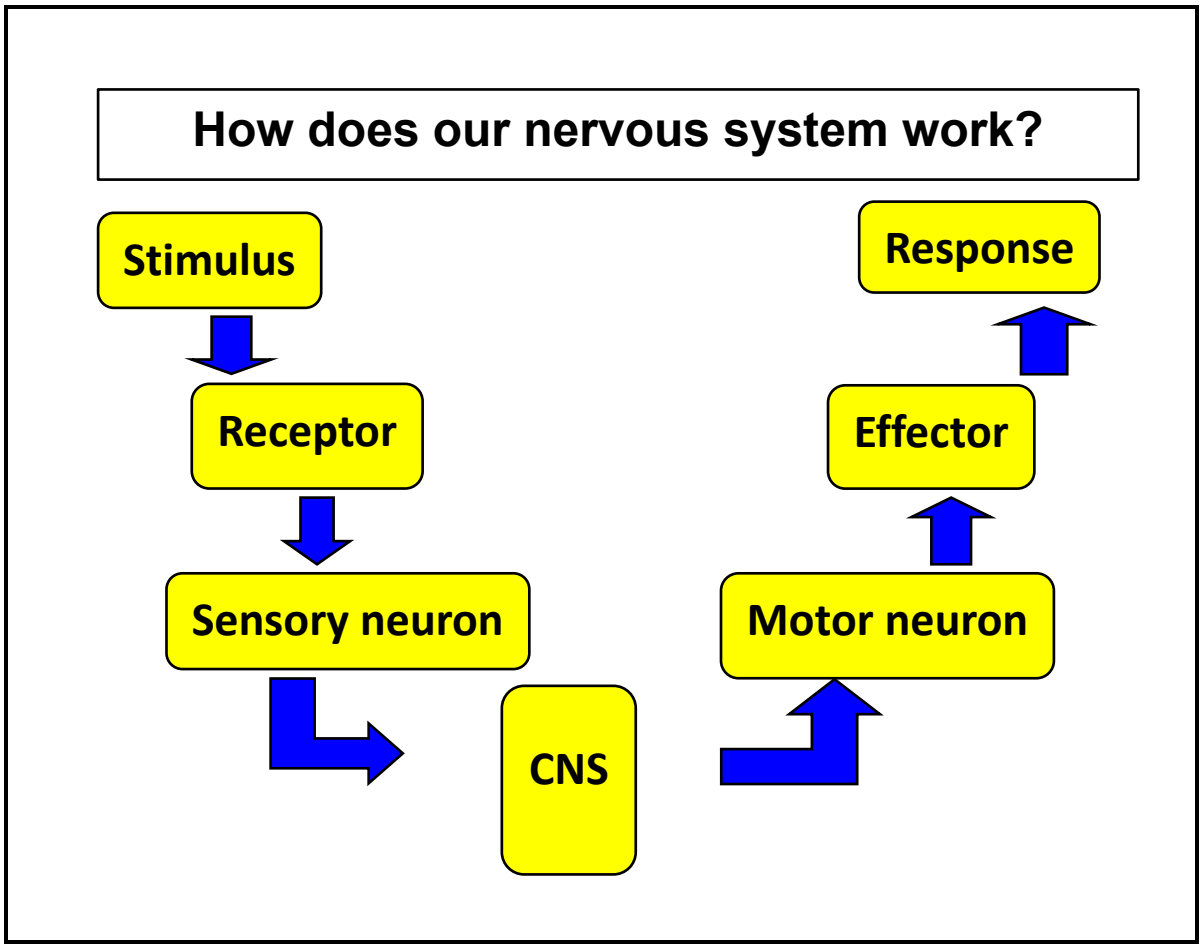
Terminology & definitions:

Biological term	Description
Afferent neuron	Neuron that carries impulses to the CNS.
Alzheimer's Disease	Progressive mental deterioration that can occur in middle or old age, due to generalized degeneration of the brain.
Autonomic nervous system	The part of the peripheral nervous system that controls involuntary actions.
Axon	The long threadlike part of a nerve cell along which impulses are conducted from the cell body to other cells.
Central nervous system	The part of the nervous system that consist of the brain and spinal cord.
Cerebrospinal fluid	A watery *fluid*, continuously produced and absorbed, which flows in the ventricles (cavities) within the brain and around the surface of the brain and spinal cord.
Dementia	A general term used for memory loss and loss of other intellectual abilities.
Dendrite	A part of the neuron that conducts impulses towards the cell body.
Efferent neuron	Neuron that carries impulses to the CNS.
Effectors	Are muscles or glands that respond to the message from the nervous system (brain and spinal cord).
Medulla oblongata	The part of the brain that controls the heart rate.
Meninges	A collective name for the membranes that protect the brain.
Multiple sclerosis	A disorder of the nervous system that is characterised by the breakdown of the myelin sheath of neurons.
Myelin sheath	A fatty layer wrapped around the neuron, which acts as insulation.
Nerve	Bundle of neurons.
Neuron	One nerve cell.
Neurotransmitter	Chemical that is released from a nerve cell which thereby transmits an impulse from a nerve cell to another nerve, muscle, organ, or other tissue.

Peripheral nervous system	The part of the nervous system made up of cranial and spinal nerves.
Receptors	Structures located in the sense organs. They convert a stimulus into an impulse.
Stem cells/meristematic cells	Undifferentiated cells that can develop into any cell type.
Stimulus	A detectable change (e.g. pain, heat, light, sound) that will be received by a receptor and converted into an impulse.
Synapse	A junction between two nerve cells, consisting of a minute gap across which impulses pass by diffusion of a neurotransmitter.

Nervous co-ordination

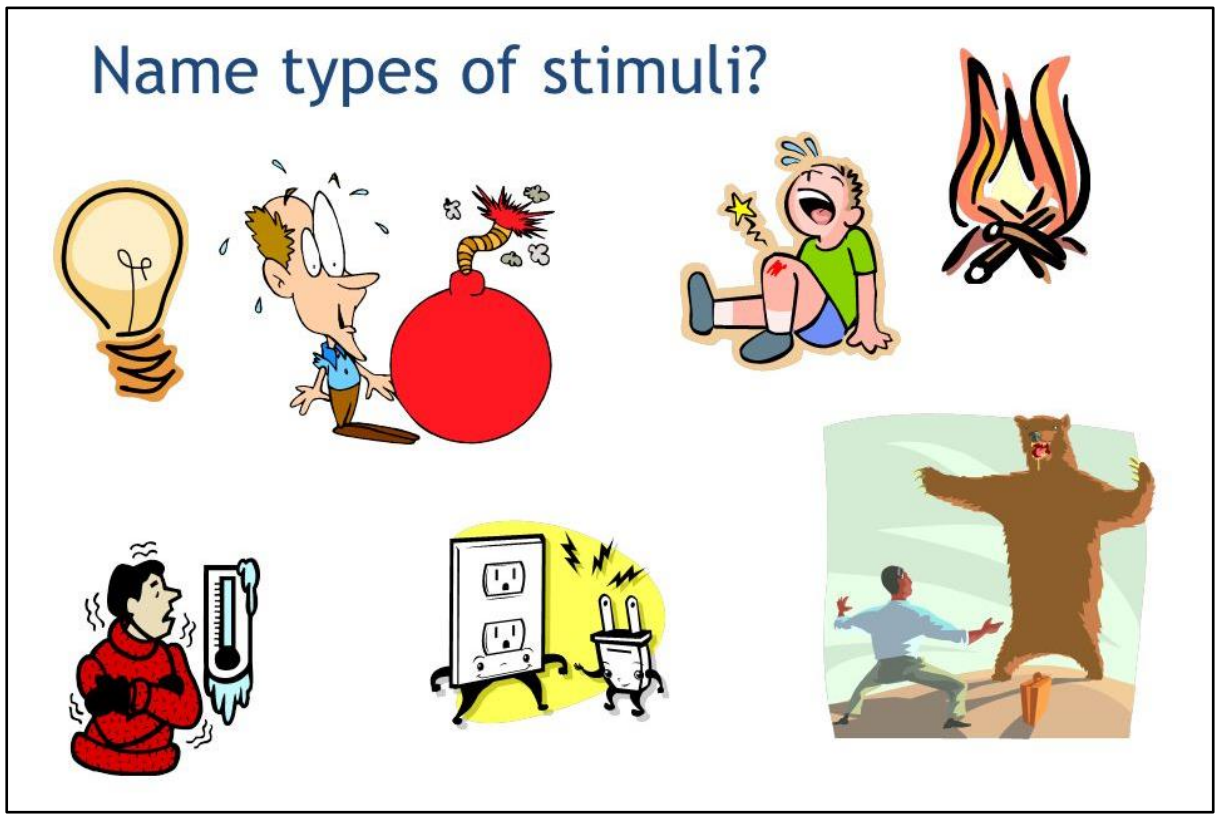
- To survive, all organisms need to be able to sense changes in their environment and to control their responses to these changes.
- The nervous system and the endocrine system are important communication systems that co-ordinate, intergrade and carry out the activity of body cells, tissues, organs and the organism.
- They maintain a constant internal balance, while reacting to the changes that occur in both the external and internal environment



Reaction to stimuli in the environment

- The nervous system and sense organs play an important part in picking up stimuli, gathering information and responding quickly to changes from both the external and internal environment to maintain a constant state.
- The nervous system in vertebrates performs five main functions:

    1 Gathers information using the senses
    2 Transmits information to processing areas of the brain
    3 Processes information
    4 Formulates responses to stimuli
    5 Sends information back through the network of effector organs to execute the response



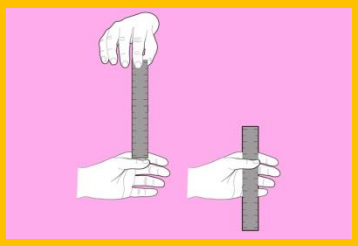
ACTIVITY 2.1

AIM: To enable participants to carry out an investigation on reaction time

METHOD: in pairs carry out the instructions of the 3 investigation below and record the results in the provided. Answer the related questions

WORKSHEET 6 – Gr.12 resource material
REACTION TIME

Reaction time is a measure of how quickly you can respond to a given stimulus



This experiment will be broken down into three phases.

- You will first use one ruler and react visually
- Secondly you will use one ruler but be blindfolded
- Thirdly you will use two rulers

Experiment 1
In this phase you and your partner will test visual reaction time using one ruler
Method

- Your friend must hold the ruler at the 30 cm mark and your hand must be at the 0 cm mark.
- Your friend must release the ruler and you must catch it as quickly as possible
- You therefore react to the visual stimulus of the ruler released.
- Record the centimetre mark where you caught the ruler
- Repeat the experiment four more times
- Switch places with your partner and repeat the experiment

Record the results in the following table

Visual stimulus

Name	**Name**
Average	**Average**

Experiment 2

In this phase you and your partner will test tactile reaction time using one ruler

Use the same method described in experiment 1. The person who catches the ruler must be blindfolded for this experiment. Before you drop the ruler touch the blindfolded person's shoulder and again record the centimetre mark where the ruler is caught.

Record the results in the following table

Tactile stimulus

Name	**Name**
Average	**Average**

Experiment 3

In this phase you and your partner will test audio reaction time using two rulers.

Use the same method described in experiment 1. Before your partner drops the ruler he must call out "left" or "right" (randomly) and again record the centimetre mark where the ruler is caught.

Record the results in the following table

Audio stimulus

Name	**Name**
Average	**Average**

QUESTIONS

1. Did you get the same reaction time of your five trials? What factors might cause this?
2. What was your fastest reaction time? (Visual, tactile or audio). Give a reason for your answer.
3. If you wanted to know how long it might take you to react to any given stimuli, would it be better to consider your fastest, slowest or average reaction time? Explain your answer.
4. Calculate the average of each of the three stimuli from the learners in your class.
5. Do your results match the averages mentioned above?
6. Do you think one's reaction time might improve? State two reasons for your answer.

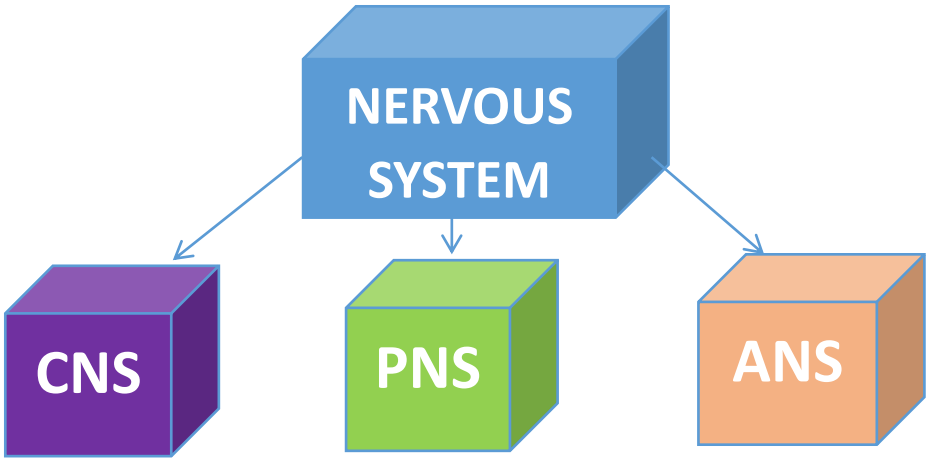
APPLICATION QUESTIONS

1. Use a stopwatch to find out how much time it takes for you or your partner to catch the falling ruler from the time it is let go to the time it is caught over the average distance (Experiment 1). This will help you compare your reaction time with that of your partner.
2. Use the reaction time calculated in question 1 above, to determine how far a car moving at 100km/h will travel before it can be stopped by the driver. Use the following formula:

$$\frac{\text{Reaction time (s)} \times 100\text{km}}{3\,600\text{ s}}$$ (Note: 3 600 s = 1 hour)

3. What implication does reaction time have for driving?

UNIT 2 – Structure of the nervous system



CENTAL NERVOUS SYSTEM

- Brain
- Spinal cord
- Consists of multipolar neurons
- Aka connector /interneurons

PERIPHERAL NERVOUS SYSTEM

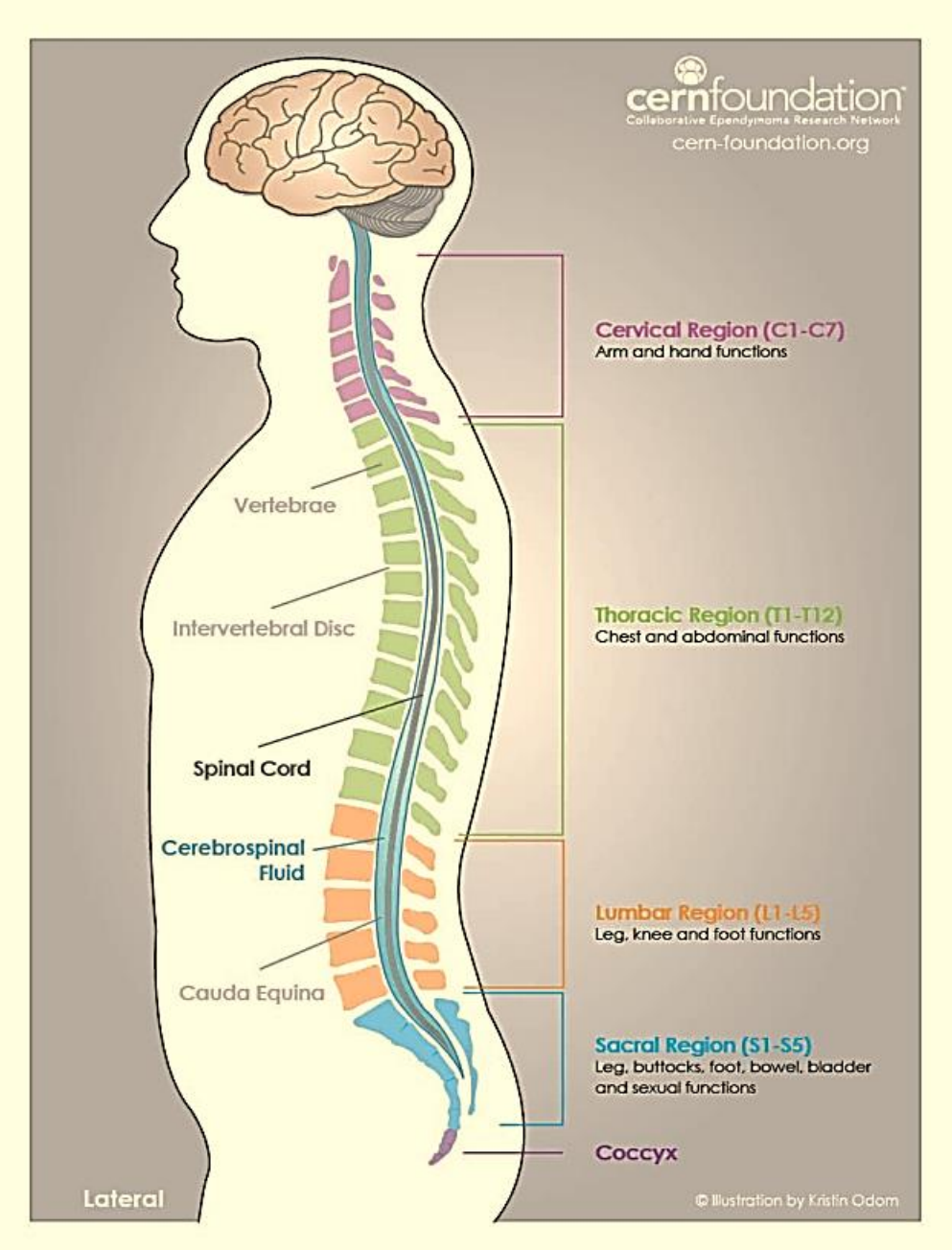
- Cranial nerves
- Spinal nerves
- Unipolar& bipolar neurons
- Aka sensory & motor neurons

AUTONOMIC NERVOUS SYSTEM

- Nerves that branch off the CNS
- E.g. Vagus nerve

The Central Nervous System (CNS)

- The brain and the spinal cord together form the central nervous system (CNS)
- The whole CNS is surrounded by a system of membranes called the meninges, which protect it.
- The brain is housed in the cranium and the spinal cord in the vertebral column



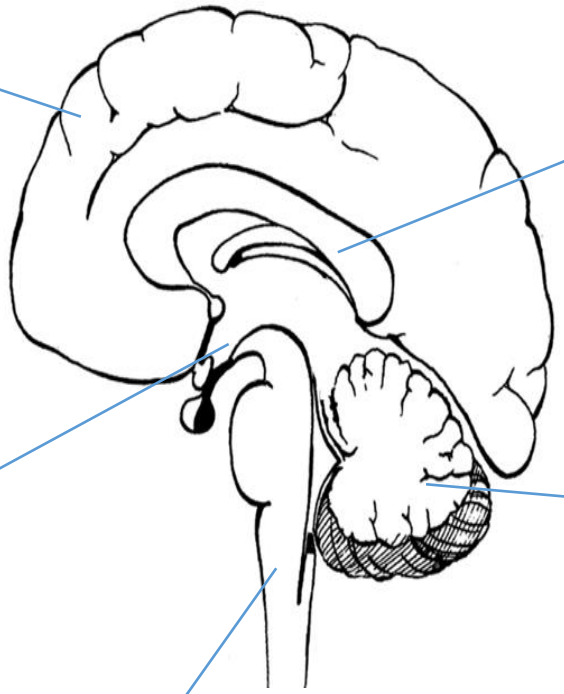
Structure and function of the parts of the brain

- The brain consists of three main external parts
    - The large cerebrum
    - The smaller spherical cerebellum
    - The brainstem which has the medulla oblongata and the pons
- The cerebrum and cerebellum are divided into two hemispheres
- The two hemispheres of the cerebrum are joined by the corpus callosum

Structure of the brain and the functions of certain parts

Cerebrum

- Controls voluntary Actions
- Receives and interprets sensations from sense organs
- Higher thought processes



Corpus callosum

- Connects the left and right hemispheres of the brain – allowing communication between both hemispheres

Hypothalamus

- Control centre for hunger, thirst, sleep, body temperature and emotions

Cerebellum

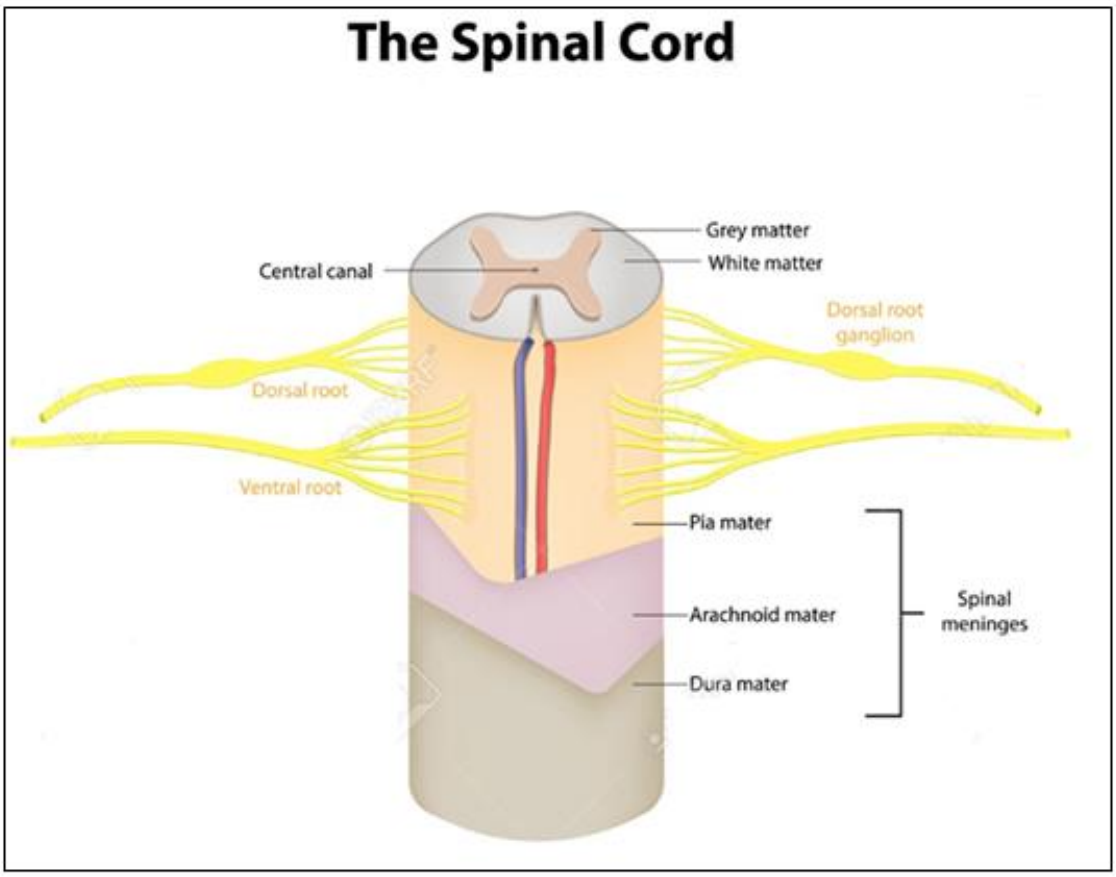
- Coordinates all voluntary movements
- Controls muscle tension to maintain balance

Medulla oblongata

- Transmits nerve impulses between the spinal cord and the brain
- Controls involuntary actions such as heartbeat and breathing

The spinal cord

- The spinal cord is inside the vertebral canal and is an extension of the brain.
- Protection: vertebrae, meninges and cerebrospinal fluid.
- From each side of the cord 31 pairs of spinal nerves arise from ventral and dorsal roots.
- Function:
    - The spinal cord is the pathway for all impulses conducted to and from the brain.
    - The grey matter lies on the inside in the shape of an 'H'
    - The white matter lies on the outside (opposite to the cerebrum).
    - The spinal cord processes all reflex actions.
    - The spinal cord functions automatically and is not controlled by the will.
    - Sympathetic and parasympathetic nerve impulses are conducted along the spinal cord to all organs.



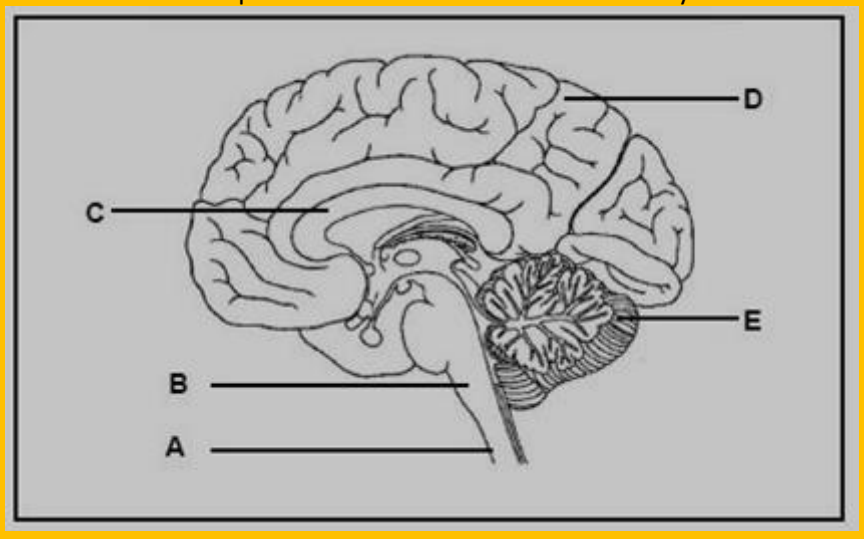
ACTIVITY 2.2

AIM: To enable participants to identify structures of the brain and state their functions

METHOD: Complete the following questions from a past exam paper

DBE/November 2019

1 The diagram below shows some parts of the human central nervous system.



1.1 Identify part:

(a) A (1)

(b) C (1)

1.2 Write down the LETTER and the NAME of the part that:

(a) Has the centre for interpreting taste (2)

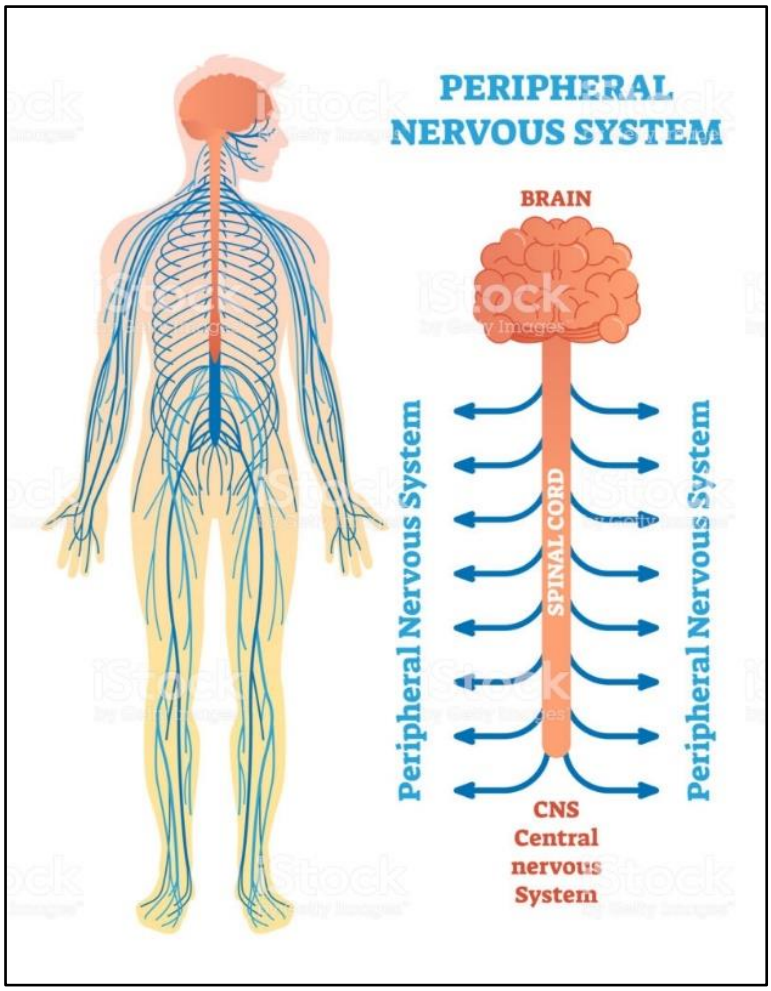
(b) Regulates the heart rate (2)

(c) Is responsible for motor coordination (2)

(8)

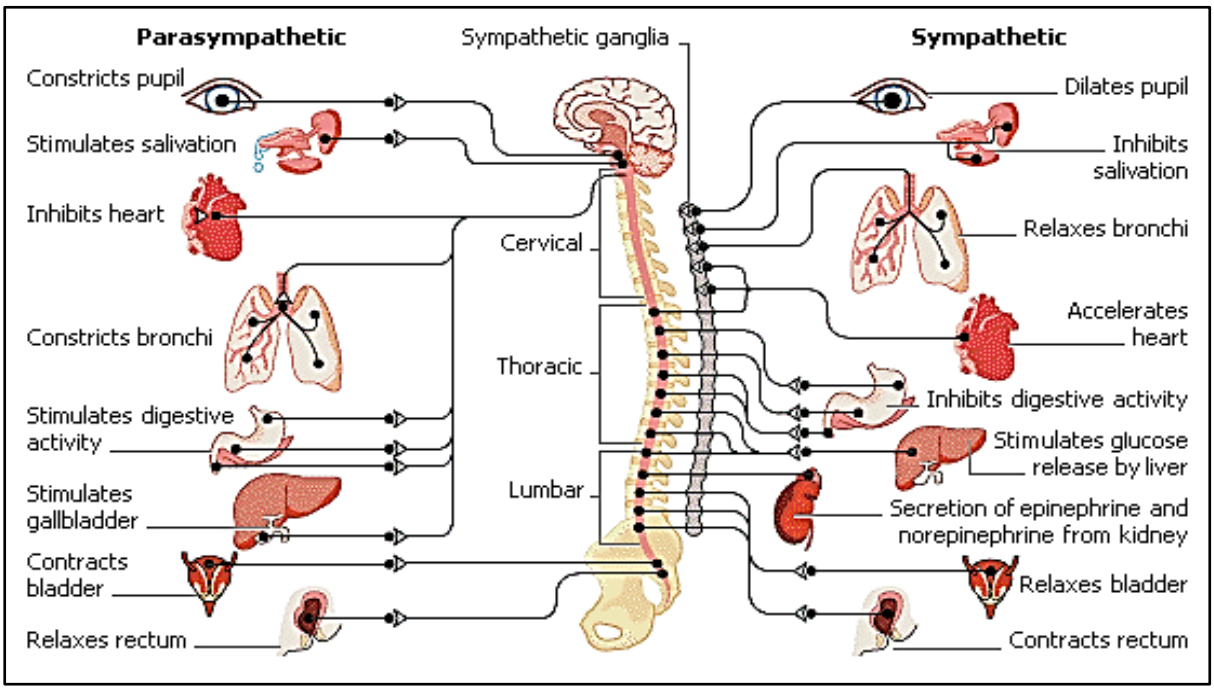
Peripheral nervous system

- The peripheral nervous system (PNS) is all the nervous tissue outside the central nervous system (CNS).
- It is divided into the somatic nervous system and autonomic nervous system and is made of 43 pairs of nerves:
    - 12 pairs of cranial nerves
    - 31 pairs of spinal nerves
- Function: the somatic nervous system receives information from receptors and conveys the information to the CNS.
- It also transmits the impulses from the CNS to effector organs



Autonomic nervous system

- The autonomic nervous system (ANS) controls the heart rate, breathing, digestion and gland functions e.g. salivary glands secreting saliva.
- The autonomic nervous system has TWO branches.
- The sympathetic branch prepares the body for energy-expending, stressful, or emergency situations.
- The parasympathetic branch is active under ordinary, restful conditions.
- The two systems have an opposite effect: one stimulates, the other inhibits i.e. each organ in the body is innervated by the sympathetic nerve and parasympathetic nerve.
- This is known as double innervation.
- E.g. the sympathetic nerve causes the iris to dilate and the parasympathetic nerve causes the iris to constrict.



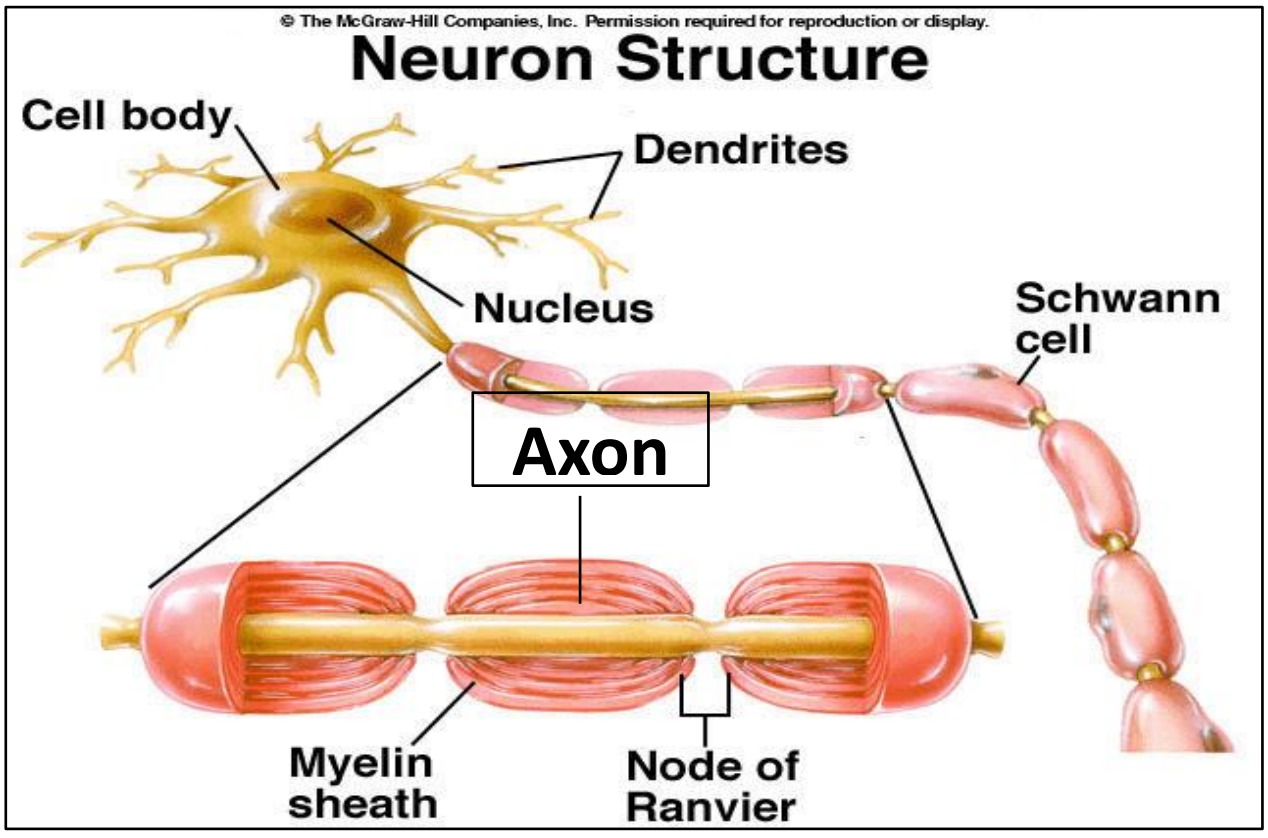
Sympathetic branch	Parasympathetic branch
1. Increases heart rate	1. Decreases heart rate
2. Relaxes walls of the bladder	2. Contracts wall of the bladder
3. Dilates pupils	3. Constricts pupils
4. Constricts many arteries	4. Dilates arteries
5. Increases blood pressure	5. Decreases blood pressure

Neurons – nerve cells

- Neurons are specialized cells which connect the **brain and spinal cord** to all other parts of the body.
- Each neuron has the following parts:

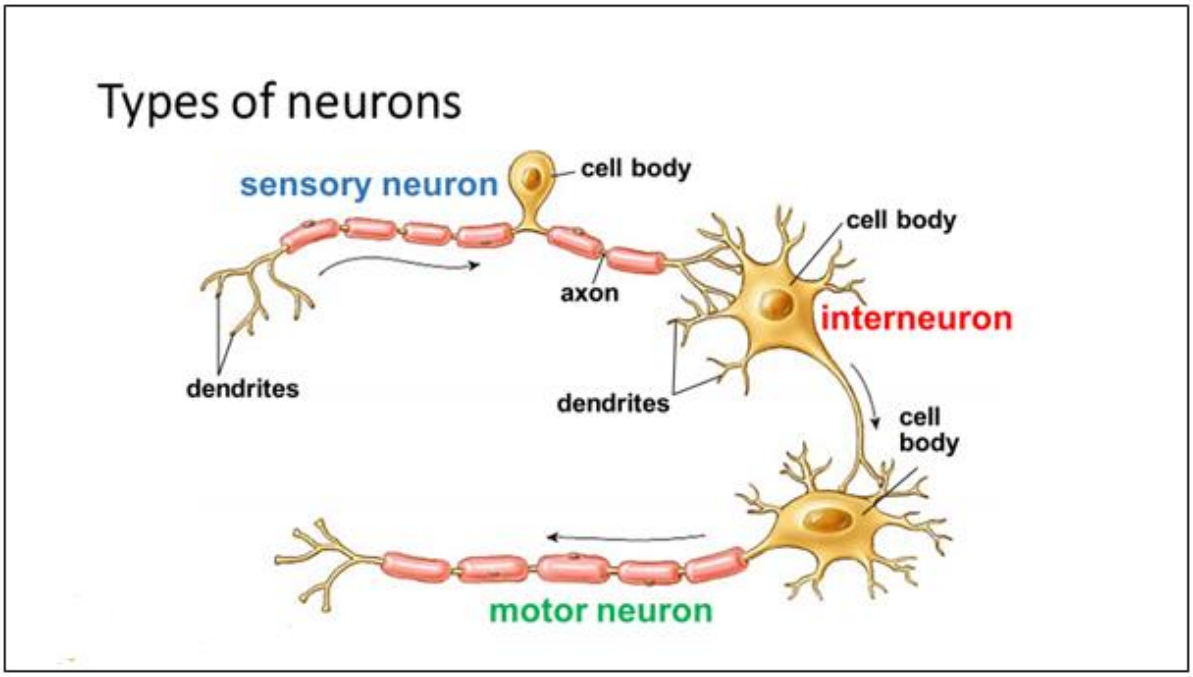
    1. Cell body
    2. Dendrites
    3. Axon

- The **dendrites always carry the impulse to** the cell body and the **axon always carries the impulse away** from the cell body.
- **Axons** and **dendrites** may be **myelinated** i.e. they have a fatty layer wrapped around them, which acts as insulation.
- **Bundles of neurons** form **nerves.**



Types of neurons

- Sensory neurons
  - afferent neurons
  - carry impulses to CNS
  - either unipolar or bipolar
  - sensitive to stimuli in the environment
- Connector/inter neurons
  - receive impulse from sense organs
  - always multipolar
  - integrates or analyses information
  - effects a response
- Motor neurons
  - efferent neurons
  - carry impulses away from CNS
  - always multipolar
  - effect a response



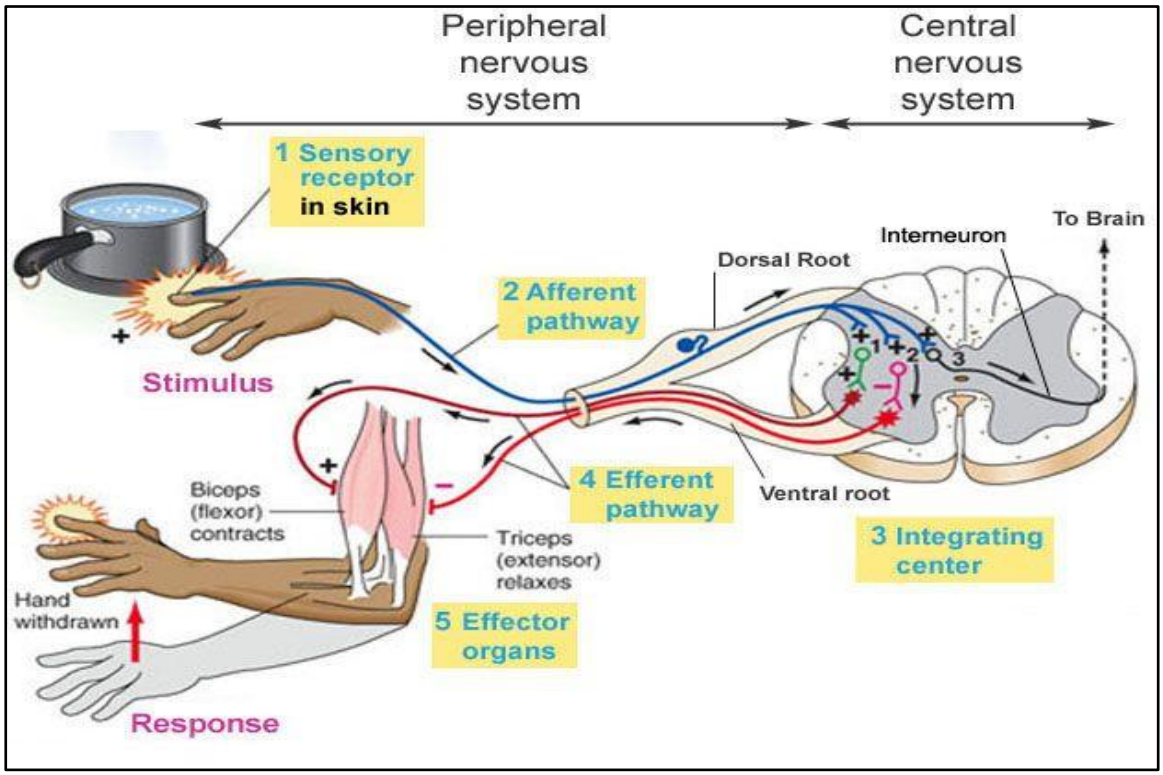
UNIT 7 – Structure and function of a simple reflex arc

A reflex arc

- The simplest form of nervous activity is the reflex action, which are actions you do without thinking.
- The nerve pathway taken in a reflex action is called a **reflex arc.**
- The nervous message goes to the spinal cord, and then a message passes from the spinal cord directly to an effector to give an immediate response.

Significance of a reflex arc

- A reflex action is involuntary or automatic.
- Simple reflexes are inborn safety mechanisms to protect the body by producing immediate responses to the changes in the external and internal environments.



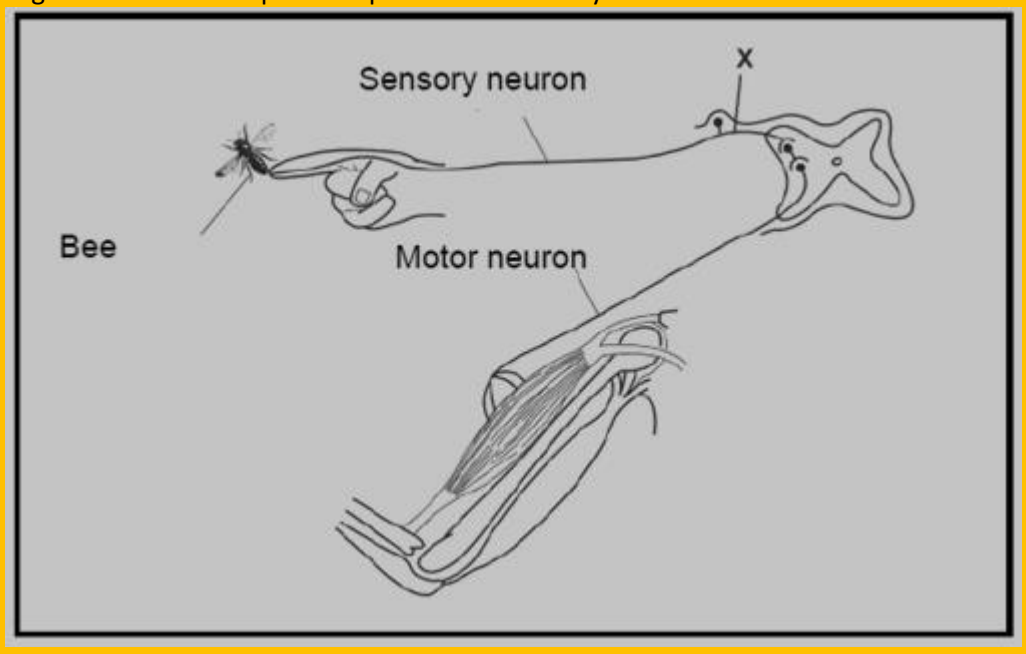
ACTIVITY 2.3

AIM: To enable participants to describe the parts of an reflex arc and explain a reflex action

METHOD: Complete the questions from past papers

GP Prelim P1 2018

1. The diagram below shows part of a person's nervous system that has been cut at X.

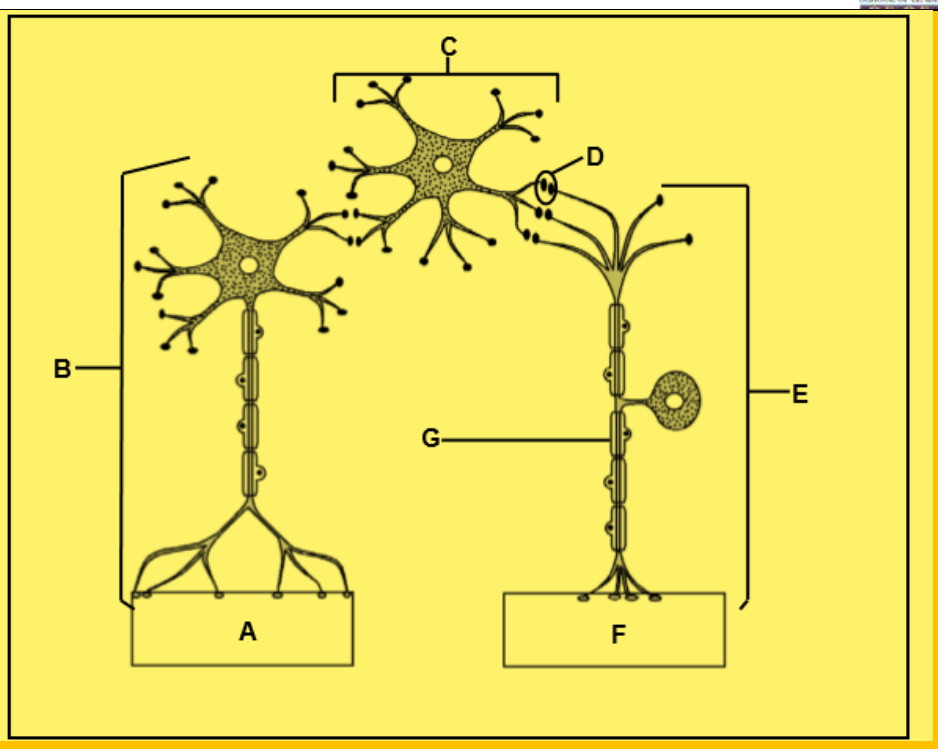


A bee stings the finger, as shown in the diagram above. What are the effects of this sting on the person?

A The person feels no pain and does not move his / her arm away.
B The person feels no pain and moves his / her arm away.
C The person feels pain and does not move his / her arm away.
D The person feels pain and moves his / her arm away.

DBE, June 2018, Paper 1

2. The diagram below represents a possible 'path' followed by an impulse when a person touches a hot plate.



2.1 Name the 'path' represented in the diagram (1)
2.2 Identify the type of neuron represented by:
(a) B (1)
(b) C (1)
(c) E (1)
2.3 Give the LETTER only of the part that represents the:
(a) Receptor (1)
(b) Effector (1)
2.4 Give the LETTER and NAME of the:
(a) Region where the impulse is transmitted chemically (2)
(b) Part that has an insulating function (2)
(10)

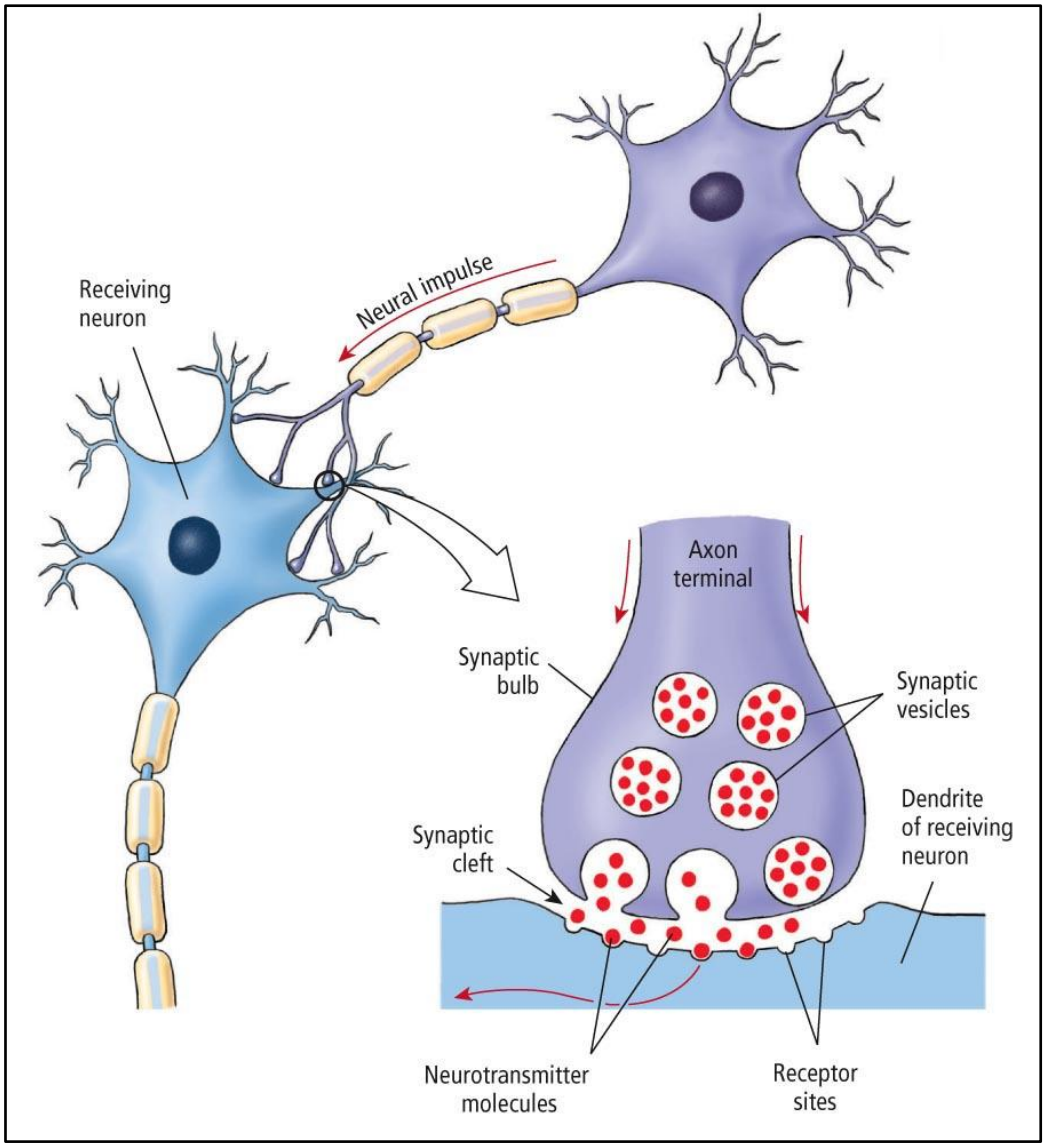
A synapse

- A synapse is the point where an impulse passes from the terminal branch of the axon of the one neuron to the dendrite of the next neuron.
- The neurons NEVER touch each other.
- The gap between the two neurons is called the synaptic gap.
- Chemical neurotransmitters such as acetylcholine/dopamine/serotonin help to transmit the impulse from one neuron to the next across the synaptic gap.

Significance of a synapse

- Ensures that the impulse travels in one direction.
- At the synapse a nerve impulse can either be speeded up or slowed down or blocked.
- Therefore, it enables unnecessary or unimportant background stimuli to be filtered out.

- Channels impulses so that reactions are integrated and become part of learning and memory.



UNIT 8 – Disorders of the CNS

Diseases of the Nervous system

Alzheimer's Disease

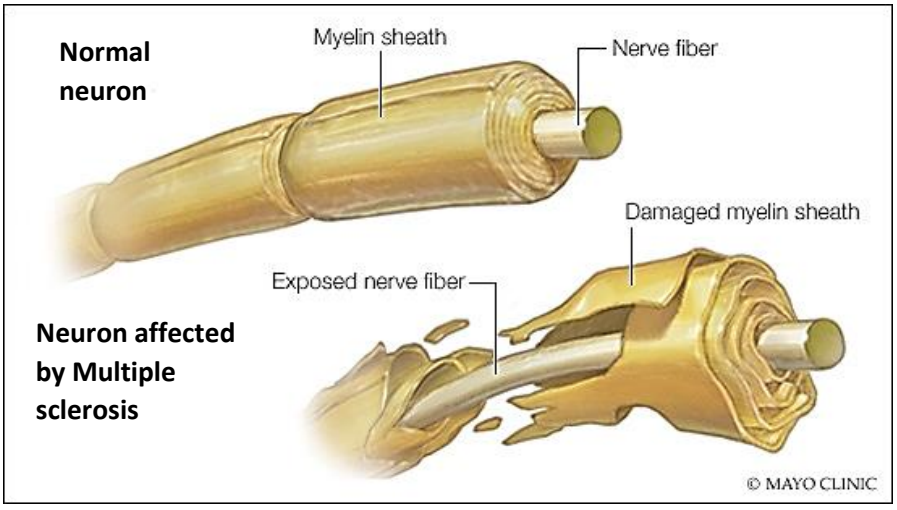
- Alzheimer's disease (AD) is the most common form of dementia.
- Usually affecting people over 65, although some people may develop early-onset AD.
- Characterized by a loss of neurons and synapses in the cortex of the brain, as well as the presence of clumps of proteins (amyloid plaques) and tangled bundles of fibers.
- There is no cure for the disease, which is progressive and eventually leads to death.
- **Cause:** Unknown
- **Symptoms:** The loss of brain function results in

- Slower thinking
- Behaviour changes
- Confusion about events, time and places
- Difficulty recognizing people they know
- Difficulty speaking, swallowing and walking

- **Cure:** None
- **Treatment**:
  - Researchers are trying to find better ways to treat the disease, delay its onset and prevent it from developing.
  - Stem-cell research and therapeutic cloning hold great potential for providing a cure for Alzheimer's disease.

Multiple sclerosis

- Multiple sclerosis (MS) is a progressive, degenerative disorder of the central nervous system (CNS), including the brain, optic nerve and spinal cord.
- MS commonly occurs between the ages of 20 – 40 and affects more women than men.
- Multiple sclerosis means 'many scars', resulting in damage to the axon-coating myelin sheath of nerve cells in communication pathways.
- Scattered patches of demyelination in the pathways make it impossible for messages to move these hard areas.
- **Cause:** Auto-immune disease
- **Symptoms:** MS affects:
  - Movement, feeling and co-ordination and balance
  - Vision, tingling and numbness, muscle weakness and spasms
  - Fatigue
  - Bladder and bowel problems
  - Pain
  - Concentration and memory loss
  - Mood swings
- **Cure:** None
- **Management strategies:**
  - Healthy lifestyle
- Stem-cell research and biologically engineered production of interferons slow down the progress of the disease

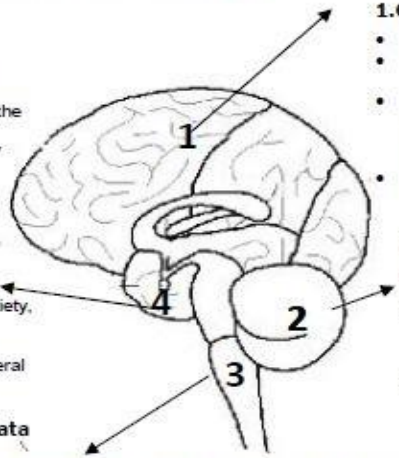


Brain, types of neurons and reflex arc

4. Hypothalamus

Functions:

- Thalamus is situated under the corpus callosum, and the hypothalamus is situated under the thalamus
- Maintenance of homeostasis, by regulating the following:
  - blood pressure
  - heartbeat
  - body temperature
  - water balance
  - hunger, appetite, thirst
  - sleep
- Control of emotions such as anxiety, anger and fear
- It controls the functioning of the hypophysis, which secretes several vitally important hormones



1.Cerebrum

- Functions: Occupies two-thirds of the cranial space
- Contains **motor areas** where all voluntary actions originate
- Contains **sensory areas that interpret nerve impulses from the sense organs so that the sensation of sight, sound, smell, taste and touch can arise**
- Seat of higher mental functions such as memory, intelligence etc.

2.Cerebellum

Functions

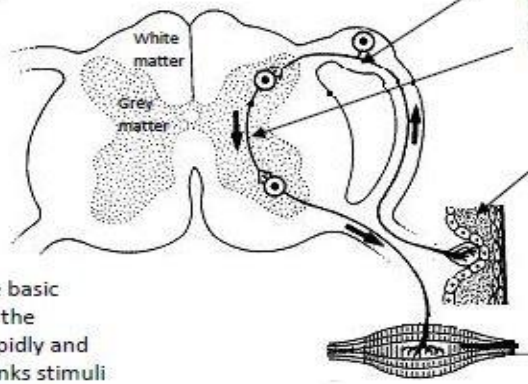
- It is situated below and behind the cerebrum
- It co-ordinates and controls the actions of all voluntary muscles to make smooth and precise movement possible
- It controls the tension in the muscles (muscle tone) to maintain balance and poise

3. Medulla oblongata

Functions:

- Lowest part of the brain stem and is an extension of the spinal cord
- It transmits nerve impulses between the spinal cord and the brain
- Controls autonomic functions, including the following:
  - rate and depth of breathing
  - heartbeat
  - vasomotor activity- widening and narrowing of blood vessels

Diseases affecting the nervous system	
Alzheimer's disease (AD)	progressive mental deterioration that can occur in middle or old age, due to generalized degeneration of the brain.
Multiple sclerosis (MS)	A disorder of the nervous system that is characterised by the breakdown of the myelin sheath of neurons



2. Sensory neuron: carries impulse from the receptor to the CNS

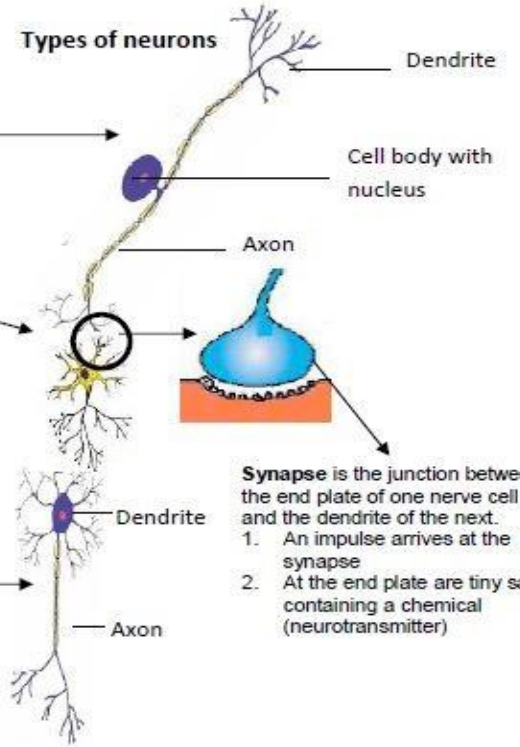
3. Inter neuron: carries impulse from sensory neuron to motor neuron in the spinal cord

1. Receptor: A cell or organ which receives a stimulus and convert it into a impulse

4. Motor neuron: carriers impulse from the central nervous system to the effector

Reflex arc

Reflex arc is the basic working unit of the neurons and rapidly and automatically links stimuli to responses via inter neurons of the central nervous system



Synapse is the junction between the end plate of one nerve cell and the dendrite of the next.

1. An impulse arrives at the synapse
2. At the end plate are tiny sacs containing a chemical (neurotransmitter)

RESOURCES

https://viaafrika.com/free-downloads/

https://www.youtube.com/watch?v=qPix_X-9t7E&t=23s

https://www.britannica.com/science/nervous-system

https://www.dictionary.com/

MODULE SUMMARY

The structure of the brain and reflex arc must be studied with the aid of diagrams. There is practical work listed in CAPS that needs to be performed to enhance teaching and learning.

REFERENCES

- DBE Exam guidelines for learners
- GDE ATP
- 2015-2019 NSC past papers
- 2014-2019 national diagnostic report on learner performance
- Approved grade 12 national textbooks
- 'Mind the Gap'
- Internet
- Gauteng grade 12 Life Sciences Revision booklet

MODULE 3 – THE HUMAN EYE

INTRODUCTION

The body responds to a variety of different stimuli such as light, sound, touch, temperature, pressure, pain and chemicals (taste and smell).

Visual perception starts with the light emitted from or reflected from an object or a scene entering our eyes through the cornea, pupil and lens. The cornea and the lens help to concentrate and project the light onto a photosensitive layer of cells located at the back of the eyeball —the retina. The lens has the additional function of regulating the focus on objects at different distances by making the necessary adjustments. The amount of light that reaches the retina is regulated by changing the size of the pupil, which is an opening between the cornea and the lens delimited by the iris. The retina is responsible for translating the differences in light wavelength (colour), contrast and luminance into a biological signal. This signal is transmitted through the optic nerve and neuronal pathways to the visual processing areas of the brain.

Only one week is allocated on the ATP for the teaching of the human eye. Because the structure and function of the eye has to be taught, it is important to use diagrams for the teaching and learning of this topic. You will also notice that we have included terminology lists as these are crucial for good performance. Please ensure that your learners do regular terminology activities and tests.

The dissection of the eye is listed in CAPS as one of the investigations that need to be performed to enhance teaching and learning and therefore a video clip was also included.

OVERVIEW

This module deals with the human eye. There is a detailed terminology list, followed by the structure and functions of certain parts of the eye, accommodation and the pupillary mechanism and the nature and treatment of visual defects.

SPECIFIC OBJECTIVES

By the end of this session, participants will be able to:

- Draw and label the parts of the eye.
- Describe the functions of the different parts.
- Briefly explain the changes occurring in the eye during accommodation and pupillary reflex.
- Identify and describe the various defects of the eye.
- Illustrate the existence of the blind spot.
- Illustrate the role of binocular vision in depth perception.
- Dissect the eye and identify all the different parts.
- Set questions on the different levels of Bloom's taxonomy.

CONTENT

You will study this module through the following units:

Unit 1: Structure and functions of the parts of the human eye, using a diagram
Unit 2: Binocular vision and its importance
Unit 3: Changes that occur in the human eye during accommodation and pupillary reflex, using diagrams
Unit 4: The nature and treatment of visual defects, using diagrams

UNIT 1 - Structure and functions of the parts of the human eye, using a diagram

Terminology & definitions:

Biological term	Description
Accommodation	The ability to change the focal length of the object by changing the convex shape of the lens to assist with focussing on a near or distant object.
Astigmatism	Uneven the curvature of the lens or cornea resulting in distorted images
Effectors	Are muscles or gland that respond to the message from the nervous system (brain and spinal cord)
Hypermetropia	Long-sightedness caused by a lens that cannot become rounded enough to refract light, so the image falls behind the retina.
Myopia	Short-sightedness caused by a cornea that is too rounded, so the image falls short of the retina.
Neuron	One nerve cel.l
Photoreceptors	Specialized receptors to receive the stimulus of light and convert it to an impulse. Photoreceptors in the retina of the eye are called rod and cone cells.
Receptors	Are located in the sense organs. They convert a stimulus into an impulse.
Refraction	To bend light – refraction takes place when light passes through a lens that is bent by a **convex** [**()**] shape or a **concave** [**)(**] shape
Stereoscopic vision	Also known as binocular vision - to see with **two** eyes, where each eye will produce a slightly different image of the same object and allows us to judge distance, depth and size of an object.

The human body responds to a variety of stimuli, such as light, sound, touch, temperature, pressure, pain and chemicals (like taste and smell).

The eye (sight) and the ear (hearing and balance) are part of the **peripheral nervous system.**

Activity 3.1

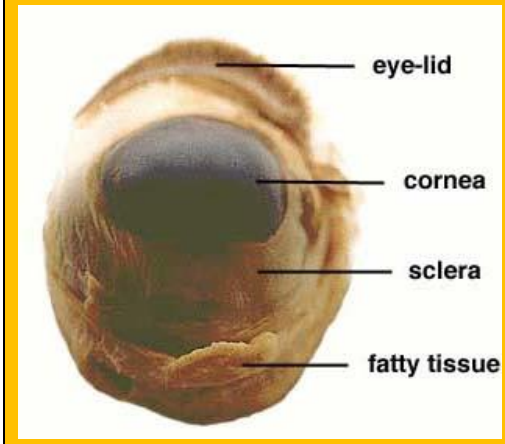
AIM: investigation of the structures of the eye
METHOD: Dissection of a sheep's eye.
Follow the instructions on the practical worksheet

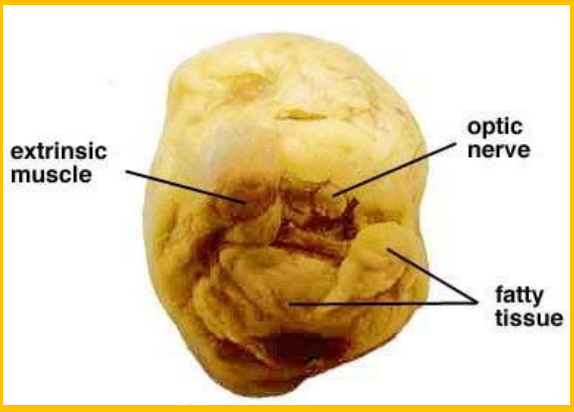
Sheep Eye Dissection

The anatomy of the human eye can be better shown and understood by the actual dissection of an eye. One eye of choice for dissection, that closely resembles the human eye, is that of the sheep. Sheep eyes are removed at the time the animal is slaughtered and then preserved for later use. Differences between the two eye types will be mentioned as the dissection is completed.

Material needed:

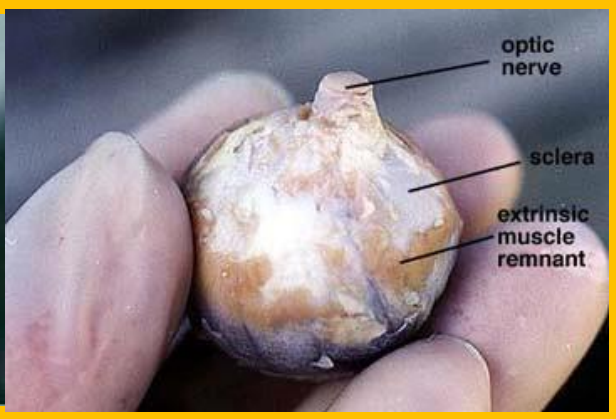
- Sheep eye
- Dissecting pan
- Surgeons gloves
- Scissors
- Single edge razor blade
- Probe
- Forceps
- Paper towels
- Notebook and pencil for recording information about the eye as it is dissected.





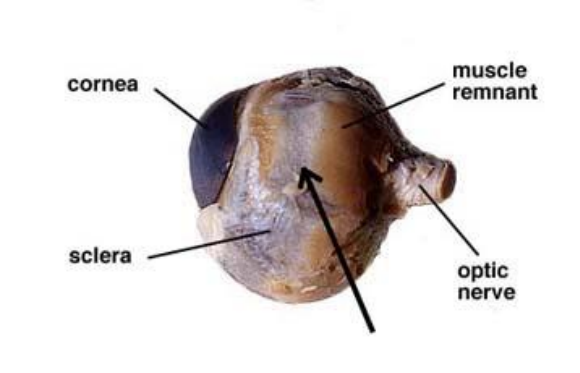
Step 1:
Wash the sheep eye in running water to remove the preservative fluid. Dry the eye with paper towelling. Examine the front of the eye and locate the eye-lid, cornea, sclera (white of the eye) and fatty tissue. Examine the back of the eye and find extrinsic muscle bundles, fatty tissue and the optic nerve. The four extrinsic muscles (humans have six) move the sheep eye while the fatty tissue

cushions the eye. If the optic nerve is not visible use the probe to move the fatty tissue around until the nerve is exposed.



Step 2:

Use your scissors to cut away the eye-lid, muscle and fatty tissue from both the front and rear surfaces of the eye. Be careful not to remove the optic nerve. Cut along the surface of the sclera until all the tissue is removed and your specimen looks similar to the photographs you see here. The sclera is very tough so you do not need to worry about cutting into this layer of the eye. When you have finished removing the tissue surrounding the eye identify the sclera, cornea, optic nerve, and the remaining extrinsic muscle remnants. The cloudy nature of the cornea is caused by the death of this tissue. It is transparent in the living state.

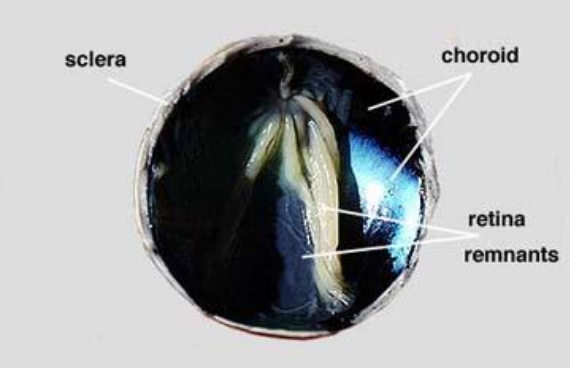


Step 3:

Place your eye specimen in the dissection pan. Turn the specimen so the cornea is on the left and the optic nerve is on your right. Select a place to make an incision of the sclera midway between the cornea and optic nerve. Use the point of a very sharp razor blade to make a small cut through the sclera. Fluid should ooze out of the eyeball when you have cut deeply enough. You will be reminded of how tough the sclera is when you make this cut.

Step 4:
Insert the point of the scissors into the slit made by the razor blade and cut the sclera with a shallow snipping motion. Turn the eye as you continue the cutting action. Cut the sclera all the way around the ball of the eye. You will need to support the eye in the palm of your hand while you complete this step of the dissection. Do not be surprised if some fluid from the eye oozes from the slit as you make this cut.

Step 5:
Arrange the two hemispheres of the eye as you see in the left photograph. Observe the semi-fluid vitreous humour that fills the central cavity of the eye. It is transparent in the living eye but might be cloudy in the preserved specimen. The vitreous humour along with the aqueous humour helps to maintain the shape of the eye. The retina lines the posterior cavity of the eye and extends forward to the ciliary body. Use your probe to lift and pull the retina back from the underlying choroid layer. See the photograph on the right side above. Notice that the retina is only firmly attached to the choroid at one place. This region is the optic disc or blind spot. Here the nerve fibres leave the retina and form the optic nerve which is directly behind the blind spot.

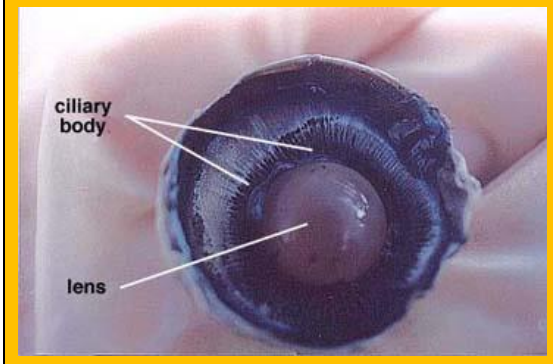


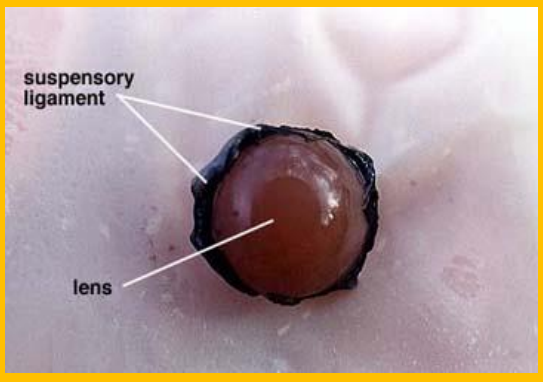
Step 6:

Use your forceps to peel the retina away from the underlying choroid coat. The retina should remain attached at the blind spot. The choroid coat is dark and relatively thin. Use your forceps or probe to gently separate the choroid from the outer sclera. Verify that the eye has three distinct layers, the retina, choroid and sclera. See left photograph above. The choroid contains an extensive network of blood vessels that bring nourishment and oxygen to itself and the other two layers. The dark colour, caused by pigments, absorbs light so that it is not reflected around inside of the eye. In just a moment you will see that the choroid extends forward to the ciliary body.

Step 7:

Use your forceps and probe to remove the vitreous humour from the anterior hemisphere of the eye. See right photograph above. This will take some time and effort as the semi-fluid material separates easily. It helps to turn the hemisphere on edge and to use a scrapping motion to remove the fluid. Try not to disturb the lens that is just below the vitreous humour.



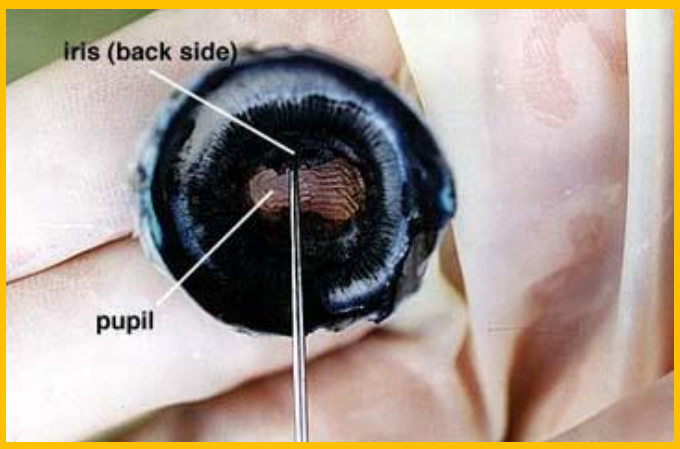


Step 8:

Removal of the vitreous humour reveals the lens, ciliary body and suspensory ligaments. In the normal condition the lens is transparent except, when as a condition of aging, the lens turns cloudy. The cloudy condition, called cataract, prevents or reduces the amount of light reaching the retina. Cataract can be treated by removing the lens and replacing it with a stiff artificial one. The normal lens is convex shaped and somewhat elastic. It is held in place by the suspensory ligaments that in turn join with the smooth muscle containing ciliary body. When the smooth muscle fibres contract the resulting force flattens the lens and the degree of bending of the light rays is reduced. Relaxation of the smooth muscle results in a thickening of the lens and a greater bending of the rays of light.

Step 9:

Remove the lens by pulling it free from its attachments. Note the shape of the lens, its stiffness and opaqueness. Suspensory ligaments may also be visible along the edge of the lens.



Step 10:

When the lens is removed, an opening, allowing light to enter the eye is seen. This opening, the pupil is located in the center of the iris. Two muscle layers of the iris regulate the size of the pupil. One layer increases the pupil size with decreasing light intensity and the other layer reduces pupil size with increasing light intensity. Note the oblong shape of the sheep pupil; in humans the pupil is circular. The back side of the iris can be seen just above the pointer in the photograph. Part of the iris is being lifted by the pointer but the iris continues all the way around the pupil opening.

A second cavity or space is present between the iris and the cornea. This space is filled with a second semi-liquid fluid, the aqueous humour. This fluid, like the vitreous humour helps to maintain the shape of the eye. Glaucoma is a condition where the fluid pressure becomes too high causing eye damage.

Step 11:

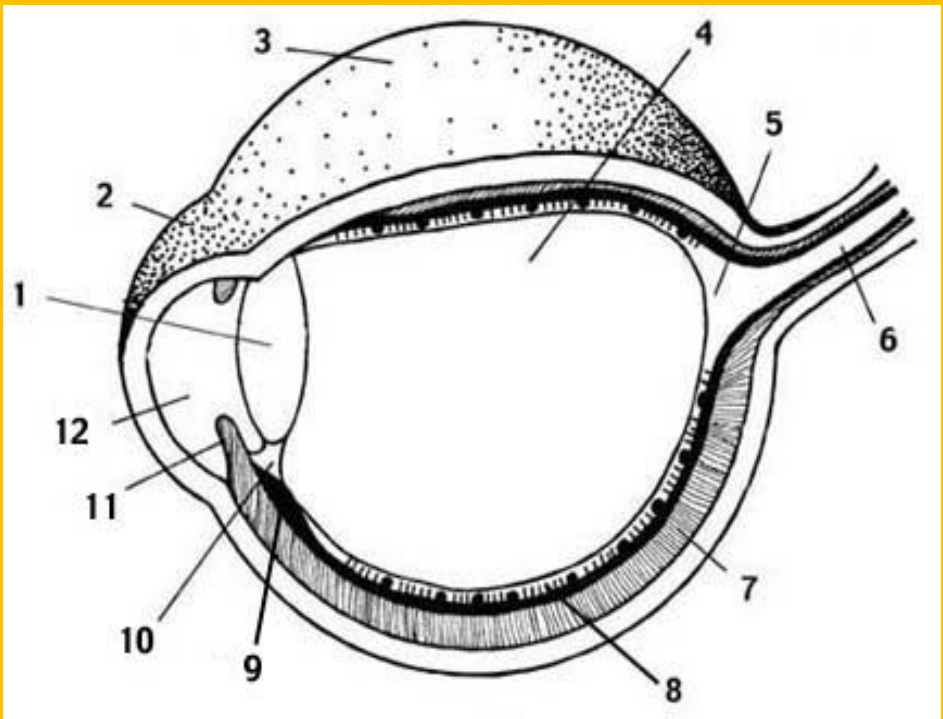
Remove the cornea from the front eye hemisphere. Use a razor blade to puncture a small slit at the boundary between the cornea and sclera. Then insert the scissors into the slip and cut all the way around the cornea to remove it. Notice the thickness of the cornea. How does it compare to the thickness of the sclera? Carefully observe the front side of the iris and pupil. Which structure of the

eye would be just behind the pupil opening?

Worksheet:

Answer the following questions based on the practical.

1. Label the diagram and explain each structure.



Label	Structure
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	

2. Sketch and label the external structure of the eyeball.

3. State the function of the fatty tissue, muscle and optic nerve.

.....

.....

.....

.....

4. A survey was conducted to investigate visual defects among 40 Grade 12, learners. The class has equal number of boys and girls. Look at the data collected then answer the questions that follow.

Visual defects of 40 learners:

	Short sightedness	Long sightedness	Astigmatism	Cataracts	No visual defects
Boys	5	2	3	0	15
Girls	4	1	2	0	14

4.1 Which part of the brain interprets eyesight?

.....

4.2 On the same set of axes, draw a bar graph for girls and boys to show the number of people with each visual defect.

4.3 Do you expect these numbers to change with time? Give a reason for your answer.

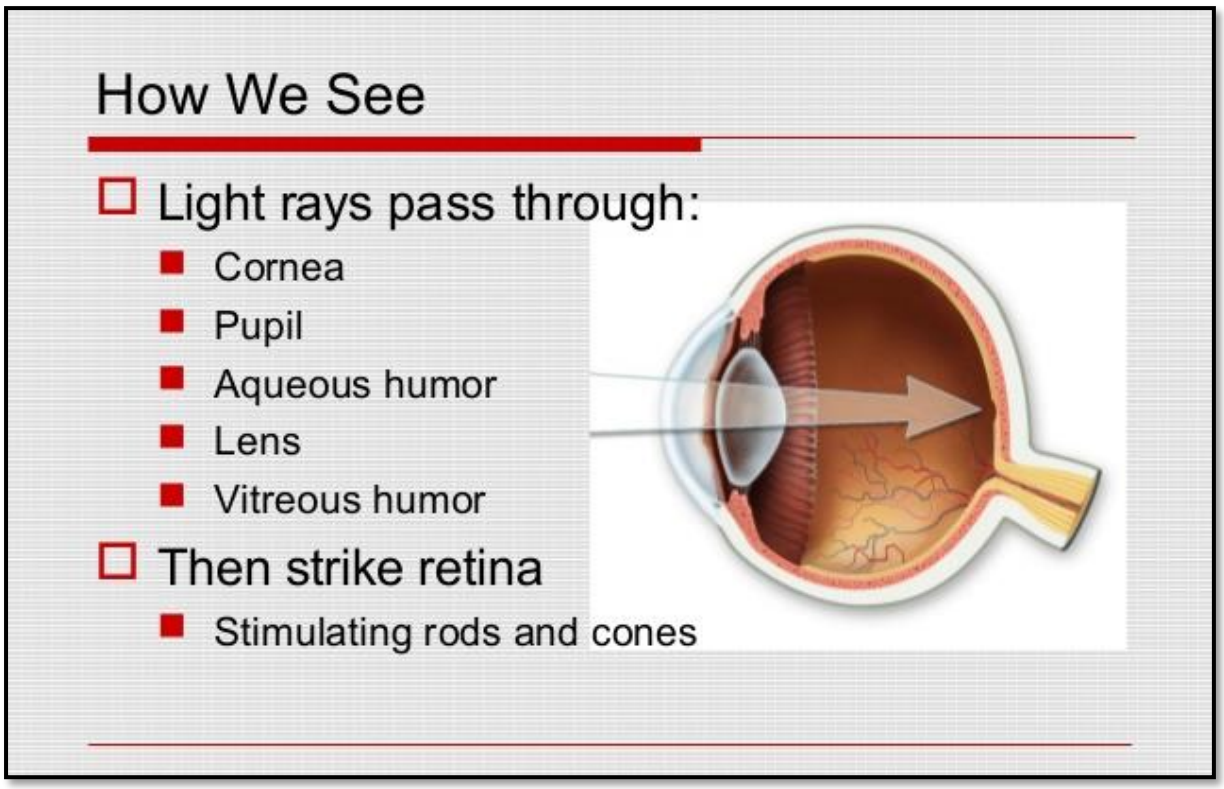
……

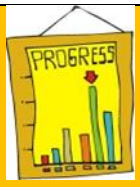
4.4 How could you improve reliability of your investigation?

……

Functioning of the eye – path of light:

- Light rays pass from an object to the eye, through the transparent **convex cornea, aqueous humour**, the biconvex **lens** and **vitreous humour**.
- As the light rays pass through the curved surfaces of the cornea and the lens, **light is refracted** (bent).
- The lens refracts the light rays and forms an **inverted** (upside-down) image on the retina, bringing the image into focus by making fine adjustments.
- The **rod and cone cells** (photoreceptors) are stimulated by the light rays and convert the stimulus into impulses.
- These impulses are transmitted along the **optic nerve** across the optic chiasma (cross-over) so that impulses enter the **lower visual centres** on opposite sides of the mid-brain at the **occipital lobes**.
- The upright images are interpreted for size, shape and colour of the object that was seen.

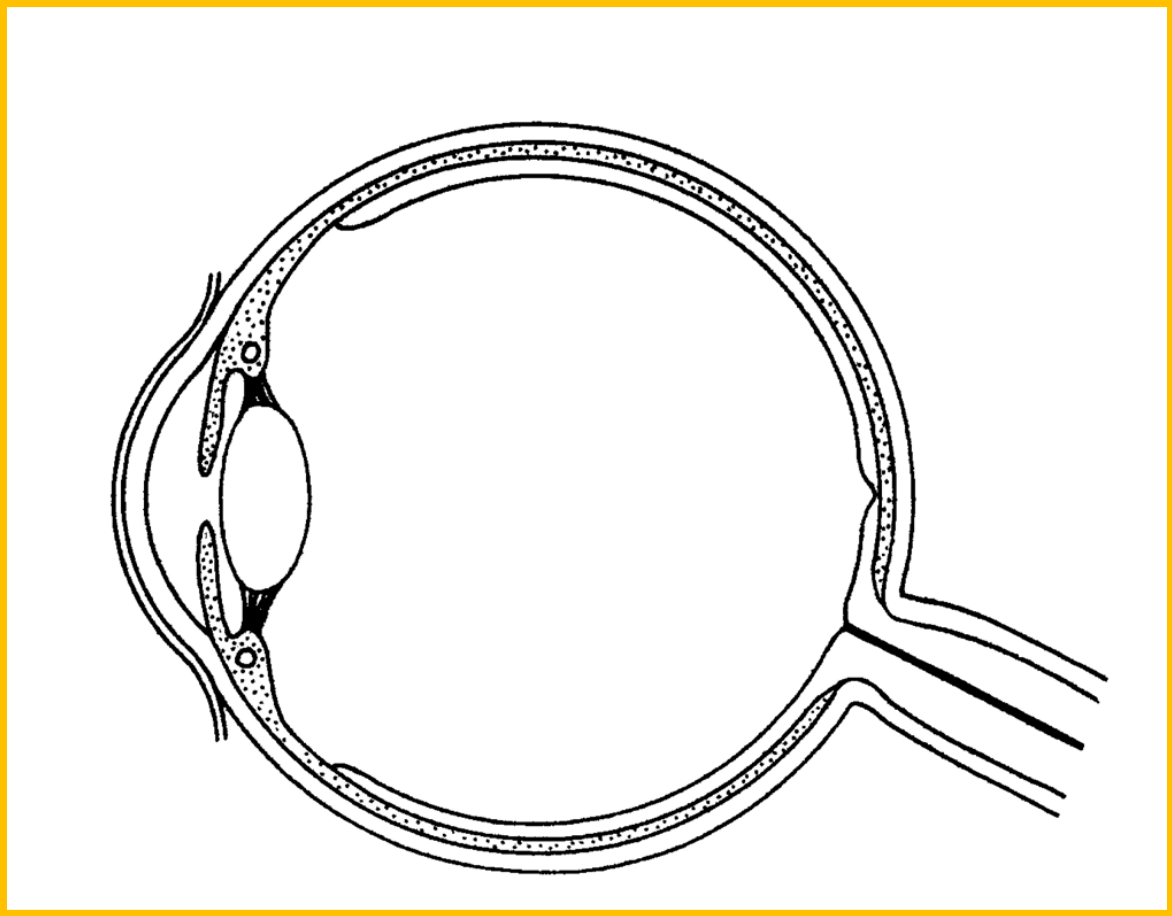




Activity 3.2

AIM: To identify and label the different parts of the human eye

METHOD: Label the parts of the eye



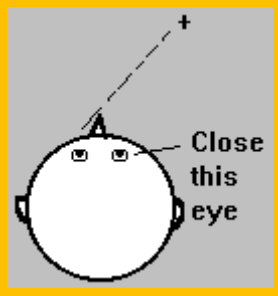
Activity 3.3

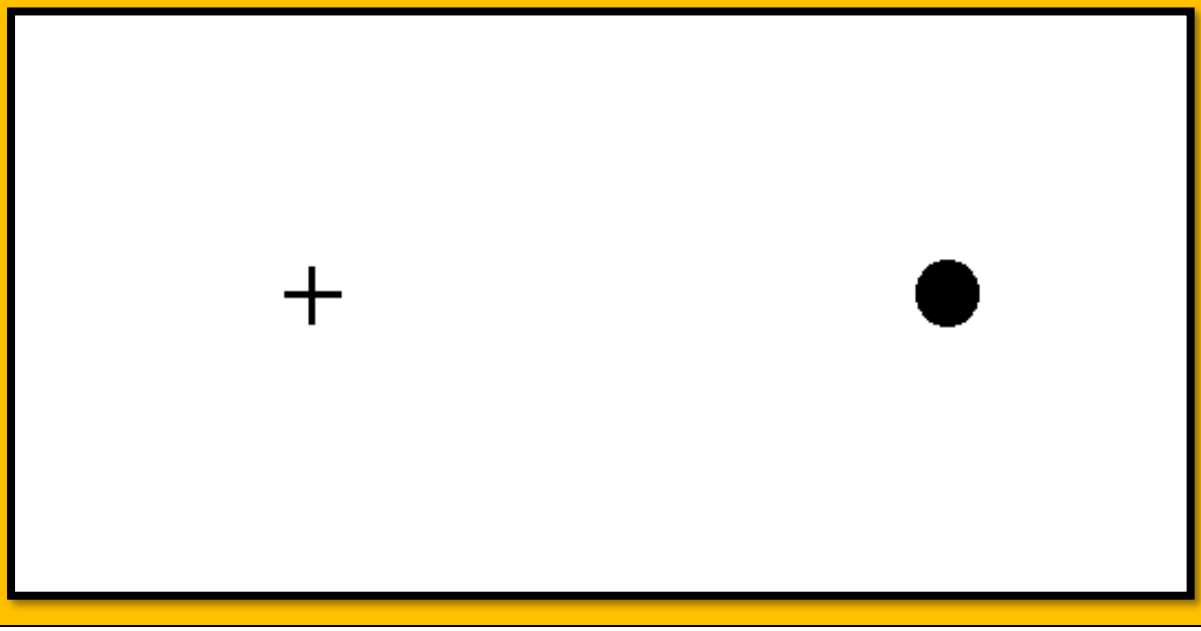
AIM: to be able to practically demonstrate that the eye has a blind spot

METHOD: EACH participant performs the investigation by following the steps below.

How to demonstrate that the eye has a blind spot

1. Close your right eye.
2. Hold the image about 50 cm away.
3. With your left eye, look at the +. Slowly bring the image (or move your head) closer while looking at the +. At a certain distance, the dot will disappear from sight...this is when the dot falls on the blind spot of your retina.
4. Reverse the process. Close your left eye and look at the dot with your right eye. Move the image slowly closer to you and the + should disappear.





UNIT 2 - Binocular vision and its importance

Binocular vision means to see with TWO eyes (bi = two). We can focus on one object with both eyes increasing the field of vision. A sharp image falls on each retina. The image from the left eye is always slightly different to the image from the right eye. The two images join in the brain (occipital lobes) and results in **stereoscopic vision,** which allows us to **judge distance, depth and size of objects**.

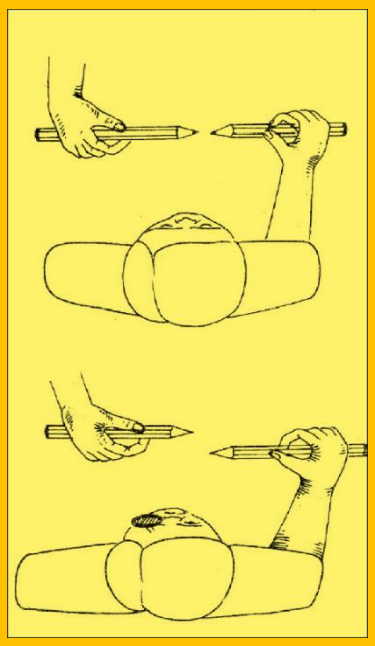
Activity 3.4

AIM: to be able to practically demonstrate depth perception by the eye
METHOD: EACH participant performs the investigation by following the steps below.

Depth perception is the ability to judge objects that are nearer or farther than others.

- To demonstrate the difference of using one vs. two eyes to judge depth, hold the ends of a pencil, one in each hand.
- Hold them either vertically or horizontally facing each other at arms-length from your body.
- With one eye closed, try to touch the end of the pencils together.
- Now try with two eyes: it should be much easier. This is because each eye looks at the image from a different angle.

This experiment can also be done with your fingers, but pencils make the effect a bit more dramatic.

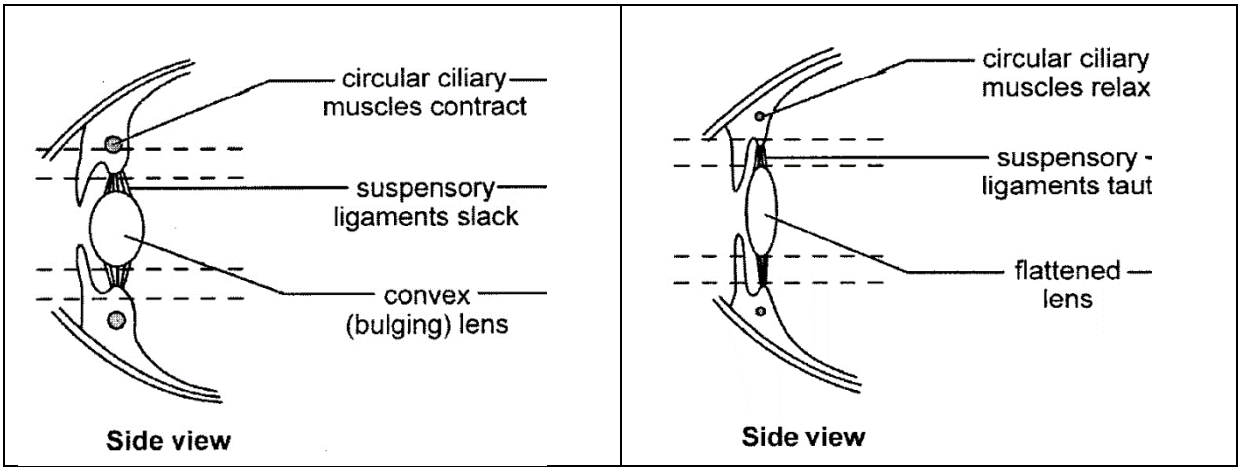


UNIT 3 - Changes that occur in the human eye during accommodation and pupillary reflex, using

Accommodation:

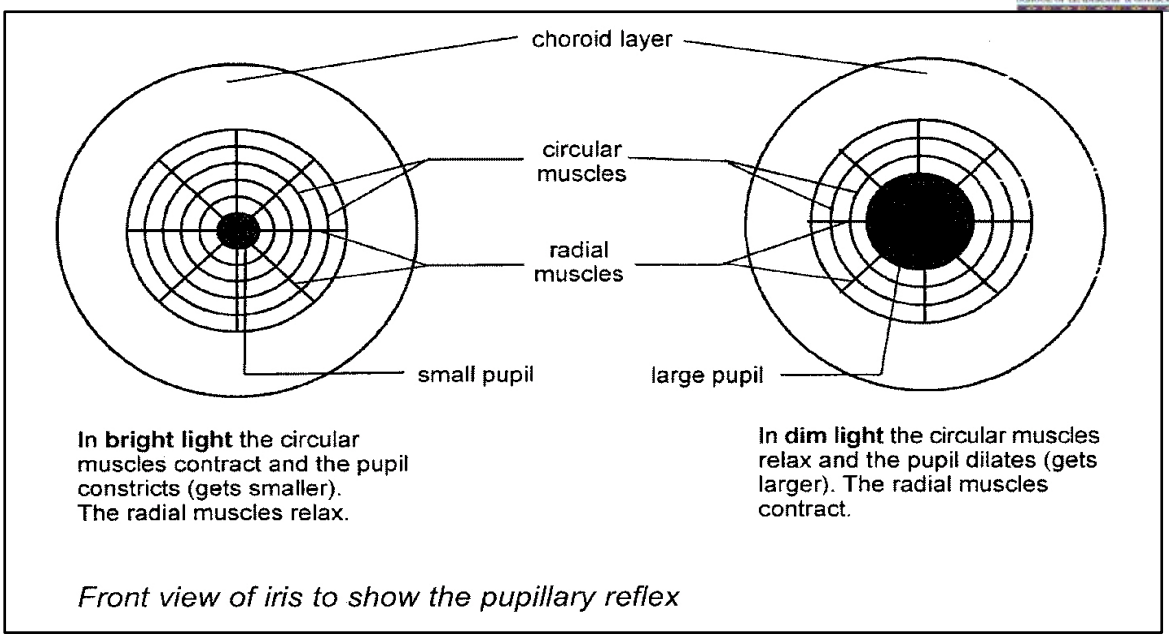
The eyes can change the **convex curve** of the lens and therefore the focal length. This process is termed **accommodation**.

Near vision (round lens) (an object is **closer than 6 metres)**	**Distant vision (long lens)** (an object is **further than 6 metres)**
1. Ciliary muscles **contract**	1. Ciliary muscles **relax**
2. Suspensory ligaments to **slacken**	2. Suspensory ligaments tighten (become taut)
3. Tension on the lens **decreases**	3. Tension on the lens **increases**
4. Lens becomes **more convex** and **rounded**	4. Lens becomes **less convex** and **flatter**
5. Light rays are **more** refracted (bent)	5. Light rays are **less** refracted (bent)
6. Light rays are focussed onto the retina (yellow spot)	6. Light rays are focussed onto the retina (yellow spot)



Pupillary mechanism / Pupillary reflex action:

The pupillary mechanism is a reflex action regulated by the Autonomic Nervous System, to prevent excess light from passing into the eye at one time. Excess light will cause damage to the retina and the photoreceptors (rod and cone cells). The **iris** functions to control the amount of light that enters the eye by controlling the size of the pupil. The **circular and radial** muscle fibres in the iris regulate the size of the **pupil.**

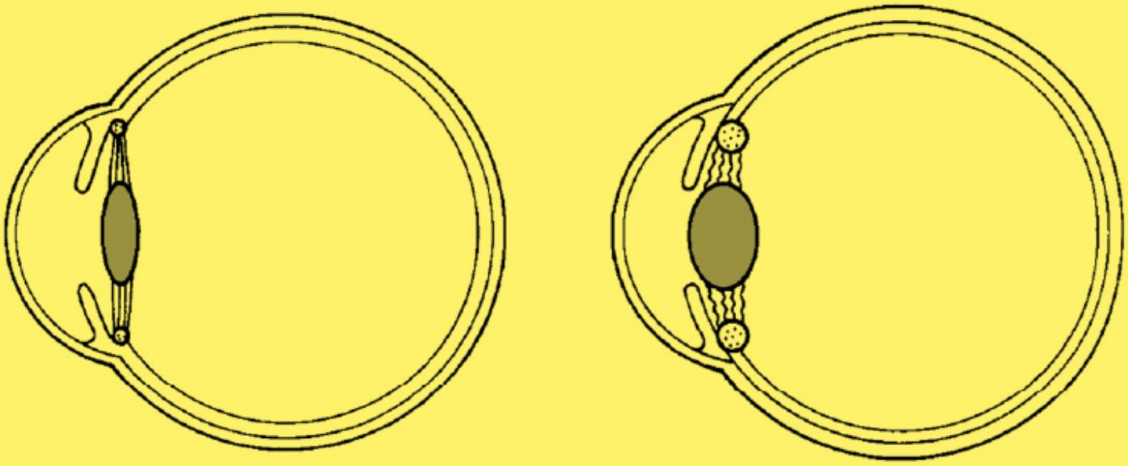


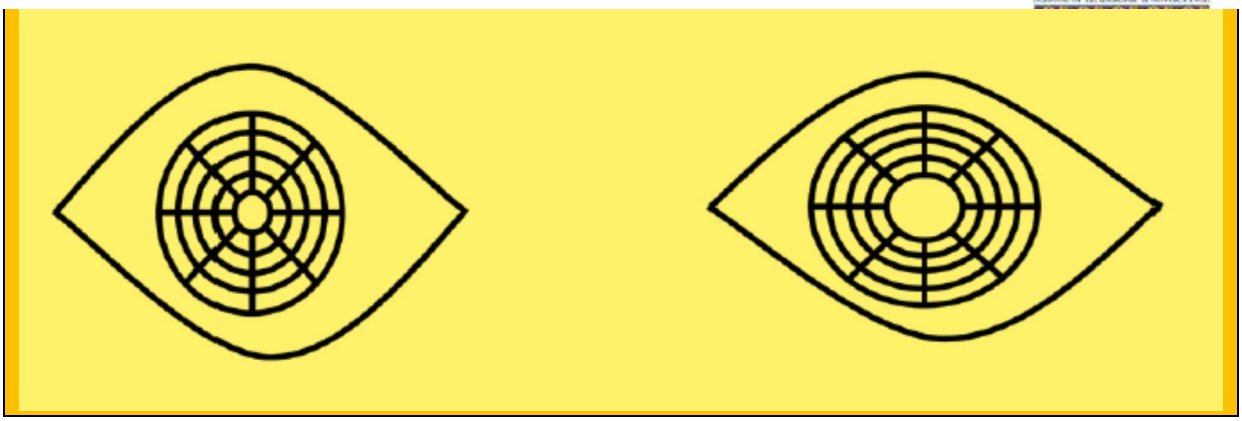
Front view of iris to show the pupillary reflex

Activity 3.5

AIM: To be able to identify the processes in the eye that ensures proper functioning; labelling the parts involved and discussing the processes

METHOD: Using diagrams to explain the functioning of the eye with a partner.





Visual defects:

Short-sightedness

This is also called **myopia** or near-sightedness. It is a refractive defect where the image focuses **in front** of the retina because the cornea is **too rounded**. Distant objects are seen as blurred. Myopia may be **genetic,** or it may result when people place regular strain on their eyes by working on computers or in a job where they are required to focus closely on objects, like microscope work. Glasses and contact lenses that are concave [**)(**] are prescribed to **reduce refraction**. **Refractive surgery** may be an option, where the cornea is reshaped to flatten it and so decrease refraction. This causes the image to be focused onto the retina.

Long-sightedness

This is also called **hypermetropia** or farsightedness. This is a refractive defect where the image focuses **behind** the retina. The person will not be able to see objects when they are close by, as the images are blurred. This condition is caused by the following:

- An eyeball that is **too short** (genetic): This is corrected with prescription eyeglasses or contact lenses which assist to increase refraction of light by using convex lenses [**()**].
- When the lens **cannot become round** enough during accommodation: This may be genetic, or it may be as a result of aging. As one ages, the ciliary muscles are unable to contract enough to cause the lens to become rounder. Eyeglasses or contact lenses are prescribed to assist to increase refraction of light by using convex lenses [**()**].
- A cornea that is **too flat**: Refractive surgery is performed in extreme cases.

Distant vision
(long-sightedness)

eye ball shape is too rounded

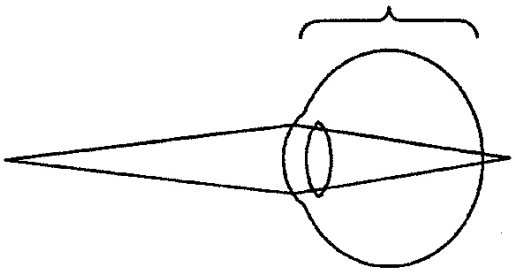
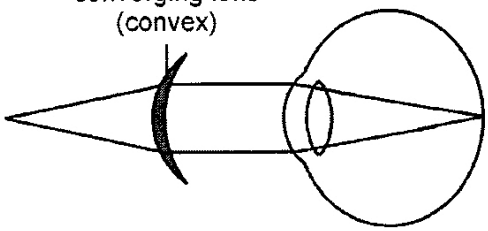


image falls past focal point for near objects

converging lens
(convex)



long-sightedness can be corrected by using a converging lens

Near vision
(near-sightedness)

eye ball shape is longer than normal

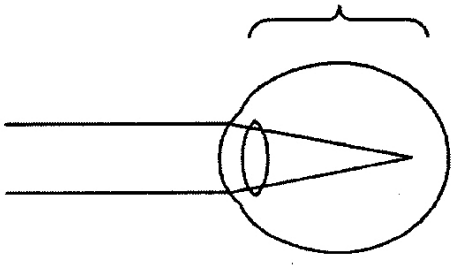
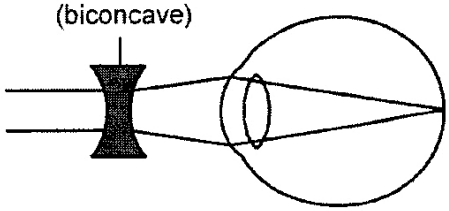


image falls short of focal point for distant objects

diverging lens
(biconcave)



near-sightedness can be corrected by using a diverging lens

UNIT 4 - The nature and treatment of visual defects, using diagrams

Astigmatism

This is an optical defect that results in blurred vision. It is caused by an **irregular curvature** of the cornea or the lens so the eye has **different focal points** that occur in different planes. Glasses and hard contact lenses correct the irregular focal points.

Cataracts

This is the **clouding** of the lens when the lens cortex liquefies to form a milky white fluid. Cataracts progress over time and may result from long-term exposure to ultra-violet light, radiation, diabetes, hypertension, old age and physical trauma. Genetically, people may have a predisposition to cataracts. Cataracts must be removed surgically. Extra-capsular surgery (ECCE) can be used to remove the lens, leaving the lens capsule intact. Intra-capsular surgery (ICCE) is used when both the lens and capsule are removed. The lens is replaced with a **plastic lens** in both cases.

Nature and treatment of Visual defects

Long – sightedness (Hypermetropia)
Nature
May be caused by:
- Too rounded eyeball
- Inability of the lens to become more convex.

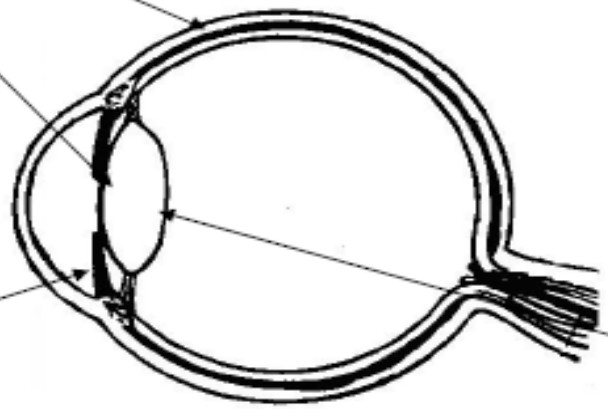
Image for near objects is blurred.
The best image falls behind the retina.
Yet they can see the objects that are far clearly.
Treatment
It can be corrected by wearing glasses with a convex lens.

Short – sightedness (Myopia)
Nature:
May be caused by
- Too long eyeball
- Inability of the lens to become flat (less convex)

Image for far objects is blurred.
The best image falls in front of the retina.

Treatment
It can be corrected by wearing glasses with a

concave lens



Astigmatisation.

Nature:
This occurs when the **front surface** of the **cornea** is **curved more in one direction than the other.**
Symptoms:
- Distortion or blurring of the image
- Headache and fatigue
- Squinting and eye discomfort or irritation

Treatment:
If the degree of astigmatisation is slight and there are no sight problems, then corrective lenses may not be needed.
If the degree is great enough to cause eye strain, headache, or distortion of vision, prescription lenses will be needed for clear vision.

Cataracts

Nature:
For reasons not clearly understood, the **clear, transparent lens** of the eye **sometimes** becomes **cloudy and opaque.**

Treatment:
Removal of the **lens surgically** and **replacing** it with a **synthetic lens(intraocular implant).**

Activity 3.6

AIM: To be able to set questions on the four levels of cognitive demand, using Bloom's taxonomy.

METHOD: Using the data/information given, the participant must set questions that could be used in informal or formal assessment.

- In an investigation a learner was asked to thread a cotton thread through the 'eye' (hole) of a needle 10 times with both eyes open and then with only the right eye open. This was done under the same light intensity and at a distance of 30 cm from the eyes. The results are recorded in the table below.

	TIME TAKEN TO THREAD THE NEEDLE in seconds(s)	
Attempts	**Two eyes open**	**Only right eye open**
1	**12**	**38**
2	**12**	**35**
3	**10**	**37**
4	**11**	**36**
5	**9**	**34**
6	**9**	**33**
7	**10**	**30**
8	**8**	**31**
9	**7**	**29**
10	**7**	**28**

Activity:

Set 5 questions incorporating all four cognitive levels on the investigation on the eye.

RESOURCES

https://www.youtube.com/user/crashcourse

http://cssmith.co/wp-content/uploads/2017/10/cow-eye-labeled-diagram-human-reproductive-system-anatomy-charts-blank.jpg

http://ellenjmchenry.com/store/wp-content/uploads/2016/11/Paper-eye-model-1.pdf

MODULE SUMMARY

This module covers all the requirements for the DBE NSC exams w.r.t. the topic: The human eye. It is very important to be able to identify parts of the human eye on a **diagram** and to provide the functions of that part. The same applies to accommodation and the pupillary mechanism. The nature and treatment of visual defects must also be covered.

REFERENCES

- DBE Exam guidelines for learners
- GDE ATP
- 2015-2019 NSC past papers
- 2014-2019 national diagnostic report on learner performance
- Approved grade 12 national textbooks
- Internet
- Gauteng grade 12 Life Sciences Revision booklet

MODULE 4 – THE HUMAN EAR

INTRODUCTION

The body responds to a variety of different stimuli such as light, sound, touch, temperature, pressure, pain and chemicals (taste and smell).

The Human ear is the organ of hearing and equilibrium that detects and analyses sound by transduction (or the conversion of sound waves into electrochemical impulses) and maintains the sense of balance (equilibrium).

Only one week is allocated on the ATP for the teaching of the human ear. Because the structure and function of the ear has to be taught, it is important to use diagrams for the teaching and learning of this topic. You will also notice that we have included terminology lists as these are crucial for good performance. Please ensure that your learners do regular terminology activities and tests. The role of the ear in maintaining balance is also very important and examiners often set questions on this topic.

OVERVIEW

This module deals with the human ear. There is a detailed terminology list, followed by the structure and functions of certain parts of the ear, the functioning of the human ear in hearing (include the role of the organ of Corti without details of its structure) and balance (include the role of maculae and cristae without details of their structure) and the cause and treatment of middle ear infections (Use of grommets) and deafness (Use of hearing aids and cochlear implants).

SPECIFIC OBJECTIVES

By the end of this session, participants will be able to:

- Draw and label the parts of the ear.
- Describe the functions of the different parts.
- Briefly describe the path of sound as it travels through the ear.
- Briefly describe the functioning of the maculae and cristae and their role in balance.
- Briefly describe the nature and treatment of hearing defects.

CONTENT

You will study this module through the following units:

Unit 1: Structure of the human ear and the functions of the different parts, using a diagram
Unit 2: Functioning of the human ear in hearing and balance
Unit 3: The nature and treatment of hearing defects

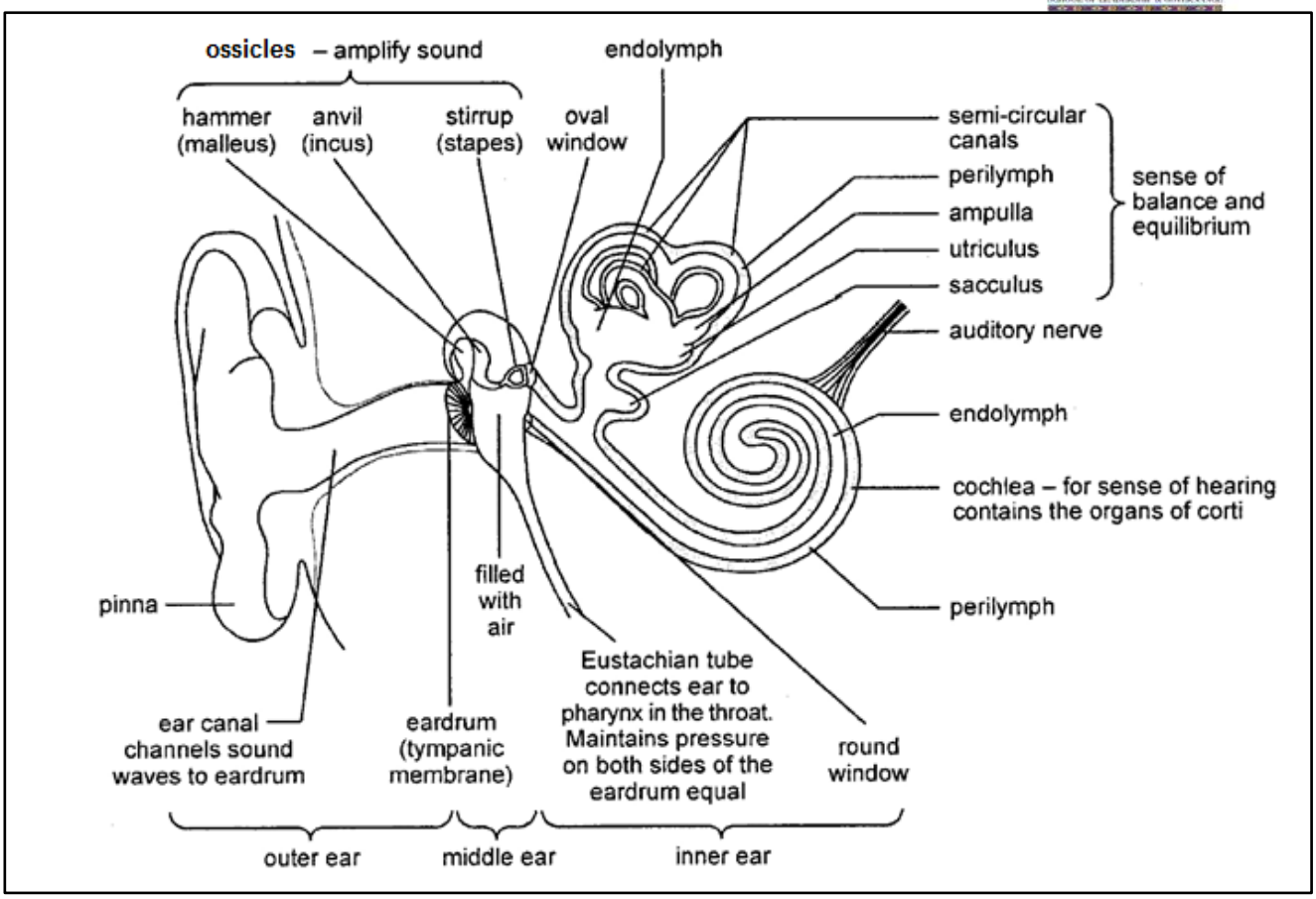
UNIT 1 - Structure of the human ear and the functions of the different parts, using a diagram

Terminology & definitions:

Biological term	Description
Auditory Canal	The open passage through which sound waves travel to the middle ear.
Auditory Nerve	Bundle of nerve cells that carry signals from the sensory fibres to the brain.
Cochlea	Coiled, fluid-filled structure of the inner ear that contains hair cells called cilia. Cilia sway in response to sound waves, transmitting signals toward the brain.
Eardrum	A taut, circular piece of skin that vibrates when hit by sound waves.
Eustachian Tube	The passageway that connects the ear to the back of the nose to maintain equal air pressure on both sides of the eardrum.
Mechanoreceptors	The Organs of Corti are receptors located in the cochlea of the ear, which are stimulated by sound waves and convert the sound waves into impulses.
Ossicles	Three little bones called the hammer, anvil and stirrup located in the middle ear and that function to amplify sound.
Otis media	Inflammation and infection of the middle ear which causes pressure on the eardrum.
Pinna	The outer portion of the external ear: sound travels through the outer ear to the ear canal.
Semi-circular Canals	Fluid-filled structures in the inner ear that detect movement and function as balance organs.

The Human Ear:

The ears are the sense organs for **hearing**. **Mechanoreceptors** in the ear are stimulated by sound waves, which are converted to impulses. The impulses are transmitted via sensory neurons to the auditory centre in the **cerebral cortex** of the brain where they are interpreted. The ears are also the organs for **balance and equilibrium**. These impulses are transmitted via sensory neurons to the **cerebellum** where they are interpreted to ensure balance and equilibrium.

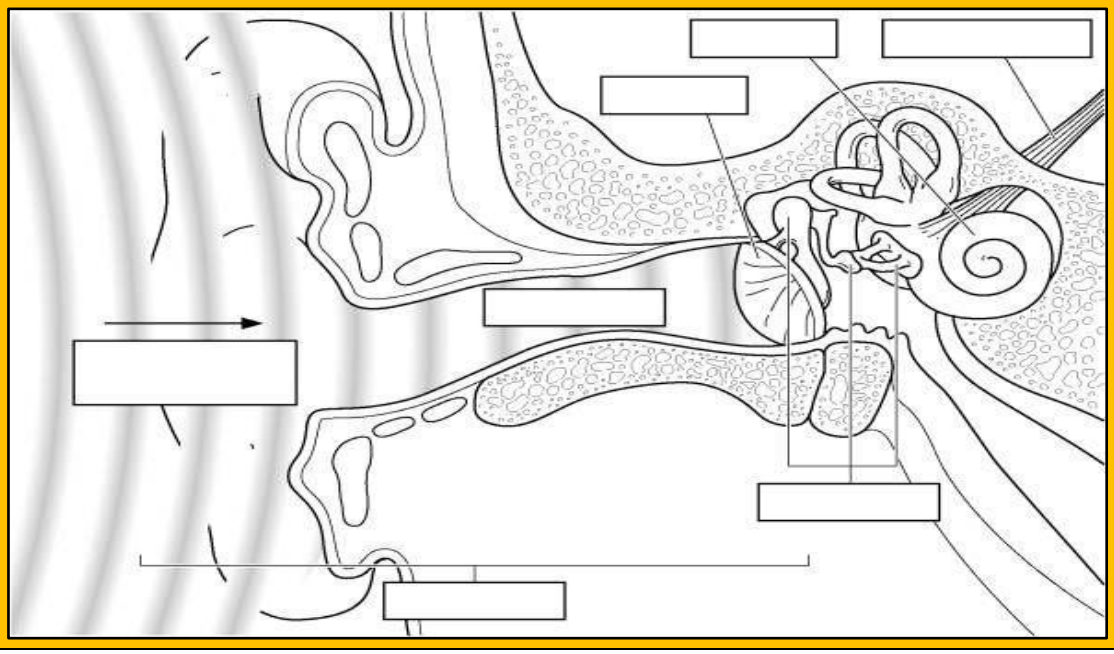

ossicles – amplify sound
hammer (malleus)
anvil (incus)
stirrup (stapes)
oval window
endolymph
semi-circular canals
perilymph
ampulla
utriculus
sacculus
sense of balance and equilibrium
auditory nerve
endolymph
cochlea – for sense of hearing contains the organs of corti
perilymph
pinna
filled with air
Eustachian tube connects ear to pharynx in the throat. Maintains pressure on both sides of the eardrum equal
round window
ear canal channels sound waves to eardrum
eardrum (tympanic membrane)
outer ear
middle ear
inner ear

Activity 4.1

AIM: To identify and label the different parts of the ear

METHOD: Complete the spaces provided

Fill in the labels of the parts of the ear



UNIT 2 - Functioning of the human ear in hearing and balance

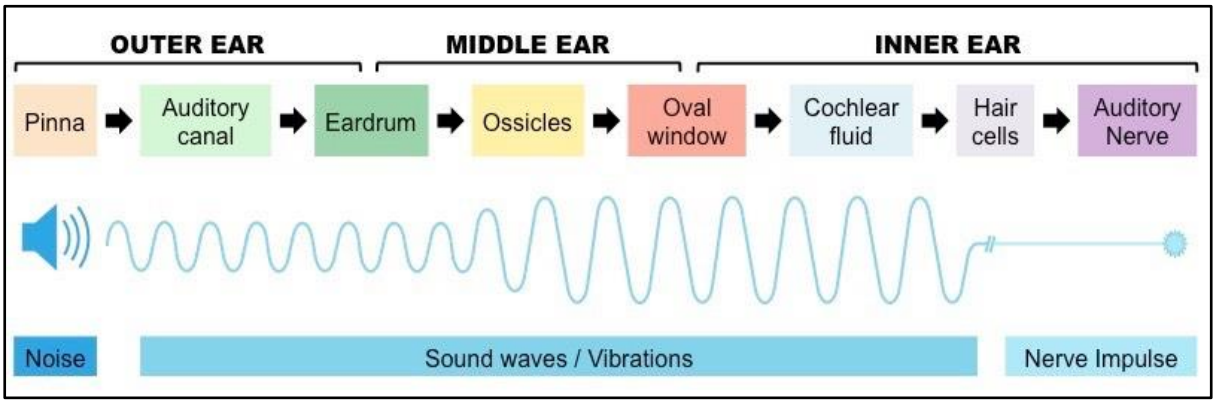
Functioning of the human ear - path of sound:

Sound waves move from the vibrating source (for example, a person talking or a car driving past) in horizontal waves. Humans hear sounds with a vibration frequency of between 16 and 20 000 Hz.

Part of ear	Function during hearing process
Pinna	Traps the sound waves and directs them into the auditory canal
Tympanic membrane (ear drum)	Vibrates to the frequency of the sound waves and transmits the vibration to the ossicles in the middle ear
Ossicles	• The **three ossicles** (the hammer, anvil and stirrup) **amplify** the vibrations • The stirrup passes the vibration through the

Part of ear	Function during hearing process
	oval window, into the inner ear
Oval window	Vibrates and causes pressure wave movements in the liquid of the **perilymph** in the inner ear to the **endolymph** inside the **cochlea**
Cochlea	These vibrations cause the sensory cells in the **Organ of Corti** (the mechanoreceptors) to brush or bend against the membranes converting the stimulus into an **impulse**
Auditory nerve	Transmits the impulse to the cerebrum where the sensation of sound is perceived and interpreted
Round window	**Excess vibrations** are passed out through the **round window**, to prevent pressure and echoes

The pathway of sound through the ear:

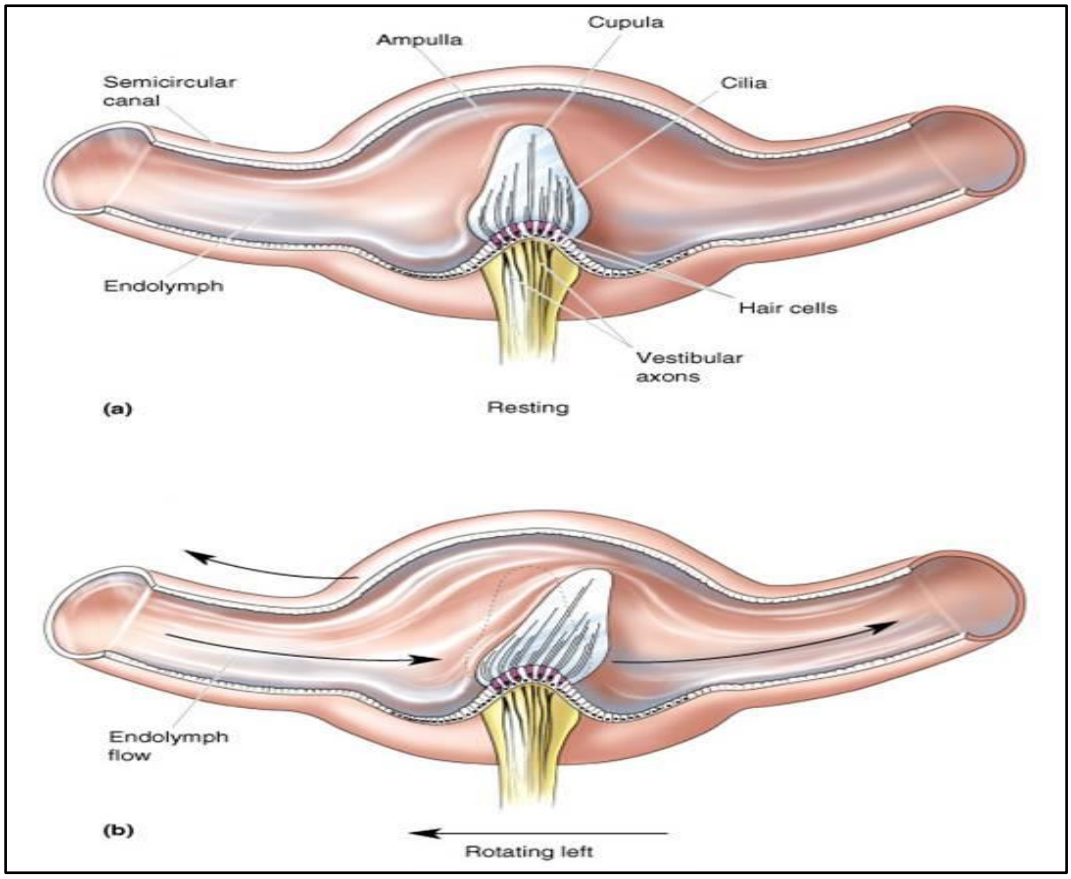


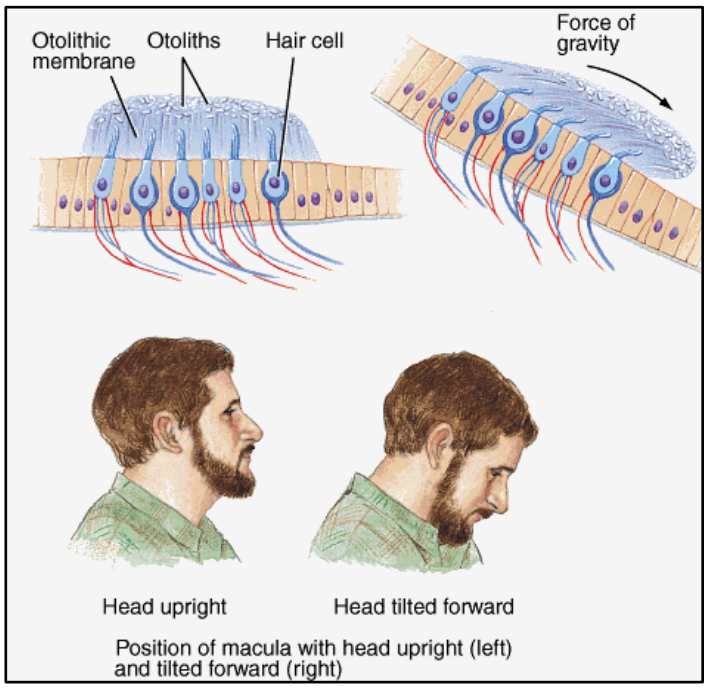
Balance and equilibrium:

The human ear is responsible for maintaining balance.

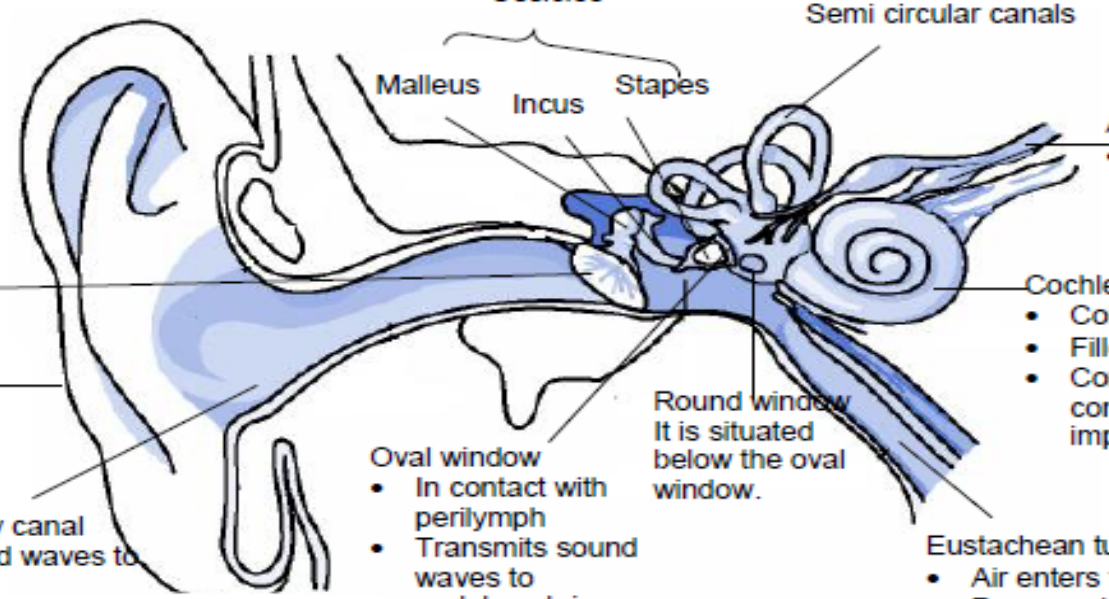
- The semi-circular canals each have a swelling called the **ampulla.** The ampulla contains fine sensory hair cells called **crista**. When there is a change in speed or direction, the cristae are stimulated and a nerve impulse is discharged. This impulse is transmitted along the auditory nerve to the **cerebellum** where it is interpreted. The cerebellum will send impulses to the muscles, to restore balance.

- The **sacculus and utriculus** contain sensory hair cells called **maculae**. When the head position changes, the **pull of gravity** stimulates the maculae, which convert the stimulus into an impulse, transmitted along the auditory nerve to the **cerebellum** where it is interpreted. The cerebellum will send impulses to the muscles, to restore balance.


Ampulla
Cupula
Semicircular canal
Cilia
Endolymph
Hair cells
Vestibular axons
(a)
Resting
Endolymph flow
(b)
Rotating left


Otolithic membrane
Otoliths
Hair cell
Force of gravity
Head upright
Head tilted forward
Position of macula with head upright (left) and tilted forward (right)

EAR



Tympanum (ear drum)
- Sound waves make it vibrate.
- It transmits sound waves to the middle

Pinna
- Made of cartilage
- Directs sound waves to ear drum

Ear canal / auditory canal
- Transmits sound waves to the ear drum

Oval window
- In contact with perilymph
- Transmits sound waves to endolymph in cochlea

Round window
It is situated below the oval window.

Auditory nerve
- Transmits impulses to the auditory center in the brain

Cochlea
- Coiled tube with cochlea duct
- Filled with endolymph
- Contains the organ of Corti which converts sound waves into nerve impulses

Eustachean tube
- Air enters the middle ear from throat
- Pressure behind the ear drum is equalized with atmospheric pressure

Hearing:
- Sound waves in the air are received by the pinnae and directed into auditory canal.
- The tympanic membrane vibrates and transmits the vibrations to the ossicles in the middle ear.
- The ossicles amplify the vibrations and carry them via the middle ear to the membrane of the oval window
- The membrane vibrates and causes pressure waves in the perilymph of the scala vestibule.
- The waves travel along the scala vestibule causing the vestibular membrane to vibrate.
- This produces waves in the endolymph of the scala media, causing basilar membrane to vibrate.
- These vibrations cause the hair cells in the organ of corti to stimulated and nerve impulses are generated.
- Nerve impulses are conducted via cochlear nerve and finally thr auditory nerve to the cerebral cortex of the brain, where the sesation of hearing is produced.

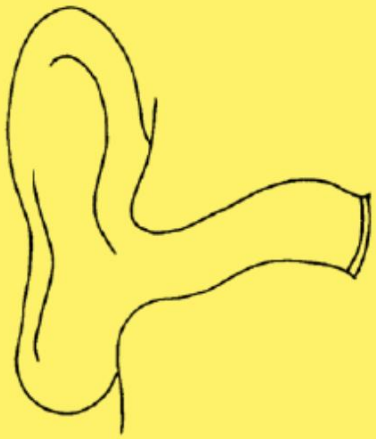
Balance
- Sudden changes in speed and direction causes the endolymph within the semicircular canals to move.
- The movement of the fluid stimulates the cristae in the ampullae – situated at the base of the semi circular canal.
- When the direction of the head changes, gravitational pull stimulates maculae – in the sacculus and utriculus
- Within the cristae and maculae the stimuli is convoerted to impulses
- These impulses are sent to the brain by the vestibular branch of the auditory nerve to the

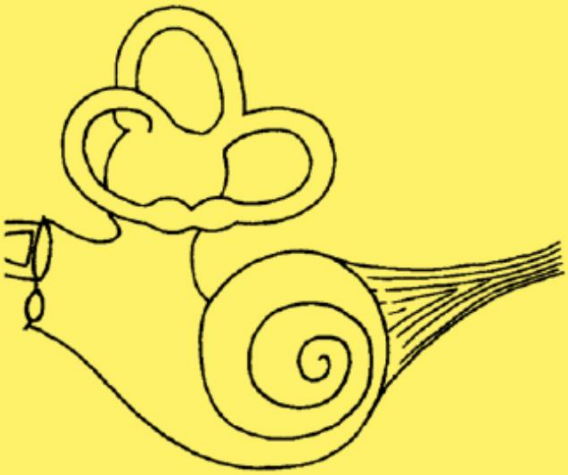
Activity 4.2

AIM: to be able to identify, label and give the functions of different parts of the ear.

METHOD: Annotated diagrams

Label structures and write function next to structure:





UNIT 3 - The nature and treatment of hearing defects

Hearing defects:

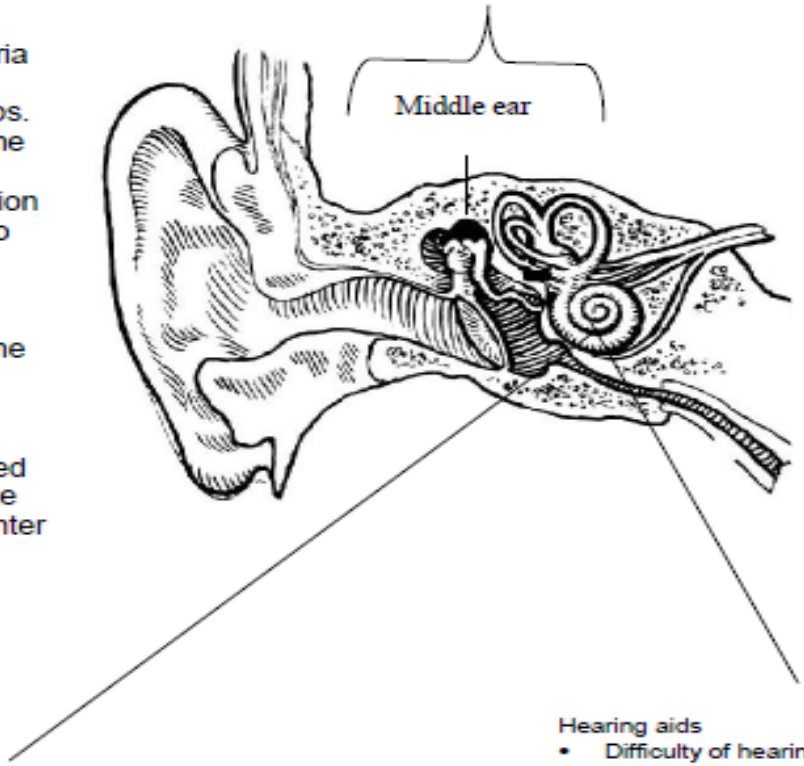
Hearing defect:	Causes:	Treatment:
Middle ear infection (called **otitis media)**	Middle ear becomes infected with bacteria. Pressure builds up (pus and excess fluid) in the middle ear behind the ear drum, causing **extreme pain.**	• inserting grommets (allows excess fluid to drain from middle ear) • antibiotics
Deafness ('hearing impairment', 'hard of hearing' or 'deafness')	• Injury to parts of the ear, nerves or parts of the brain. • Hardened wax collected in the auditory canal • Hardening of ear tissue like around ossicles	• Hearing aids (amplify sounds) • Cochlear implants (stimulates the auditory nerves with an electronic field, inside the cochlea)

Middle ear infections:

- Caused by viruses and bacteria that cause common cold, influenza, measles and mumps.
- They cause inflammation of the middle ear.
- The fluid caused by the infection makes the eustachean tube to be swollen, inflamed and clogged.
- Increasing pressure on either side of the ear drum – ear ache

Treatment:

- Successful treatment with medication
- Grommets are sometimes used to bypass the eustachean tube and allow air to continuosly enter the middle ear.



Deafness

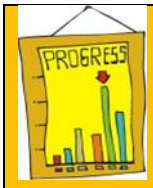
- People hard who have difficulty hearing are said to experience hearing loss or hard of hearing or are hearing impaired.
- Causes of hearing loss:
  - It is due the fluid in the middle ear
  - Injury to the parts of the ear,
  - Ageing process or
  - Nerves and parts of the brain
- Not all the cases of hearing loss can be treated.
- Treatment:
  - Medication
  - Drainage of the middle ear
  - Hearing aids
  - Cochlea implants

Cochlear implants

- Some people are hard of hearing or deaf
- Cochlear implants (bionic ear) are implanted into their ears.
- It is an electrical device
- They work by directly stimulating any functioning auditory nerve inside the cochlea with an electric field

Hearing aids

- Difficulty of hearing may be caused by damage to the hairs in the cochlea.
- Which may be due to diseases, ageing, or injury from noise, or certain medicine.
- In such cases, hearing aids may help in amplifying the sound for a person affected to communicate and participate fully in daily activities.
- A Hearing aid has three parts:
  - Microphone – receives sound waves and converts them into electrical impulses
- Amplifier – recieves electrical impulses from the microphone and increases the power of the signals
- Speaker- receives the amplified sound from the amplifier
- Therefore the hearing aid magnifies the sound vibrations which the surviving hair cells can detect and convert to nerve impulses.



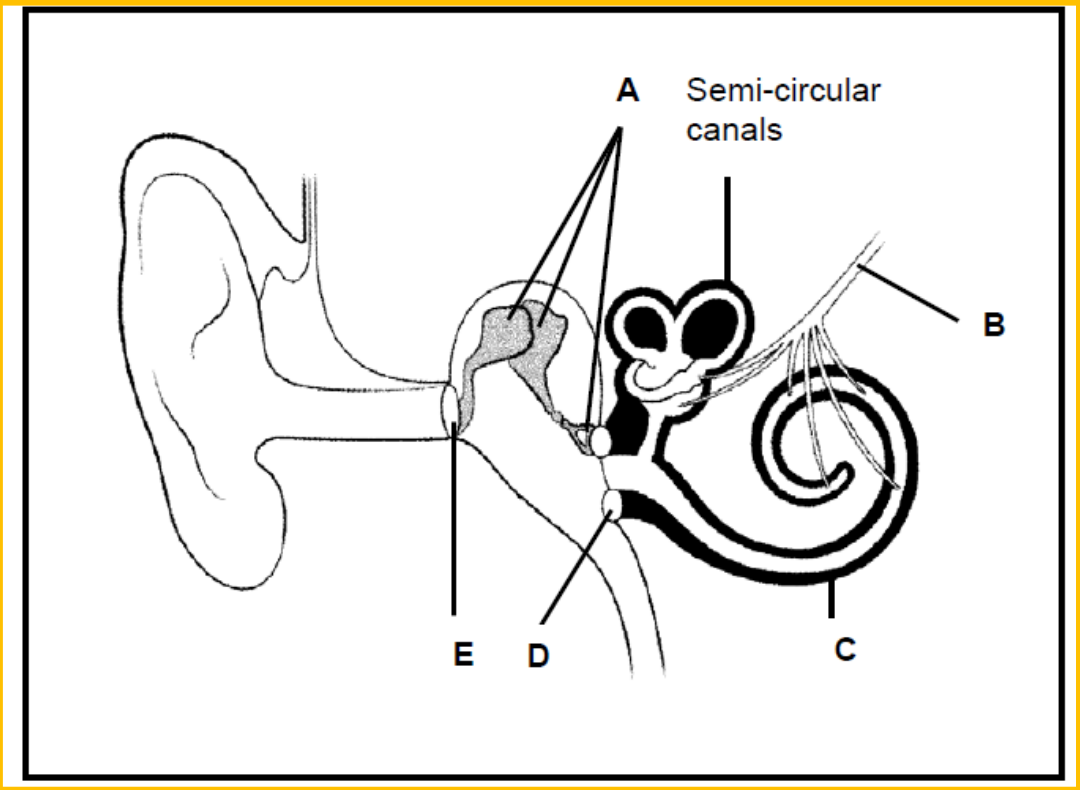
Activity 4.3

AIM: to be able to answer questions set on the human ear

METHOD: Questions and answers

QUESTION 1: ***(Taken from DBE November 2017 Paper 1)***

Study the diagram of the human ear below.



1.1. Identify:

(a) B

(b) D

1.2 Describe the role of the semi-circular canals in maintaining balance.

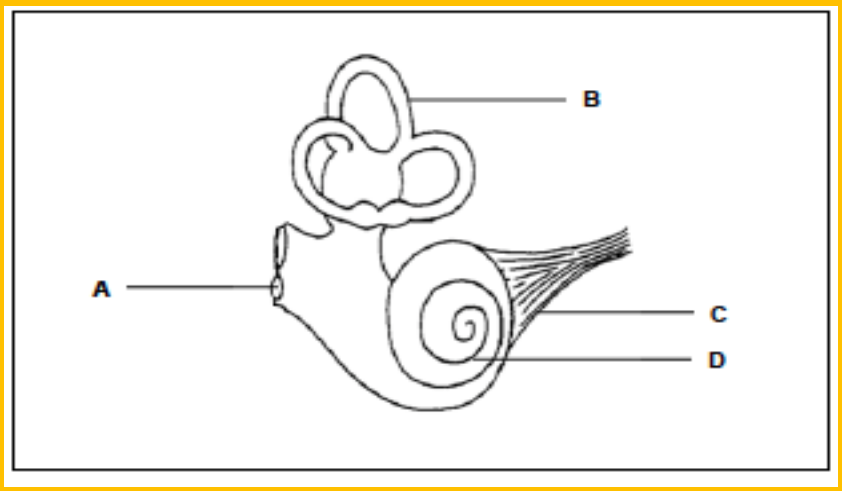
1.3 Describe how an increased production of mucus in the nose and throat may lead to the bursting of part E.

1.4 Explain why fusion of the structures at A may lead to hearing loss.

1.5 Which part of the brain will receive impulses from part C?

QUESTION 2: ***(Taken from DBE Feb/March 2016)***

The diagram below represents a part of a human ear.



2.1 Identify part:

a) A

b) D

2.2 Name the receptors that are found in part B.

2.3 Explain the consequence to the human body if:

a) Part C is damaged

b) Part A becomes hardened

2.4 Explain why people with middle-ear infections are usually advised not to travel by aeroplane.

QUESTION 3: ***(Taken from DBE Nov 2015 P1)***

Describe how the sacculus and utriculus in the human ear maintain balance in the human body.

RESOURCES

https://slocountyhearingaids.com/how-the-ear-works/

http://www.scholastic.com/browse/article.jsp?id=3757140

http://www.scholastic.com/listencarefully/pdf/starkey_68_imallears.pdf

https://www.britannica.com/science/ear

MODULE SUMMARY

This module covers all the requirements for the DBE NSC exams w.r.t. the topic: The human ear. It is very important to be able to identify parts of the human ear on a **diagram** and to provide the functions of that part. It is important to remember that the ear plays a role in hearing as well as in balance.

REFERENCES

- DBE Exam guidelines for learners
- GDE ATP
- 2015-2019 NSC past papers
- 2014-2019 national diagnostic report on learner performance
- Approved grade 12 national textbooks
- Internet
- Gauteng grade 12 Life Sciences Revision booklet

MODULE 5 - ENDOCRINE SYSTEM

INTRODUCTION

The endocrine system uses chemical messengers namely hormones. It is a system comprising of feedback loops of the hormones that are released by endocrine glands directly into the bloodstream. These hormones are transported to target organs or tissues where they carry out their functions. Some of the functions carried out by hormones are the body's growth, metabolism and sexual development and function.

Hence, the endocrine system has the following main functions, namely regulating metabolism, growth and development, tissue function, reproduction, sexual function, sleep and mood.

In the grade 12 CAPS specific focus is on the thyroid gland, sexual development that links with human reproduction, the adrenal glands, and the pituitary gland.

Other important concepts in this topic are homeostasis and negative feedback mechanisms that learners need to know.

OVERVIEW

This module deals with the endocrine system. We will look at the different glands and the hormones they secrete as well as each hormone's function.

Next we will look at homeostasis and the different negative feedback mechanisms.

SPECIFIC OBJECTIVES

By the end of this session, participants will be able to:

- Differentiate between endocrine and exocrine glands
- Discuss the differences between the nervous system and the endocrine system
- Identify the different endocrine glands and the hormones they secrete
- Discuss the different negative feedback mechanisms
- Define homeostasis

CONTENT

You will study this module through the following units:

Unit 1: What is the endocrine system?
Unit2: What is a negative feedback mechanism?

UNIT 1 - What is the endocrine system?

1. Terminology & definitions:

Biological term	Description
Endocrine glands	Ductless glands secreting hormones directly into bloodstream.
Exocrine glands	Secrete substances into **ducts** that lead **into cavities** in the body or lead directly to the external environment. (Examples: sweat glands, mammary glands, the liver, salivary glands and the pancreas.)
Hormones	Organic chemical messengers secreted directly into the blood by an endocrine gland.
Homeostasis	It is the process of **maintaining a constant internal environment** within narrow limits, despite changes that take place internally and externally.
Negative feedback mechanism	When there is an increase from normal, a corrective mechanism causes a decrease and vice versa to maintain a balanced system.

2. What is the endocrine system?

- The endocrine system works in conjunction with the nervous system. The endocrine system is responsible for **chemical coordination**, regulating the functioning of all the organs in the body.
- It consists of glands situated throughout the body.
- These endocrine glands secrete organic chemical messengers called hormones in the bloodstream.
- **Hormones** are organic substances and are mostly proteins, but a few are lipids (fats) (usually the sex hormones).
- Hormones are produced in small quantities
- They are carried in the blood stream to a target organ/tissue where they control the activities of a target organ to perform a specific function
- Hormones work together as an **integrated system** where they either stimulate or inhibit organs.

3. The differences between the endocrine system and the nervous system

- The nervous system and endocrine system controls different types of activities in the body.
- They are jointly responsible for the functioning of all the different organs and systems, this is known as coordination.
- The nervous system co-ordinates very quick responses to external stimuli.
- The endocrine system controls responses that are not that fast but are long-lasting and reflect the body's internal environments.

Endocrine system	Nervous system
1. Made up of glands **2.** Produces hormones **3.** Hormones are transported by the blood **4.** Effects are slower and more general **5.** Hormones control long-term changes (e.g. growth)	**1.** Made up of nerves **2.** Produces nerve impulses **3.** Impulses are transmitted along the nerves **4.** Effects are very quick and very specific **5.** Nerve impulses control short-term changes (e.g. sneezing, lifting your arm)

4. The differences between endocrine glands and the exocrine glands

Endocrine glands	Exocrine glands
Glands are **ductless,** secrete **directly into bloodstream**	Secrete their substances into **ducts** and not the bloodstream (think of the salivary glands secreting saliva in ducts that transport it to the mouth)
Secrete hormones	Does not secrete hormones

The pancreas is the only gland that is both exocrine (pancreatic juices for digestion) and endocrine (insulin and glucagon).

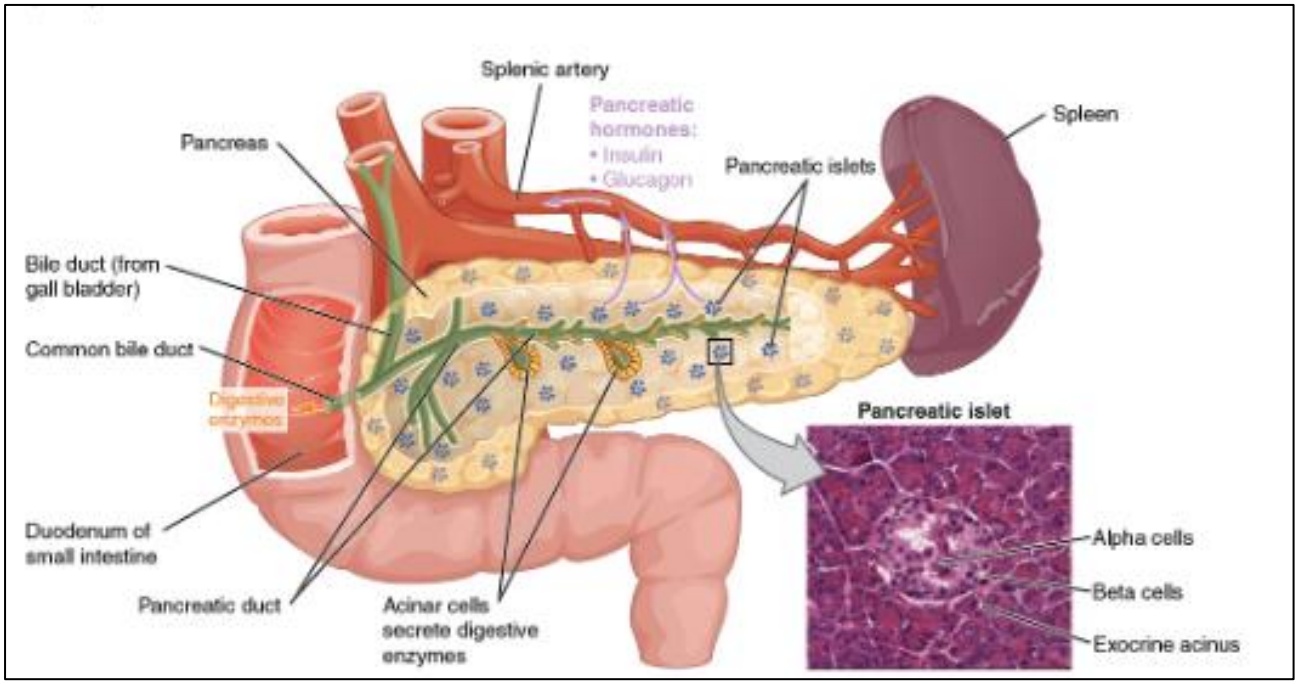
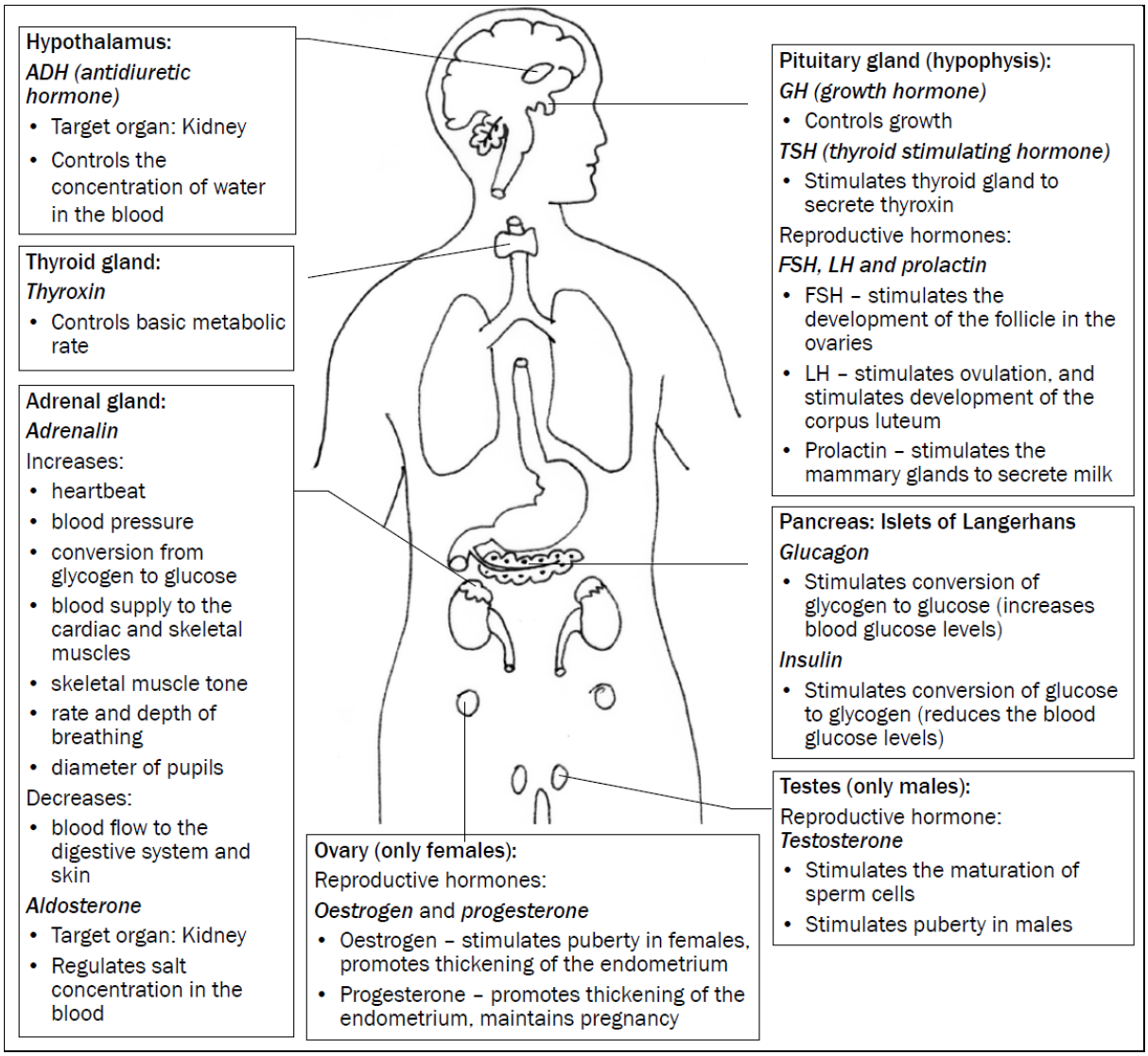


Diagram of the pancreas illustrating the islets which are the endocrine glands composed of alpha and beta cells. The exocrine glands are represented by the acinar cells that secrete digestive enzymes . Source: http://pathology.jhu.edu/pancreas/basicoverview3.php?area=ba

Useful Tips

It is strongly suggested that learners have to know the following diagram well. This is a snapshot of all the relevant glands, with the hormones they secrete and the function of each hormone.

SNAPSHOT of human endocrine system



Hormone	Gland	Location	Function
Antidiuretic hormone (ADH)	Neurosecretory cells of the **hypothalamus** ADH is stored in the **Pituitary gland**	In the centre of the brain	Regulates osmoregulation in the kidneys (in the distil convoluted tubules and the collecting tubules)

Hormone	Gland	Location	Function
Thyroxin	**Thyroid gland**	Below the larynx in the neck region	• Regulates the basal metabolic rate of the cells in the body • Affects growth and functioning of the heart and the nervous system • Stimulates growth and differentiation of tissue in a foetus and in children • Regulates the body temperature when stimulated by the hypothalamus
Adrenalin **(fight-and-flight hormone)**	**Adrenal gland**	Above the kidney	Prepares the body to deal with stress: • Increase in heartbeat rate • Increase in breathing rate • Increase in blood pressure • Increase in muscle tone • Increase in blood sugar levels • Decrease in blood supply to the skin and digestive system • Causes pupils to dilate
Aldosterone	**Adrenal gland**	Above the kidney	Helps the uptake of sodium ions in the loop of Henle in the kidneys
Prolactin	**Pituitary gland:**	Base of the brain and attached to the hypothalamus	• Stimulates the mammary glands to produce milk • Counteracts the effect of dopamine which is responsible for sexual arousal
Oestrogen	**Gonads: ovaries**	Located in the lower	• Oestrogen promotes

Hormone	Gland	Location	Function
		abdominal region with each ovary located within the pelvic bones (in line with the ball-and-socket joints of the femurs)	the development of the secondary sexual characteristics in females like breasts, the thickening of the endometrium (uterus) and the female body shape • Necessary for the process of ovulation • Oestrogen **inhibits** the secretion of FSH by the anterior pituitary gland so that only one follicle is produced during ovulation • High oestrogen levels will trigger the secretion of **luteinising hormone (LH)**
Progesterone	**Gonads: ovaries**	Located in the lower abdominal region with each ovary located within the pelvic bones (in line with the ball-and-socket joints of the femurs)	• Progesterone prepares the endometrium of the uterus for implantation once fertilisation of the egg cell has occurred • Necessary for the production of the mucus plug to prevent sperm or other substances from entering the uterus during pregnancy • Decrease in progesterone levels causes menstruation • Progesterone improves memory and cognitive ability
Testosterone	**Gonads: testes**	Leydig cells in the testes of males located in the scrotum at the bottom of the pelvis	• Testosterone is responsible for the secondary sexual characteristics in males like a deeper voice,

Hormone	Gland	Location	Function
			pubic hair, hair on face • Necessary for the normal development of sperm • Activates genes in the cells of Sertoli to promote the differentiation of the spermatogonia
Glucagon	Pancreas: **Islets of Langerhans**	Endocrine cells of the pancreas	Controls the increase in the blood sugar level by causing the conversion of glycogen to glucose
Insulin	Pancreas: **Islets of Langerhans**	Endocrine cells of the pancreas	• Controls blood sugar by causing the conversion of glucose into glycogen • Inhibits the functioning of glucagon
Growth hormone **(somatotrophin)**	**Pituitary gland:**	Base of the brain and attached to the hypothalamus	For growth, repair and replacement of cells
Follicle stimulating hormone (FSH)	**Pituitary gland:**	Base of the brain and attached to the hypothalamus	**In males:** stimulates spermatogenesis **In females:** stimulates the development of the follicle for process of ovulation
Luteinising hormone (LH)	**Pituitary gland:**	Base of the brain and attached to the hypothalamus	**In males:** stimulates the synthesis of the hormone testosterone by the Leydig cells in the testes **In females:** LH stimulates the release of the secondary oocyte from the Graafian follicle and then the development into the corpus luteum

Hormone	Gland	Location	Function
Thyroid-stimulating hormone (TSH)	**Pituitary gland:**	Base of the brain and attached to the hypothalamus	Stimulates the production of thyroxin by the thyroid gland
Prolactin	**Pituitary gland**	Base of the brain and attached to the hypothalamus	Stimulates mammary glands to secrete milk

UNIT 2 - What is a negative feedback mechanism?

Homeostasis

It is a process of maintaining a constant internal environment (blood and tissue fluid) within the body. This enables the body to function efficiently, despite changes in the external or internal environment

The following changes of the internal environment in the tissue fluid and blood, will affect the homeostatic balance of the body:

- temperature
- glucose levels
- carbon dioxide levels
- water levels and
- salt levels

NEGATIVE FEEDBACK MECHANISMS

They operate in the human body to detect changes or imbalances in the internal environment and to restore the balance.

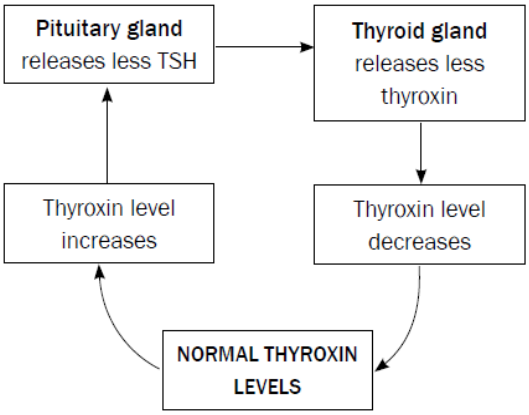
General sequence of events in a negative feedback mechanism:

- **STEP 1-** An **imbalance** is **detected**
- **STEP 2** - A **control** centre is **stimulated**
- **STEP 3-** Control centre **responds**
- **STEP 4-** Message sent to **target organ/s**
- **STEP 5-** The **target organ responds**
- **STEP 6-** It opposes/**reverses** the **imbalance**
- **STEP 7- Balance is restored**

1. Regulation of thyroxin levels in body

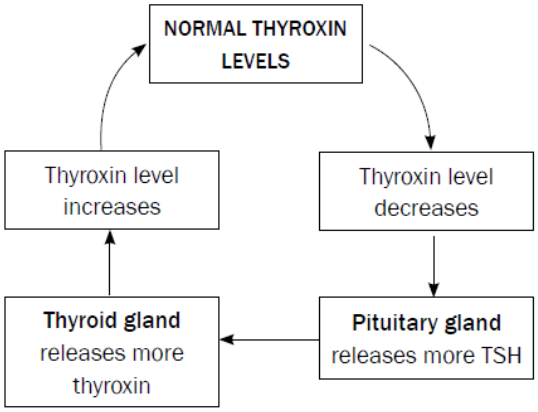
Thyroxin levels are too high:

Situation 1	
Step 1:	Thyroxin levels **increase** above normal limits
Step 2:	Pituitary gland is stimulated
Step 3:	Pituitary gland produces **less TSH**
Step 4:	Low TSH level stimulates the thyroid gland
Step 5:	The thyroid gland secretes **less thyroxin**
Step 6:	The thyroxin level thus **decreases**
Step 7:	Thyroxin level returns to normal



Thyroxin levels are too low

Situation 2	
Step 1:	Thyroxin levels **decrease** below normal limits
Step 2:	Pituitary gland is stimulated
Step 3:	Pituitary gland produces more TSH
Step 4:	High TSH level stimulates the thyroid gland
Step 5:	The thyroid gland secretes more thyroxin
Step 6:	The thyroxin level thus increases
Step 7:	Thyroxin level returns to normal

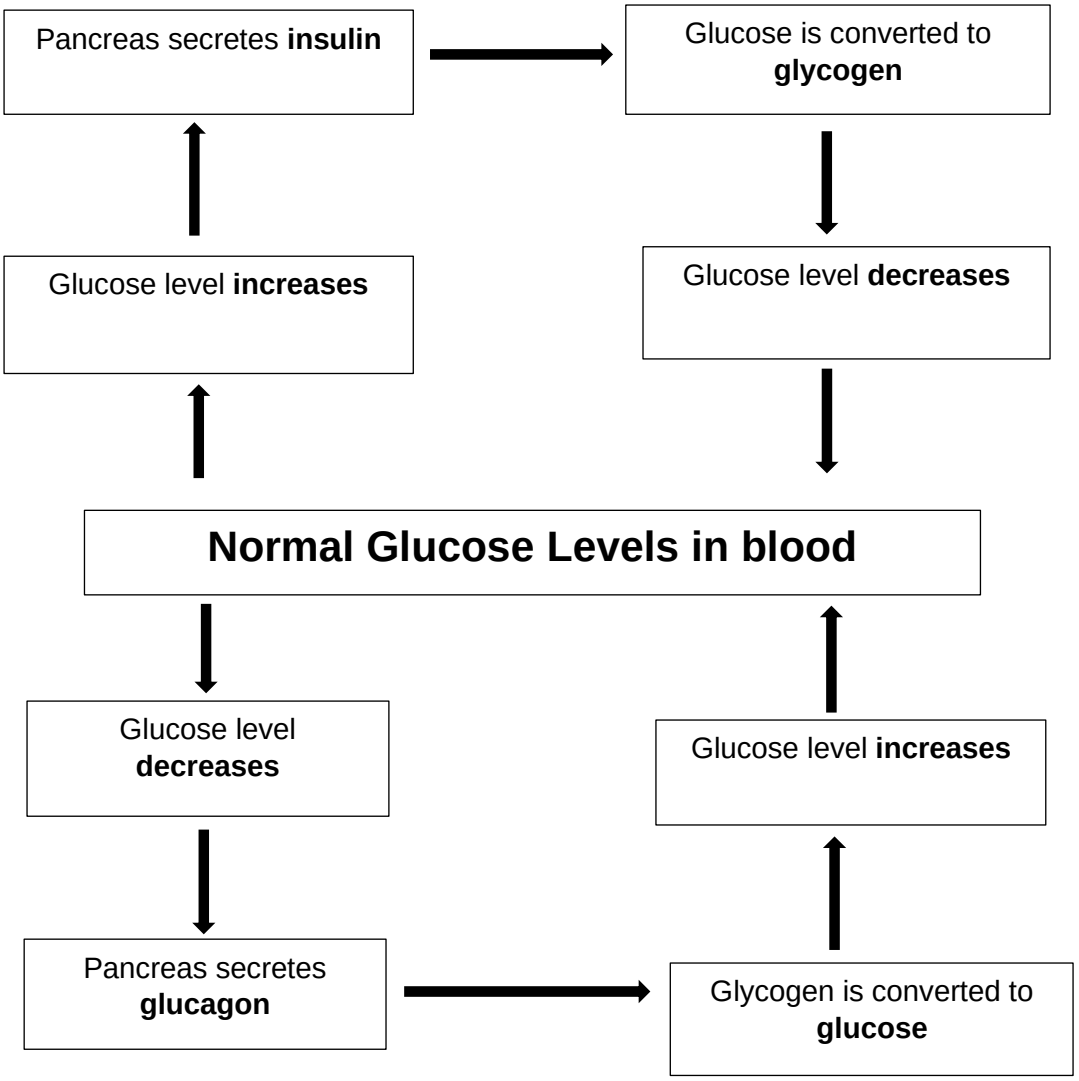


2. Regulation of <u>Glucose</u> levels through negative feedback mechanism

When the glucose level in the blood INCREASES above normal levels:	
Step 1	Glucose levels in the blood **increase** above normal levels
Step 2	The beta cells of the pancreas are **stimulated**
Step 3	to secrete **insulin** into the blood
Step 4	Insulin travels in the blood to the liver and muscle cells (target organ/s)
Step 5	where it stimulates the conversion of **excess glucose** to **glycogen** which is then stored
Step 6	The glucose level in the blood now **decreases**
Step 7	and returns to normal

When the glucose level in the blood DECREASE below normal levels:	
Step 1	Glucose levels in the blood **decrease** below normal levels
Step 2	The alpha cells of the pancreas are **stimulated**
Step 3	to secrete **glucagon** into the blood
Step 4	Glucagon travels in the blood to the liver and muscle cells (target organ/s)
Step 5	where it stimulates the conversion of **stored glycogen** to **glucose**
Step 6	The glucose level in the blood now **increases**
Step 7	and returns to normal

A flowchart depicting the negative feedback mechanism of glucose levels in the blood



3. The regulation of Carbon dioxide levels in the blood:

When the CO_2 level in the blood increases above normal levels:	
Step 1	CO_2 levels in the blood **increase** above normal levels
Step 2	Receptor cells in the carotid artery in the neck are stimulated
Step 3	To send impulses to the medulla oblongata in the brain
Step 4	Medulla oblongata stimulates breathing muscles (intercostal muscles and diaphragm) and heart
Step 5	Breathing muscles contract more actively – increases the rate and depth of breathing. The heart beats faster.
Step 6	More CO_2 is taken to and exhaled from the lungs
Step 7	The CO_2 level in the blood returns to normal

4. The regulation of water balance in the blood. Osmoregulation in the blood.

When the blood has less water than normal:	
Step 1	Blood has less water than normal
Step 2	The hypothalamus is stimulated
Step 3	and sends impulses to the pituitary gland to secrete more ADH
Step 4	ADH travels in the blood to the kidneys
Step 5	ADH increases the permeability of the collecting ducts and the distal convoluted tubules of the kidney
Step 6	More water is re-absorbed and passed to the surrounding blood vessels
Step 7	The water level in the blood returns to normal

When the blood has more water than normal:	
Step 1	Blood has more water than normal
Step 2	The hypothalamus is stimulated
Step 3	and sends impulses to the pituitary gland to stop secreting ADH/to secrete less ADH
Step 4	No ADH/less ADH travels in the blood to the kidneys
Step 5	The collecting ducts and the distal convoluted tubules of the kidney become less permeable to water
Step 6	Less water is re-absorbed and passed to the surrounding blood vessels. More water is now lost
Step 7	The water level in the blood returns to normal

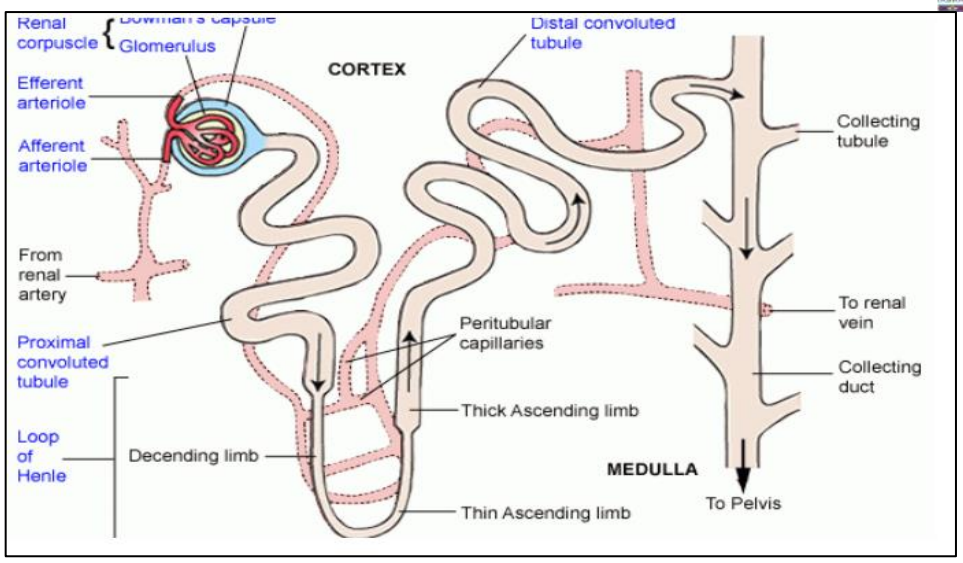
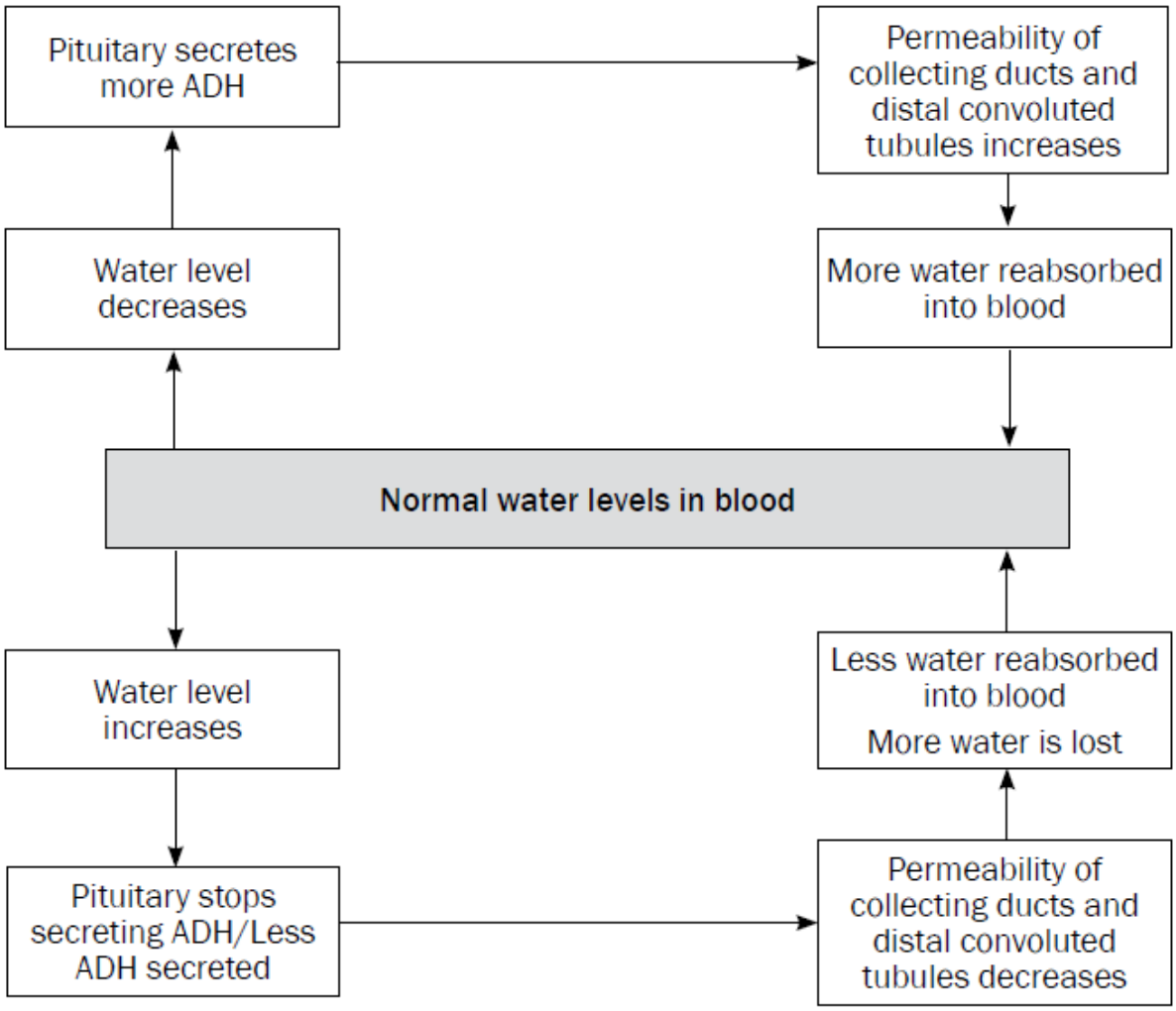


Diagram of the nephron in the kidney with distal convoluted tubule and collecting tubule.

Flow chart depicting the regulation of water in the blood (osmoregulation)

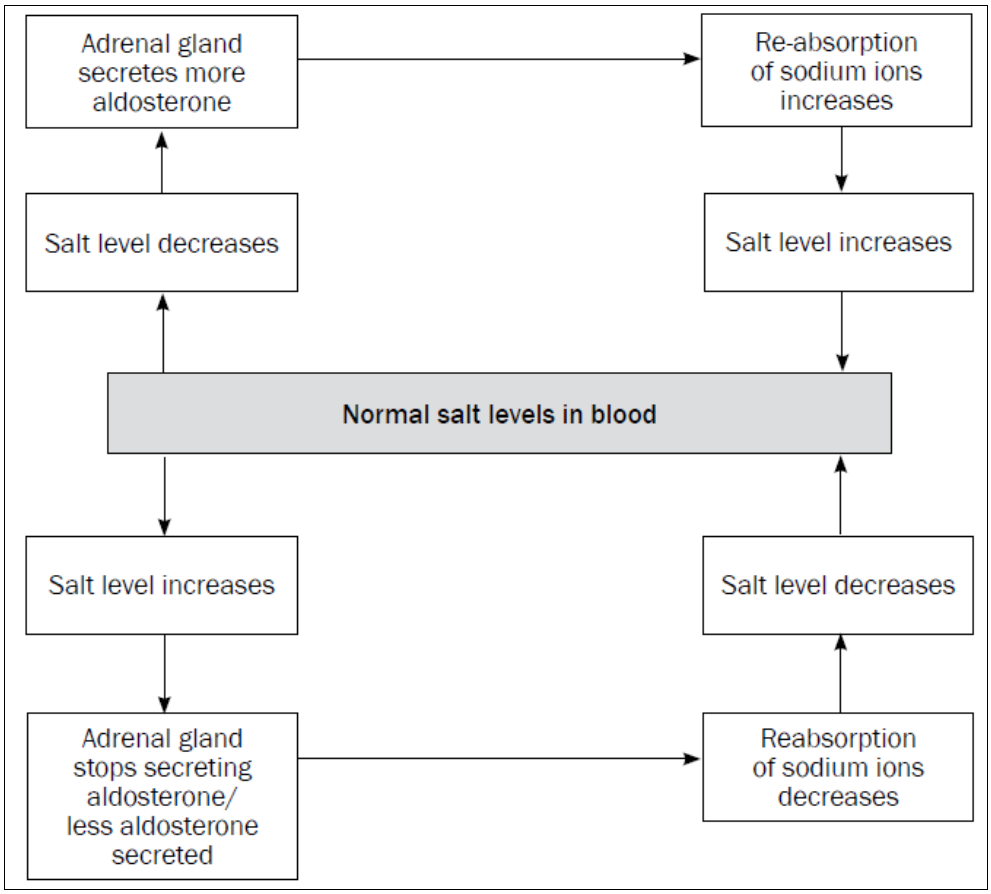


5. The regulation of Salt levels in the bloodstream

When the salt level in the blood increases:	
Step 1	The salt level in the blood increases
Step 2	Receptor cells in the afferent and efferent arterioles of the kidney detect the high salt level
Step 3	The adrenal gland is stimulated
Step 4	to stop secreting aldosterone/to secrete less aldosterone
Step 5	This decreases the re-absorption of sodium ions from the renal tubules in the kidney into the surrounding blood vessels
Step 6	The salt level in the blood vessels decreases
Step 7	and returns to normal

When the salt level in the blood decreases:	
Step 1	The salt level in the blood decreases
Step 2	Receptor cells in the afferent and efferent arterioles of the kidney detect the low salt level
Step 3	The adrenal gland is stimulated
Step 4	into secreting more aldosterone
Step 5	Aldosterone increases the re-absorption of sodium ions from the renal tubules in the kidney into the surrounding blood vessels
Step 6	The salt level in the blood vessels increases
Step 7	and returns to normal

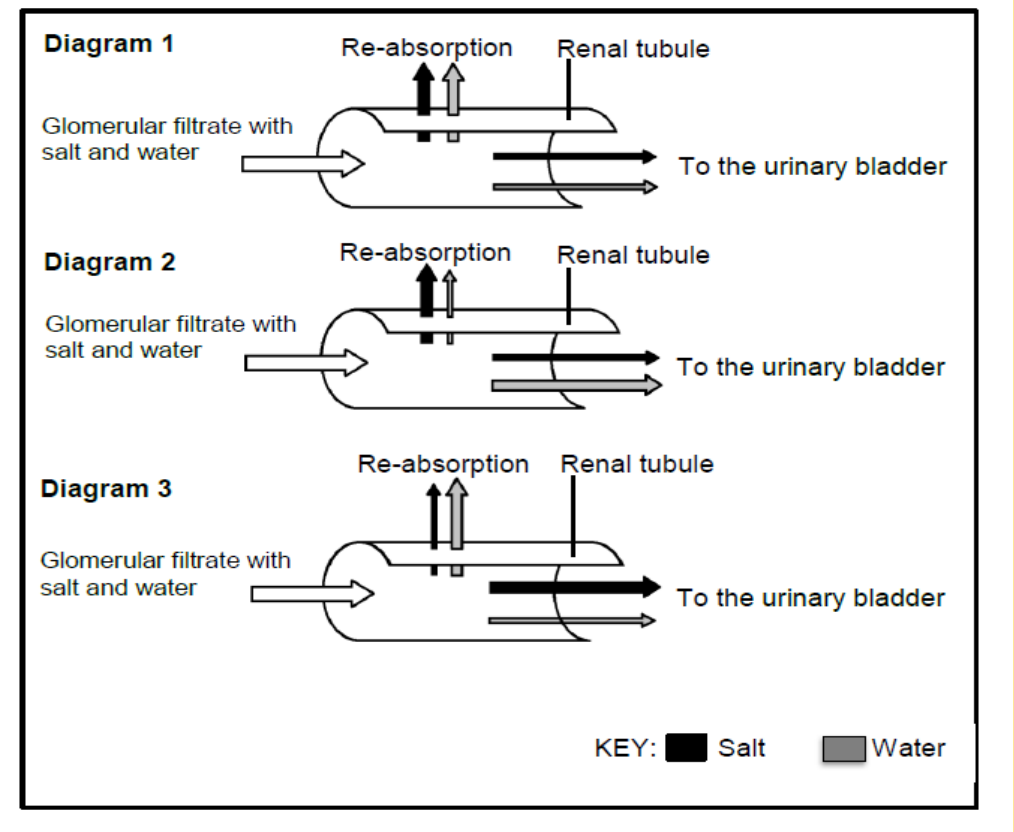
Flow chart depicting the regulation of salt levels in the bloodstream



Activity 5. 1

AIM: To enable participants to answer questions on the endocrine system.
Method: Answer the following question:

The diagram below show the re-absorption of salt and water through the tubules of a nephron in the kidney under three different conditions. The width of the arrows represents the amounts of salt and water.



1. Name the hormone in a human body that is responsible for controlling the:
a) Water content (1)
b) Salt content (1)
2. Name the gland that secretes the hormone in **question 1b**. (1)
3. Which diagram (1,2,3) would represent a person who had eaten salty chips on a hot day without any intake of water? (1)
4. Explain your answer to **question 3**. (5)

Reflection:
How does this link with grade 11?

RESOURCE

https://classroom.kidshealth.org/classroom/9to12/body/systems/endocrine.pdf

https://www.healthline.com/health/the-endocrine-system#diagram

https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the nervous-and-endocrine-systems/v/intro-to-the-endocrine-system

MODULE SUMMARY

The endocrine system together with the nervous system coordinates most of our bodily functions. Homeostasis and negative feedback mechanisms are important concepts that learners need to know. There are links to human reproduction as well as to grade 11 syllabus. Ensure that your learners are well prepared for the examination by drawing the links between the content. Also ensure that learners answer **more** or **less** hormones are secreted because there are always a small amount of the hormones in the bloodstream. **They should never say – no hormones are secreted**.

REFERENCES

- DBE Exam guidelines for learners
- GDE ATP
- 2015-2018 NSC past papers
- 2014-2019 national diagnostic report on learner performance
- Approved grade 12 national textbooks
- Internet
- Gauteng grade 12 Life Sciences Revision booklet