

The New Senior Secondary Curriculum for Sierra Leone

Subject syllabus for Popular Science
Subject stream: Science & Technologies



This subject syllabus is based on the National Curriculum Framework for Senior Secondary Education. It was prepared by national curriculum specialists and subject experts.



Curriculum elements for Popular Science – an everyday subject

Subject description

This subject pursues a public understanding and/ or appreciation of science and technology, that hinges on the communication of science and technology in a manner that appeals to the common sense of significant proportion of the general population, regardless of their level of expertise. Its importance is demonstrated, through rational and logical active public participation when for example – established and novel scientific and technology items or developments are key news items. A contextual – interaction model that ensures the experts and the public, as well as the continuous process of mutual and reciprocal co-construction of various techno-scientific and societal communities (while accommodating indigenous knowledge systems) experiences are key components of this subject.

Rationale for Inclusion of Popular Science in the Senior Secondary School Curriculum

- a. It improves public knowledge and appreciation of science and technology
- b. Provides an opportunity for non-science students to gain knowledge of science
- c. Can be presented to an audience with little or no scientific background
- d. Discusses science related controversies
- e. Explains general concepts simply
- f. Makes science more accessible to students
- g. Encourage active public participation
- h. Accommodates indigenous knowledge systems
- i. Humanizes science so that readers can relate to it

General Learning Outcomes (Broad Goals)

At the end of the course student will be able to:

- a. Understand scientific concepts in simple language
- b. Explain many sciences related controversies
- c. Explain scientific concepts simply
- d. Develop an interest in science to pursue traditional science subjects.



Subject Content Outline by Broad Themes & Specific Topic

Introduction to popular science:

- Contributions of popular science
- Why we study popular science

How scientist work

- Experimentation

Cultural indigenous knowledge and safety in modern day science:

- Role of traditional healers in science
- Contributions of indigenous knowledge
- Contribution in medicine
- Contribution in food security
- Setbacks of indigenous knowledge
- The way forward

The Germ Theory:

- Scientist who contributed to the germ theory
- Principle of the germ theory
- Transmission of germs
- Impact of the germ theory in medicine
- Methods of controlling germs

Pandemics and Epidemics:

- Introduction - definition – example of epidemics and pandemic disease
- Epidemics – how it occurs, spreads and control
 - Ebola – an example of an epidemic disease
- Pandemics – how it occurs, spreads and control
 - Covid 19 – an example of a pandemic disease

5G technology and viral pandemics:

- Use of technology in controlling viral pandemics
- Technology devices used in controlling viral pandemics
- 5G technology in controlling viral pandemics
 - Advantages and Disadvantages





Vaccination and herd immunity

- Discovery of vaccines
- Controversies about vaccines
- Benefits of vaccines
- Meaning of herd immunity

Holes in the ozone layer and human convenience:

- What cause holes in the ozone layer
- Effect of holes in the ozone layer

Maintain Biodiversity:

- Importance of biodiversity
- Human influence on biodiversity/threats
- Protecting biodiversity

Carbon footprints and our lifestyles:

- Our lifestyle and climate change
- Lifestyle changes to reduce climate change
- Carbon footprints in;
 - Transportation
 - Food
 - Energy consumption
 - Manufactured products
 - Geographical location

Mutation, selective breeding, and GM food:

- GM foods – meaning & types
- Benefits of GM food
- Selective breeding and GM foods – advantages and disadvantages
- Mutation and GM foods – advantages





Structure of the Syllabus Over the 3-Year Senior Secondary Cycle

	SSS 1	SSS 2	SSS 3
Term 1	<p>Introduction to Popular Science</p> <ol style="list-style-type: none"> Why we study popular science How scientist work. Experimentation 	<ol style="list-style-type: none"> Pandemics and Epidemics <ul style="list-style-type: none"> Introduction Epidemics – How it occurs, spreads, and control Ebola Pandemics – how they occur, spread and means of control Covid 19 	<ul style="list-style-type: none"> Holes in the ozone layer <ol style="list-style-type: none"> Causes Effects Maintaining biodiversity <ol style="list-style-type: none"> Importance of biodiversity Human influence on biodiversity Protecting biodiversity
Term 2	<p>Cultural indigenous knowledge and safety in modern day science:</p> <ul style="list-style-type: none"> Role of traditional healers in science Contribution of indigenous knowledge Contributions in medicine and in food security Setbacks of indigenous knowledge The way forward 	<p>5G technology and viral pandemics</p> <ul style="list-style-type: none"> Use of technology in controlling viral pandemics Technological devices in controlling viral pandemics <p>5G Technology</p> <ul style="list-style-type: none"> Advantages Disadvantages 	<p>Our lifestyle, carbon footprints and climate change.</p> <ul style="list-style-type: none"> Our lifestyles and climate change Lifestyle changes to reduce climate change Carbon footprint in: <ol style="list-style-type: none"> Transportation Food Energy consumption Manufactured products Geographical locations
Term 3	<p>The Germ Theory</p> <ul style="list-style-type: none"> Scientific who contributed to the germ theory and their work Principles of the germ theory Transmission of germs Impact of the germ theory in medicine Methods of controlling germs 	<p>Vaccination and Herd immunity</p> <ul style="list-style-type: none"> Discovery of vaccines Controversies about vaccines Benefits of vaccines Herd immunity 	<p>Mutation, selective breeding, and GM food</p> <ul style="list-style-type: none"> GM foods- meaning & types Benefits of GM foods Selective breeding and GM foods <ol style="list-style-type: none"> Advantages and disadvantages Mutation and GM foods



Teaching Syllabus

Topic/Theme/Unit	Expected learning outcomes	Recommended teaching methods	Suggested resources	Assessment of learning outcomes
<p>Popular Science:</p> <ul style="list-style-type: none"> • Introduction. • Contribution of some Scientist on Popular Science 	<p>At the end of the lesson pupils would be able to</p> <ul style="list-style-type: none"> • Explain why the subjects is called Popular Science • Explain the history of popular science • Explain why we need to study popular science • Pupils would be able to name some scientist who contributed to popular science 	<ul style="list-style-type: none"> • Introduce the lesson by asking pupils the meaning of the word popular • Explain why the subject is called popular science. E.g., It captures the methods and accuracy of science while making the language easy to understand, also for mass audience who come up with the ideas of popular science • Discuss the work of John Hechel , Mary Somerville and Charles Darwin • Ask pupils to state what Darwin is famous for. 	<ul style="list-style-type: none"> • Textbooks • Internet • Picture of Darwin and other Scientist who wrote on popular science 	<p>Resources:</p> <ul style="list-style-type: none"> • pupils find out the contribution of Darwin to popular science • let them find out the advantages of learning popular science



<p>Why we study popular science? Current Approach to popular science</p>	<ul style="list-style-type: none"> • At the end of the lessons, pupils would be able to explain why we study popular science • Pupils can state current approaches to popular science 	<ul style="list-style-type: none"> • Now together with the pupils why we need to study popular science e.g., discusses many sciences related controversies • Can be used to convince scientific outsiders of the significances of data and conclusions • Ask pupils to find out other reasons for studying popular science • Ask pupils to first come up with some suggestion; mentions, films, TV documentaries, web pages. 	<ul style="list-style-type: none"> • Internet 	<ul style="list-style-type: none"> • Pupils find out popular topics studied in popular science • Pupils find out some more methods
<p>How scientist work</p>	<ul style="list-style-type: none"> • At the end of the lesson, the pupils will be able to list the method used by scientists at work • Explain how these methods are used • Carry out activities to demonstrate some of these methods 	<ul style="list-style-type: none"> • Introduce the lesson by showing the pupils pictures of scientist at work • Ask the pupils to name some scientists both international and local. • Ask pupils to find out what these African scientists are known for; Lambo, Davidson Nicol, Monty Jones, Konotey, Ahulu. • Now ask how scientists work. List them on the blackboard. This was taught at JSS 		
<p>Experimentation</p>	<p>Pupils would be able to record the steps in an experiment.</p>	<p>Now explain each of these processes</p> <ul style="list-style-type: none"> • Discussion: • let pupils explain how long they can use the scientific method to 	<ul style="list-style-type: none"> • Filter paper • water from a nearby pond • Cotton wool 	<ul style="list-style-type: none"> • pupils outline the processes involved in the scientific method



		<p>find out the effect of pollution. Discuss the steps used in recording an experiment. Using the steps described. Let the pupils in groups carry out a simple experiment to make water from the pond for drinking</p> <ul style="list-style-type: none"> Hypothesis: untreated water contains impurities 	<ul style="list-style-type: none"> Filter funnel Clean white cloth 	<p>Group work: pupils carry out their experiment using the scientific method</p> <ul style="list-style-type: none"> Find out the scientific process involved in making soda soap, fufu and omole
<p>Cultural, Indigenous knowledge and safety in modern day science</p> <p>Role traditional healers in science</p>	<p>At the end of the lesson, pupils would be able to:</p> <ul style="list-style-type: none"> State the role of herbalists in their communities State some of the diseases that traditional indigenous healers can heal 	<ul style="list-style-type: none"> Introduce the lesson by asking the student the meaning of indigenous knowledge Ask the pupils if they have traditional healers in their locality What do they use to treat people? Stress their role in their society especially where there are no health facilities What are some of the reasons why some people look down on indigenous traditional knowledge in medicine? 	<ul style="list-style-type: none"> Picture Textbook Resource's person Traditional healer association 	<p>Pupils find out some local herbs used to treat people</p>
<p>Contribution of Indigenous knowledge</p>	<p>Show understanding of wealth of experience and knowledge of indigenous healers</p>	<p>How safe is traditional treatment of diseases?</p> <ul style="list-style-type: none"> What are some of the diseases that they treat? Point out the people had been treated successfully long before the advent of modern-day science 	<ul style="list-style-type: none"> Resource person (COMAS) Internet 	<p>Find out how traditional healer complement our health system, in Sierra Leone</p>



		<ul style="list-style-type: none"> • How is medicine given by traditional people? • Point out that indigenous people have decades of personal experience and vast knowledge about environment and ecological relationship within them • They are closer to the people and less expensive 		
<p>Contributions in Agriculture</p> <p>Contributions in Medicine</p>	<p>Pupils will be able to: State how indigenous knowledge contributes to</p> <ol style="list-style-type: none"> Agriculture Medicine 	<ul style="list-style-type: none"> • Stress how this can contribute to modern science and natural resource management, disease, prevent on heal • Ask pupils to state their contribution in Agriculture e.g., growing of crop plants • Discuss their role in pharmaceutical development e.g., medicinal plant properties are still recognized. Stress that every culture has its own system of medicines to treat diseases Talk about acupuncture 	<ul style="list-style-type: none"> • Internet • Resources person (Master Farmer) 	<p>Find out traditional practices in Agriculture</p>
<p>Food security</p> <p>Setback of Indigenous knowledge</p>	<p>Pupils will be able to:</p> <ul style="list-style-type: none"> • Explain how indigenous knowledge can solve problem of food security. • Pupils can list some of the setback in indigenous knowledge 	<ul style="list-style-type: none"> • Use of herbs for family planning insect repellants • How can traditional indigenous people help in solving food security? • List some of these on the blackboard • No documentation, therefore, knowledge may be lost 	<ul style="list-style-type: none"> • Resources Person • Traditional healer's association • Conservation society 	<p>Find out some other food that rural people eat</p>



		<ul style="list-style-type: none"> Deforestation leads to depletion of their resources. Therefore, can serve to save medicinal plants 		
<p>Food Security:</p> <ul style="list-style-type: none"> Setbacks The way forward 	<p>Pupils can list some of the setback faced by indigenous knowledge.</p>	<ul style="list-style-type: none"> Exploitation of their knowledge to develop new drugs. Modern science think that tradition knowledge is inferior to modern medicine. Therefore, they do not support it. May sometimes have adverse effect due to lack of dosage What do you think in the way forward: <ol style="list-style-type: none"> Develop indigenous science rather than replace it. Combining both foe excellent contribution to modern science 	<ul style="list-style-type: none"> Internet Traditional healers' association 	<p>Do a poster advocating for supporting indigenous knowledge to be preserved.</p>
<p>The Germ Theory: Scientist who contributed to the Germ theory</p>	<p>At the end of the lesson the pupils would be able to;</p> <ul style="list-style-type: none"> Name some scientists who contributed to the germ theory Name some examples of germs/micro-organisms 	<ul style="list-style-type: none"> Introduce the lesson by asking the pupils what they understand by the word germ Write their answers on the blackboard Now talk about the contribution of French Scientists Louis Pasteur and Robert Koch the German scientist to the germ theory Let the name some germs (microorganism) e.g., virus, bacteria 	<ul style="list-style-type: none"> Textbook The internet 	<ul style="list-style-type: none"> Question and answer: Let pupils name some micro-organisms Pupils find out the diseases associated with Louis Pasteur and Robert Koch



		<ul style="list-style-type: none"> • What disease are these two scientists known for • Let the pupils find out 		
Principles of the germ theory	<p>At the end of the lesson, the pupils would be able to.</p> <ul style="list-style-type: none"> • Explain the role that animals played in the germ theory • Superstition that preceded the germ theory • Name some diseases that the germ theory helped to eradicate. 	<ul style="list-style-type: none"> • State by asking pupils to state method used by scientist to work • Explain the experiments of Robert Koch and Louis Pasteur • Ask pupils to state what people believed caused disease before the germ theory e.g., witchcraft, evil spirits • Let pupils name some diseases that the germ theory has helped to eradicate or control in small children • State that disease caused by germs are infectious 	<ul style="list-style-type: none"> • Textbook • Internet 	<p>Research</p> <ul style="list-style-type: none"> • Pupils find out which of the two scientists worked with Anthrax • Pupils name three disease each caused by: bacteria, various, fungi, protozoa • Classwork; Pupils write down disease in children caused by germs
Transmission of germs	<p>At the end of the lesson pupils would be able to.</p> <ul style="list-style-type: none"> • State method of transmission of germs • Give examples of germs transmitted by these method 	<ul style="list-style-type: none"> • Introduce the lesson by asking pupils to state how germs can enter the body • List them on the blackboard • Let pupils give examples of germs that are airborne • State some examples of germs that are waterborne • Mention those that can be taken in the through food. Those that are transmitted by vectors 	<ul style="list-style-type: none"> • Textbook • Internet 	<p>Classwork;</p> <p>In groups pupils list:</p> <ol style="list-style-type: none"> 1. Germs transmitted through water 2. Through air 3. Through food 4. Through vectors 5. Group presentation



<p>Impact of the germ theory in medicine</p>	<p>At the end of the lesson, pupils would be able to; state significant contribution of the germ theory to medicine</p>	<ul style="list-style-type: none"> • Introduce the lesson by telling pupils that they have all benefited from the germ theory • Mention the discovery of antiseptics • Let the pupils find out who discovered the use of antiseptics in surgery • Talk about antibiotic. Pupils will try to find out who produced the first antibiotic <p>Which scientists worked on Rabies and Tuberculosis</p>	<ul style="list-style-type: none"> • Picture • Textbook • Internet 	<p>Research: Pupils find out</p> <ul style="list-style-type: none"> • who discovered antiseptics? • Who discovered antibiotics? • To who are the treatment of Rabies and Tuberculosis
<p>Pandemic and Epidemic: Introduction</p>	<p>At the end of the lesson pupils should be able to:</p> <ul style="list-style-type: none"> • Correctly Define pandemic and Epidemic • State the different characteristics and differences 	<ul style="list-style-type: none"> • Introduce the lesson by asking pupils to state two diseases the affect the whole Country differently. • Inform the students that Ebola was epidemic while corona pandemic • Ask pupils to state the differences in the number of people affected • Now defined Epidemic is sudden outbreak of diseases in a certain geographical area (e.g., West Africa) <p>A pandemic is a sudden outbreak of disease that spreads across continent</p> <p>Let the pupils state two similarities</p>	<ul style="list-style-type: none"> • Textbooks • Internet • Films and documentaries 	<p>Ask pupils to write down two similarities and differences between Epidemic and Pandemic</p>



<p>Pandemic and Epidemic: A. Epidemic</p>	<ul style="list-style-type: none"> • At the end of the lesson pupils would be able to • State how an epidemic occurs • Explain how its spreads • How it can be controlled • Name some Epidemics that have occurred over the years • Explain their impact on the population 	<ul style="list-style-type: none"> • Using Ebola that students are familiar with, let people explain how an epidemic occurs • How does epidemic spreads let pupils discuss this extensively? • Ask pupils how epidemics can be controlled • Discuss some other epidemics that had occurred e.g., cholera smallpox, polio. • Discuss impact on the economy, health, and human resources 	<ul style="list-style-type: none"> • Personnel from center for diseases control or from NACOVERC • Internet 	<ul style="list-style-type: none"> • Questions And answers session on the spread of pandemic • Control of pandemic <p>In groups pupils should discuss the economic and health impact of epidemic.</p>
<p>Ebola as an Example of epidemic diseases</p>	<ul style="list-style-type: none"> • At the end of the lesson the pupils should be able to' • State where Ebola was first seen in Africa • State where the first Ebola patient was first seen in Sierra Leone • How is Ebola transmitted 	<ul style="list-style-type: none"> • Introducing the lesson by asking pupils to say what they know about Ebola • Ask Them where in Africa Ebola was first discovered • In what part of Sierra Leone was Ebola first discovering • Let the pupils say what courses Ebola and how it could be prevented 	<ul style="list-style-type: none"> • Internet • Statistics from center for diseases control • Ministry of health and sanitation • Pictures 	<ul style="list-style-type: none"> • Pupils get Statistic of the number of people who were infected, those who dies and those who were healed. • The groups present their answers to the class



	<ul style="list-style-type: none"> The signs and symptoms of Ebola State how it can be prevented and controlled Discuss the impact of Ebola in Sierra Leone 	<ul style="list-style-type: none"> Divide the class into two groups Let group 1 write down the signs and symptoms of Ebola Group write down the prevention and control measures of Ebola Have a general discussion on the impact of Ebola in Sierra Leone 		<ul style="list-style-type: none"> Pupils individually talk about the impact of Ebola in Sierra Leone
Pandemics	<ul style="list-style-type: none"> At the end of the lesson pupils should be able to Explain how pandemic occur State methods of controlling pandemic Explain how its spreads Explain its impact on the lives of the people Name some previous Pandemics 	<ul style="list-style-type: none"> Let pupils explain how pandemic occur Let pupils explain how pandemic can be control. list them on the blackboard, mention smart technologies Ask pupils to explain how pandemics spread Ask general discussion with the pupils on the impact especially in Sierra Leone some examples of pandemics should be givens swine flu, plague tuberculosis 	<ul style="list-style-type: none"> Documentaries and films strip Resources personals from Center for Disease Control Textbooks Internet 	<p>General Discussion:</p> <p>How pandemics can influence our lifestyles</p>
COVID 19 (an example of a pandemic disease)	<p>At the end of the lesson, the pupils would be able to;</p> <ul style="list-style-type: none"> State what cause COVID 19 State where it was first discovered Explain some of the systems State the precaution for controlling covid 19 	<p>Question and answer session:</p> <p>Pupils respond to these questions:</p> <ol style="list-style-type: none"> What causes covid 19? Where was it first discovered? What are the symptoms of covid 19? How is the disease transmitted? Where do we have the treatment centers? How do they test one for covid 19 What precautions should one take to avoid infection 	<ul style="list-style-type: none"> Resources person from NACOVEC Poster /Chart Statistic of people who died and those who were infected during phase I 	<p>Question and answer session:</p> <ul style="list-style-type: none"> Pupils respond to this question. Pupils write down two similarities between epidemic and pandemic disease



		<p>8. What measures did the government put in place nationwide</p> <p>9. Who head NACOVERC</p>		
<p>5G technology and viral pandemics:</p> <ul style="list-style-type: none"> • Use of technology in controlling viral pandemics • Technological devices 	<p>At the end of the lesson pupils would be able to:</p> <ul style="list-style-type: none"> • Discuss the use of technology in controlling the transmission of viral pandemics • Name some devices and methods that can be used to control transmission 	<ul style="list-style-type: none"> • Start by asking the pupils what they understand by technology • Let them name some technological approaches that can be used? E.g., cell phones, computers, virtual meetings mobile clouds • How can these technologies be used? e.g., to educated, worn as increased awareness monitor patients once they are discharged, finding contracts • Explain how China was able to control the transmission of covid. through technology approach 	<ul style="list-style-type: none"> • resources personal of NACOVERC • Internet 	<p>Pupils in group explain how cell phones, computers virtual meeting can help to control transmission of viral pandemics</p>
<p>Remote working</p> <p>Reducing new cases (forecast)</p>	<ul style="list-style-type: none"> • At the end of the lesson pupils should understanding how remote working is done. • Show understanding why it may be necessary to shut down a country 	<ul style="list-style-type: none"> • How did people in England and America work even though offices were closed • Laptops, internet, basic computer • Let pupils state forecasting new cases can help to fight the transmission • Talk about shut down of countries • Restricted travel within the country 	<ul style="list-style-type: none"> • Internet • Resources Person 	<p>Pupils find out from NACOVERC the impact of the lockdown on the transmission of covid 19.</p>



<p>Contactless Services</p> <p>Fighting fake news</p> <p>Thermal screening</p>	<p>At the end of the lesson, pupils would be able to;</p> <ul style="list-style-type: none"> • Explain the use of contactless services in reducing the transmission of viral pandemic • State how technology can be used to fight fake news • Name places where infrared thermometers are used 	<ul style="list-style-type: none"> • How does technology help in quarantine? • Mention contactless services through robots to deliver where to the red zone e.g., medicines • Ask the pupils to state how technology can be used to fight again fake news • Talk about wireless thermometers. Infrared body temperature checks • As pupils to name some places that use infrared body temperature thermometers. E.g., check point, hotels schools etc. 	<ul style="list-style-type: none"> • Internet • Picture • NOCOVERC • Pictures/Chart • Resources Person 	<ul style="list-style-type: none"> • Pupils find out what other contactless service can be used apart from robots • Group Discussion: • Pupils discuss how technology can be used to fight against fake news
<p>5G Technology and viral pandemic:</p> <p>Meaning</p> <p>Advantage</p>	<p>At the end of the lesson, the pupils would be able to explain:</p> <ul style="list-style-type: none"> • What 5G technology means <p>State the advantages of 5G technology</p>	<ul style="list-style-type: none"> • Introduction the lesson by asking the pupils how many of them have mobile phones. • Ask them whether their phones are 3G or 4G • Now talk about 5G i.e., 5th generation network • Ask pupils whether 5G phones would be faster than 3G and 4G • What could be the advantages of using 5G network in controlling viral pandemics • Mention the following: <ol style="list-style-type: none"> 1. Faster speed in browsing the web and download 2. Increase bond with 	<p>Internet</p>	<p>Discussion:</p> <ul style="list-style-type: none"> • Pupils discuss how phones can be used in viral pandemics





<p>5G Technology: Advantages</p>	<p>State how 5G technology would help in the transmission of viral pandemics</p>	<ol style="list-style-type: none"> 1. Information is carried at faster rate 2. Connects everyone and everything including machines, objects, and devices 3. Massive network capacity 4. More reliability 5. Increase availability 6. More uniform user experience 7. With these characteristics, as pupils to state how it would help in the transmission of viral pandemics 	<ul style="list-style-type: none"> • Internet 	<ul style="list-style-type: none"> • Pupils list their answer down.
<p>Disadvantage</p>		<p>State some of the disadvantages e.g.,</p> <ol style="list-style-type: none"> 1. Does not work on all phones 2. More expensive 3. Uneven or less coverage 4. Battery drains on the devices 5. Few will have access to it 6. Limitation of rural areas <p>Ask pupils to discuss whether 5G technology is myth or scientifically sound in fighting viral pandemics</p>	<p>Internet</p>	<p>Discussion:</p> <ul style="list-style-type: none"> • 5G Technology a myth or scientifically sound





<p>Vaccination and herd immunity:</p> <ol style="list-style-type: none"> 1. Discovery of vaccines 2. Discovery of vaccines 	<p>At the end of the lesson the pupils would be able to:</p> <ul style="list-style-type: none"> • Understand the process of vaccination • Explain how vaccines do • Explain were discovered 	<p>Introduce the lesson by asking the student about any recent vaccination that had occurred</p> <ul style="list-style-type: none"> • What were the people vaccinated for? (polio) • Ask the students who the pioneers for vaccines were • Which vaccines did these people discover? • What do vaccines contain? <p>Ask them how people reacted the last time government announced mass</p>	<ul style="list-style-type: none"> • Picture • Charts • Internet 	<p>Discussion:</p> <p>Pupils discuss the controversies of vaccines. E.g., what do the grass root people feel about vaccination.</p>
<p>Benefits of vaccines</p> <p>Dangers of vaccines</p>	<p>At end of the lesson, pupils would be able to; state the benefits of vaccines</p>	<ul style="list-style-type: none"> • Immunization of polio • Explain the benefits of vaccines e.g., eradication of dangerous diseases. Polio prevents long term disability • Ask about some of the reactions to the covid vaccines • What other danger can vaccines cause 	<ul style="list-style-type: none"> • Under-five health card • resources person 	<ul style="list-style-type: none"> • Pupils write down some more benefits of vaccines • Pupils name the diseases that the ministry of health vaccinate children for.
<p>Herd Immunity:</p> <p>Meaning of herd immunity</p>	<p>At the end of the lesson, pupils would be able to;</p> <ul style="list-style-type: none"> • Explain the term, herd immunity • Explain the types of immunity • State the importance of herd immunity • Explain how we can reach Herd immunity. 	<p>Introduce the lesson by explain the term Herd Immunity. Now ask the pupils:</p> <ul style="list-style-type: none"> • What is immunity • Talk about the different types of immunity and how we can read herd immunity • What percentage of the population must be immunity to achieve Herd immunity? • What are variants? 	<ul style="list-style-type: none"> • Internet • Chart • Pictures • Resource's person 	<p>Pupils find out when children receive vaccines for the following diseases</p> <ul style="list-style-type: none"> • Diphtheria • Polio • Tuberculosis • Measles • Tetanus



		<ul style="list-style-type: none"> • Talk about covid Delta and how it has affected herd immunity of covid 19. • What is the importance of herd immunity? • Keeps the infection under control • Name two disease that are now refer due to herd immunity. 		
<p>SSS 3 Holes in the ozone layer and human convenience.</p>	<p>At the end of the lesson the pupils will be able to:</p> <ul style="list-style-type: none"> • State what the ozone layer is. • Explain the importance of the ozone layer. • Explain what causes holes in the ozone layer. 	<p>Introduce the lesson by asking how many pupils have heard the word ozone/ozone layer</p> <ul style="list-style-type: none"> • Explain what the ozone layer is and how it protects the earth from dangerous ultraviolet radiation. • Is ozone below the atmosphere safe for humans? • How does it affect humans? • Explain how chlorofluorocarbons and halocarbons released into the atmosphere breakdown ozone molecules creating a thin section called the ozone hole. • What name is given to fluorocarbons? 	<ul style="list-style-type: none"> • Picture • Film strip • Internet 	<p>Pupils find out how ozone is produced in the atmosphere.</p>
<p>Effect of holes in the ozone layer</p>	<p>At the end of the lesson, the pupils will be able to:</p> <ul style="list-style-type: none"> • State where the largest ozone hole is found • Explain the effect of the ozone layer on humans and other organisms. 	<p>Ask the pupils what also can cause holes in the ozone layer and talk about global warming and its effect on the earth due to holes in the ozone layer.</p> <ul style="list-style-type: none"> • Ask the pupils to find out where the largest hole in the ozone layer is found. 	<ul style="list-style-type: none"> • Internet • Film strips • Textbooks 	<p>Pupils find out where the largest hole in the ozone layer can be found. State other areas where the holes can be found.</p>



	<ul style="list-style-type: none"> Explain how we can control the size of the hole in the ozone layer. 	<ul style="list-style-type: none"> Is the size of the ozone hole constant? How also does the hole in the ozone layer affect other organisms? Talk about ultraviolet radiation destroying plant and animals and marine organisms like phytoplankton Talk about banning of fluorocarbons and reduction of Co2 in the air. 		
Introduction to biodiversity	<p>At the end of lesson, the pupils would be able to:</p> <ul style="list-style-type: none"> Explain the term biodiversity. Explain why biodiversity is important. Explain ho humans have disrupted and destroyed ecosystems. 	<p>Introduce the lesson by explaining the term biodiversity.</p> <ul style="list-style-type: none"> Ask pupils to give examples of different types of living things. Why is biodiversity important. Ask pupils to explain what an ecosystem is. What does the ecosystem provide for the organisms living there. Give some examples of biodiversity. Explain that biodiversity includes different species of plants and animals, both terrestrial and aquatic. Ask pupils to explain how has disrupted and destroyed biodiversity. 	<ul style="list-style-type: none"> Charts/ posters Pictures Resource person from agriculture Film stripes and documentaries. 	<p>Pupils discuss and write down how man has disrupted and destroyed the ecosystem.</p>



<p>Threats to biodiversity</p>	<p>At the end of the lesson the pupils will be able to:</p> <ul style="list-style-type: none"> • State why humans destroy the ecosystem. • How do they destroy the ecosystem? • Explain what happens when the ecosystem is disrupted • State what else can affect biodiversity apart from humans. 	<p>Introduce the lesson by stating that the ecosystem is being threaten every day.</p> <ul style="list-style-type: none"> • Ask pupils to explain why humans would want to disrupt the ecosystem. E.g., Land development • Ask how they destroy the environment and biodiversity. E.g., pollution. • Let the pupils explain what happens when the biodiversity is disrupted. E.g., death of some species. • Let pupils know that there are other factors like climate change and invasive species that can disrupt biodiversity. 	<ul style="list-style-type: none"> • Charts • Pictures • internet 	<ul style="list-style-type: none"> • how does climate change affect biodiversity • what happens when a new species is introduced in an ecosystem. • What happens when a new species is introduced in an ecosystem.
<p>Protecting biodiversity</p>	<p>At the end of the lesson, the pupils will be able to:</p> <ul style="list-style-type: none"> • State how biodiversity can be protected. • Explain how legislation, game reserves, habitat restoration help to conserve biodiversity. • Explain how invasive species, captive, research and climate change helps to maintain climate change., 	<p>Introduce the lesson by brainstorming to find out how much the pupils know and divide the class into three groups.</p> <ul style="list-style-type: none"> • Give each group four ways of protecting biodiversity. Let them discuss them and come up with a group presentation on how each one can be achieved. • Group I: Legislation Game Reserves Habitual restoration Seed banks 	<ul style="list-style-type: none"> • Internet • Textbooks 	<ul style="list-style-type: none"> • Group presentations





	<ul style="list-style-type: none"> Explain how sustainable products, education and science and technology helps to sustain biodiversity. 	<ul style="list-style-type: none"> Group II: Invasive species Captive breeding Research Climate change Group III: Buying sustainable product. Sustainable living education. Role of science and technology. You may need to guide them as they along with relevant questions. 		
<p>Our life styles carbon footprints and climate change</p> <p>Life style and climate change</p>	<p>At the end of the lesson, the pupils would be able to:</p> <ul style="list-style-type: none"> Talk about lifestyles Explain how a change in our lifestyles can reduce climate change. At the end of the lesson pupils would be able to state some lifestyle changes that can reduce climate change. 	<p>Start the lesson by asking pupils what they understand by lifestyles.</p> <ul style="list-style-type: none"> How do our lifestyles in the home contribute to climate change? Ask them to state their sources of fuel that they use at home. e.g., coal or firewood. What type of light bulb do you use? Do you use air conditioners at home? How do you get rid of your reuse? Do you have refrigerators and freezers at home? Do you use public transport, or do you walk to school? Now explain to the students that humans contribute to the increasing construction of greenhouse gases through their lifestyles e.g., uses of fossil fuel, deforestation, waste disposal etc. 	<ul style="list-style-type: none"> Textbooks The pupils Internet Pictures 	<ul style="list-style-type: none"> Ask pupils individually to state some activities of humans that contribute to emission of greenhouse gases and other lifestyle changes we can make. Pupils talk about lifestyle changes we can make to reduce emission of greenhouse gases.



		<ul style="list-style-type: none"> • What type of light bulb do you use? Change to fluorescent or solar. • How do you travel? By car or bus, walk or cycle to reduce emissions • What can you do to waste like plastics? “Recycle” • Do you use a generator? “ you may use Chinese light. You can let the children come up with some more examples. 		
<p>Carbon footprints</p> <p>a) Carbon footprints and transportation</p> <p>b) Food</p> <p>c) Energy consumption</p> <p>d) Manufactured products</p> <p>e) Geographical location</p>	<p>At the end of the lesson the pupils would be able to:</p> <ul style="list-style-type: none"> • Explain the meaning of carbon footprint • Name the greenhouse gases <p>At the end of the lesson, the pupils would be able to:</p> <ul style="list-style-type: none"> • Compare greenhouse gas emissions in different forms of transportation. • Compare carbon footprints in different foods. • Compare carbon footprints in different types of energy. 	<p>Introduce the topic by asking pupils what they know about the greenhouse effect.</p> <ul style="list-style-type: none"> • Ask them to name the greenhouse gases. • Explain the meaning of carbon footprints. • Ask pupils to name some ways by which greenhouse gases can be emitted. • Explain that carbon foots vary according to geological locations, type of transportation and food, energy consumption and types of manufactured products. <p>Ask the pupils to name several means of transportation and state which one produces more greenhouse gas, and which produces the least.</p>	<ul style="list-style-type: none"> • Pictures • Charts • Textbooks • Internet 	<p>Homework</p> <p>Let pupils research on these for the next lesson on carbon footprints.</p> <ul style="list-style-type: none"> • Transportation • Energy consumption • Food • Manufactured products • Let the pupils work in groups and submit their answers.



	<ul style="list-style-type: none"> Compare carbon footprints of different products. <p>State countries that have a high carbon footprint.</p>	<ul style="list-style-type: none"> Ask pupils about carbon footprints in meat, fish, and vegetables. How would hydro, solar and nuclear power compare for carbon footprint. Let pupils name some manufactured food e.g., plastics building materials etc. <p>Now ask them which would have more carbon footprints.</p> <ul style="list-style-type: none"> Ask pupils which of these countries have more carbon footprints, "America, Sierra Leone, England" 		
<p>Mutation, selective breeding and GM food</p> <p>GM food</p>	<p>At the end of the lesson, the pupils would be able to:</p> <ul style="list-style-type: none"> Explain the meaning of GM food Explain the uses of GM plants and animals. 	<p>Explain the meaning of GM foods. i.e., foods from organisms that had DNA changes using genetic engineering.</p> <ul style="list-style-type: none"> Name the two processes involved i.e., mutation and selective breeding. Are GM foods safe to eat? Do GM foods affect our genes Can they have adverse effects What are the uses of genetically modified plants and animals. 	<ul style="list-style-type: none"> Pictures Charts Internet 	<ul style="list-style-type: none"> Pupils research the answers to these questions
<p>Benefits of GM foods</p>	<p>At the end of the lesson, pupils would be able to state the benefits of GM foods</p>	<p>List the benefits of GM foods on the board</p> <ul style="list-style-type: none"> Grow more easily Produce more crops and keep food prices lower. 	<ul style="list-style-type: none"> Pictures Charts Internet 	<ul style="list-style-type: none"> Pupils discuss in groups how GM foods can help solve our food security.



		<ul style="list-style-type: none"> • Ripen slower, therefore lasts longer during shipping. • Be less at risk for diseases. • Need less pesticides. Have improved nutrients and can be used to fight malnutrition. 		
Mutation and GM foods	<p>At the end of the lesson, the pupils would be able to:</p> <ul style="list-style-type: none"> • Explain the terms <ol style="list-style-type: none"> a) Mutation b) Selective breeding c) GM foods <p>State the advantages of plants produced by mutation breeding.</p>	<p>Introduce the lesson by explaining the terms:</p> <ul style="list-style-type: none"> • Mutation • Selective breeding • Genetically modified foods <p>Give examples of chromosomal and genetic mutations.</p> <ul style="list-style-type: none"> • How is mutation used to produce GM food? • What are the advantages of plants produced by mutation? E.g. high yielding, resistant to disease, development of new species and improvement in quality. • What types of plants are produced by genetic mutation? 	<ul style="list-style-type: none"> • Internet • Textbooks 	<p>Research</p> <ul style="list-style-type: none"> • Pupils find out how mutation is used to produce GM foods (Plants)
Mutation and GM foods	<p>At the end of the lesson, pupils would be able to: Name some plants and animals produced by mutation breeding</p>	<p>e.g. tomato mutant soybean mutant rice mutant</p> <p>Can mutation be used to produce genetic modified animals?</p> <ul style="list-style-type: none"> • Ask pupils if they know any animals produced by genetic modification e.g. sheep • Explain how mutation breeding is done. E.g. use of chemicals and 	<ul style="list-style-type: none"> • Textbooks • Internet 	<ul style="list-style-type: none"> • Pupils find out some animals produced by mutation breeding. • Pupils find out some transgenic plants and animals.



		radiation to generate mutants with desirable traits. Refer students to genetic engineering or bio- engineering to produce transgenic plants and animals using DNA techniques.		
<p>Mutation Advantages of animals produced by mutation breeding</p> <p>Selective breeding/ artificial selection</p>	<p>At the end of the lesson pupils would be able to:</p> <ul style="list-style-type: none"> State the advantages of animals produced by mutation breeding. Explain the meaning of selective breeding Explain how selective breeding is done. 	<ul style="list-style-type: none"> What are the advantages of animals produced by mutation breeding? e.g., allows improvement of nutrients in animal products, quantity is quality of the who food. Introduce the lesson by asking pupils what it means to select. Explain that selective breeding involves deliberate crosses or mating. How is selective breeding done? Explain the role of bacteria plasmid. 	<ul style="list-style-type: none"> Textbooks Pictures Internet 	<ul style="list-style-type: none"> Question and answer sessions on the advantages of animals produced by mutation breeding Pupils find out the role of bacteria plasmid in selective breeding.
<p>Advantages of selective breeding</p>	<p>At the end of the lesson, the pupils would be able to: State some advantages of selective breeding</p>	<p>List some advantages on the blackboard. e.g., development of offspring with more desirable characteristics e.g. greater resistance to pests.</p> <ul style="list-style-type: none"> Research for transgenic animals Ask pupils to research for some more. 	<ul style="list-style-type: none"> Pictures Internet 	<ul style="list-style-type: none"> Pupils find out some more advantages of selective breeding.





Advantages of selective breeding	At the end of the lesson, the pupils would be able to: State some advantages of selective breeding	List some advantages on the blackboard. E.g. development of offspring with more desirable characteristics e.g. greater resistance to pests. <ul style="list-style-type: none">• Research for transgenic animals Ask pupils to research for some more.	<ul style="list-style-type: none">• Pictures• Internet	<ul style="list-style-type: none">• Pupils find out some more advantages of selective breeding.	
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