BIOMEDICAL SCIENCE

CURRICULUM FOR SECONDARY EDUCATION (SHS 1 - 3)

NaCCA

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

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FOREWORD

Through the National Council for Curriculum and Assessment (NaCCA), Ghana's Ministry of Education has introduced a series of curriculum reforms to improve the quality and relevance of learning experiences in pre-tertiary schools in the country. These reforms will improve learning through the introduction of innovative pedagogies that encourage critical thinking and problem-solving. For a long time, our learners memorise facts and figures, which does not develop their analytical and practical skills. The Ministry recognises that learners need to be equipped with the right tools, knowledge, skills and competencies to deal with the fast-changing environment and the challenges facing their communities, the nation and the world.

These curriculum reforms were derived from the Education Strategic Plan (ESP 2018-2030), the National Pre-tertiary Education Curriculum Framework (NPTECF) and the National Pre-Tertiary Learning Assessment Framework (NPLAF), which were all approved by Cabinet in 2018. The new standards-based curriculum implemented in 2019 in basic schools, aims to equip learners to apply their knowledge innovatively to solve everyday problems. It also prioritises assessing learners' knowledge, skills, attitudes, and values, emphasising their achievements. The content of the basic school standards-based curriculum was therefore designed to promote a curriculum tailored to the diverse educational needs of the country's youth. It addresses the current curriculum's deficiencies in learning and assessment, especially in literacy and numeracy. These reforms have been carried out in phases. The curriculum for the basic school level – KG, Primary and Junior High School (JHS) – was developed and implemented from 2019 to 2021.

The curriculum for Senior High School (SHS), Senior High Technical School (SHTS) and Science, Technical, Engineering and Mathematics (STEM), which constitutes the next phase, is designed to ensure the continuation of learning experiences from JHS. It introduces flexible pathways for progression to facilitate the choice of subjects necessary for further study, the world of work and adult life. The new SHS, SHTS and STEM curriculum emphasises the acquisition of 21st Century skills and competencies, character development and instilling of national values. Social and Emotional Learning (SEL), Information Communications Technology, Gender Equality and Social Inclusion, have all been integrated into the curriculum. Assessment – formative and summative has been incorporated into the curriculum and aligned with the learning outcomes throughout the three-year programme.

The Ministry of Education's reform aims to ensure that graduates of our secondary schools can successfully compete in international high school competitions and, at the same time, be equipped with the necessary employable skills and work ethos to succeed in life. The Ministry of Education, therefore, sees the Senior High School (SHS) curriculum as occupying a critical place in the education system – providing improved educational opportunities and outcomes for further studies, the world of work and adult life – and is consequently prioritising its implementation.

ACKNOWLEDGEMENTS

This standards-based SHS curriculum was created using the National Pre-Tertiary Learning Assessment Framework (NPLAF), the Secondary Education Assessment Guide (SEAG), and the Teacher and Learner Resource Packs which include Professional Learning Community (PLC) Materials and Subject Manuals for teachers and learners. All the above-mentioned documents were developed by the National Council for Curriculum and Assessment (NaCCA). The Ministry of Education (MoE) provided oversight and strategic direction for the development of the curriculum with NaCCA receiving support from multiple agencies of the MoE and other relevant stakeholders. NaCCA would like to extend its sincere gratitude, on behalf of the MoE, to all its partners who participated in the professional conversations and discussions during the development of this SHS curriculum.

In particular, NaCCA would also like to extend its appreciation to the leadership of the Ghana Education Service (GES), the National School Inspectorate Authority (NaSIA), the National Teaching Council (NTC), the Commission for Technical and Vocational Education and Training (Commission for TVET), West African Examinations Council (WAEC) and other agencies of the MoE that supported the entire process. In addition, NaCCA acknowledges and values the contributions made by personnel from various universities, colleges of education Industry players, Vice Chancellors Ghana, Vice Chancellors Technical Universities as well as educators and learners working within the Ghana education landscape.

Special appreciation is extended to consultants who contributed to development of the curriculum. The development process involved multiple engagements between national stakeholders and various groups with interests in the curriculum. These groups include the teacher unions, the Association of Ghana Industries, and heads of secondary schools.

CONTENTS

THE SHS CURRICULUM OVERVIEW

The vision for this curriculum is to ensure the nation has a secondary education system that enables all Ghanaian children to acquire the 21st Century skills, competencies, knowledge, values and attitudes required to be responsible citizens, ready for the world of work, further studies and adult life. The nation's core values drive the SHS curriculum, and it is intended to achieve Sustainable Development Goal 4: 'Inclusive, equitable quality education and life-long learning for all'. Above all, it is a curriculum enabling its graduates to contribute to the ongoing growth and development of the nation's economy and well-being.

The curriculum is inclusive, flexible, and robust. It was written under the auspices of the National Council for Curriculum and Assessment by a team of expert curriculum writers across Ghana. It reflects the needs of critical stakeholders, including industry, tertiary education, the West African Examination Council, SHS learners, teachers, and school leaders. It has been written based on the National Pre-Tertiary Learning and Assessment Framework and the Secondary Education Policy.

The key features of the curriculum include:

- flexible learning pathways at all levels, including for gifted and talented learners and those with deficiencies in numeracy and literacy, to ensure it can meet the needs of learners from diverse backgrounds and with different interests and abilities.
- the five core learning areas for secondary education: science and technology, language arts, humanities, technical and vocational and business; with emphasis placed on STEM and agriculture as integral to each subject.
- a structured, standards-based approach that supports the acquisition of knowledge, skills and competencies, and transition and seamless progress throughout secondary education, from JHS to SHS and through the three years of SHS.
- a focus on interactive approaches to teaching and assessment to ensure learning goes beyond recall enabling learners to acquire the ability to understand, apply, analyse and create.
- guidance on pedagogy, coupled with exemplars, demonstrating how to integrate cross-cutting themes such as 21st Century skills, core competencies, the use of ICT, literacy and mathematics, Social Emotional Learning, Gender Equality and Social Inclusion as tools for learning and skills for life. Shared Ghanaian values are also embedded in the curriculum.

The curriculum writing process was rigorous and involved developing and using a Curriculum Writing Guide which provided systematic instructions for writers. The process was quality assured at three levels: through (a) evaluation by national experts, (b) trialling curriculum materials in schools and (c) through an external evaluation by a team of national and international experts. Evidence and insights from these activities helped hone the draft's final version. The outcome is a curriculum coherently aligned with national priorities, policies and the needs of stakeholders. A curriculum tailored to the Ghanaian context ensures that all learners benefit from their schooling and develop their full potential.

The following section highlights the details of the front matter of the draft curriculum. The vision, philosophy and goal of the curriculum are presented. This is followed by the details of the 21st Century skills and competencies, teaching and learning approaches, instructional design and assessment strategies. The template for the curriculum frame, which outlines the scope and sequence, the design that links the learning outcomes to particular 21st Century skills and competencies, as well as Gender Equality and Social Inclusion, Social and Emotional Learning and Ghanaian values are presented together with the structure of the lesson frame showing the links between the content standards, learning indicators with their corresponding pedagogical exemplars and assessment strategies.

INTRODUCTION

Effective implementation of this Senior High School (SHS) curriculum is the key to creating a well-educated and well-balanced workforce that is ready to contribute to Ghana's progress by harnessing the potential of the growing youth population, considering the demographic transition the country is currently experiencing (Educational Strategic Plan [ESP] 2018-2030). SHS curriculum aims to expand equitable, inclusive access to relevant education for all young people, including those in disadvantaged and underserved communities, those with special educational needs and those who are gifted and talented. Senior High School allows young people to develop further skills and competencies and progress in learning achievement, building from the foundation laid in Junior High School. This curriculum intends to meet the learning needs of all high school learners by acquiring 21st Century skills and competencies to prepare them for further studies, the world of work and adult life. Changing global economic, social and technological context requires life-long learning, unlearning, and continuous processes of reflection, anticipation and action.

Philosophy of Senior High School Curriculum

The philosophy underpinning the SHS curriculum is that every learner can develop their potential to the fullest if the right environment is created and skilled teachers effectively support them to benefit from the subjects offered at SHS. Every learner needs to be equipped with skills and competencies of interest to further their education, live a responsible adult life or proceed to the world of work.

Vision of Senior High School Curriculum

The vision of the curriculum is to prepare SHS graduates equipped with relevant skills and competencies to progress and succeed in further studies, the world of work and adult life. It aims to equip all learners with the 21st Century skills and competencies required to be responsible citizens and lifelong learners. When young people are prepared to become effective, engaging, and responsible citizens, they will contribute to the ongoing growth and development of the nation's economy and well-being.

Goal of Senior High School Curriculum

The goal of the curriculum is to achieve relevant and quality SHS through the integration of 21st Century skills and competencies as set out in the Secondary Education Policy. The key features to integrate into the curriculum are:

- Foundational Knowledge: literacy, numeracy, scientific literacy, information, communication and digital literacies, financial literacy and entrepreneurship, cultural identity, civic literacy and global citizenship
- Competencies: critical thinking and problem-solving, innovation and creativity, collaboration, and communication
- Character Qualities: discipline, integrity, self-directed learning, self-confidence, adaptability and resourcefulness, leadership, and responsible citizenship.

The JHS curriculum has been designed to ensure that learners are adequately equipped to transition seamlessly into SHS, where they will be equipped with the relevant knowledge, skills and competencies. The SHS curriculum emphasises character building, acquisition of 21st Century skills and competencies and nurturing core values within an environment of quality education to ensure the transition to further study, the world of work and adult life. This requires the delivery of robust secondary education that meets the varied learning needs of the youth in Ghana. The SHS curriculum, therefore, seeks to develop learners to become technology-inclined, scientifically literate, good problem-solvers who can think critically and creatively and are equipped to communicate with fluency, and possess the confidence and competence to participate fully in Ghanaian society as responsible local and global citizens – (referred to as 'Glocal citizens').

The SHS curriculum is driven by the nation's core values of truth, integrity, diversity, equity, discipline, self-directed learning, self-confidence, adaptability and resourcefulness, leadership, and responsible citizenship, and with the intent of achieving the Sustainable Development Goal 4: 'Inclusive, equitable quality education and life-long learning for all'. The following sections elaborate on the critical competencies required of every SHS learner:

Gender Equality and Social Inclusion (GESI)

- Appreciate their uniqueness about others.
- Pay attention to the uniqueness and unique needs of others.
- Value the perspective, experience, and opinion of others.
- Respect individuals of different beliefs, political views/ leanings, cultures, and religions.
- Embrace diversity and practise inclusion.
- Value and work in favour of a democratic and inclusive society.
- Be conscious of the existence of minority and disadvantaged groups in society and work to support them.
- Gain clarity about misconceptions/myths about gender, disability, ethnicity, age, religion, and all other excluded groups in society
- Interrogate and dispel their stereotypes and biases about gender and other disadvantaged and excluded groups in society.
- Appreciate the influence of socialisation in shaping social norms, roles, responsibilities, and mindsets.
- Identify injustice and advocate for change.
- Feel empowered to speak up for themselves and be a voice for other disadvantaged groups.

21st Century Skills and Competencies

In today's fast-changing world, high school graduates must be prepared for the 21st Century world of work. The study of Mathematics, Science, and Language Arts alone is no longer enough. High school graduates need a variety of skills and competencies to adapt to the global economy. Critical thinking, creativity, collaboration, communication, information literacy, media literacy, technology literacy, flexibility, leadership, initiative, productivity, and social skills are needed. These skills help learners to keep up with today's fast-paced job market. Employers want workers with more than academic knowledge. The 21st Century skills and competencies help graduates navigate the complex and changing workplace. Also, these help them become active citizens who improve their communities. Acquisition of 21st Century skills in high school requires a change in pedagogy from the approach that has been prevalent in Ghana in recent years. Teachers should discourage and abandon rote memorisation and passive learning. Instead, they should encourage active learning, collaboration, and problem-solving, project-based, inquiry-based, and other learner-centred pedagogy should be used. As well as aligning with global best practices, these approaches also seek to reconnect formal education in Ghana with values-based indigenous education and discovery-based learning which existed in Ghana in pre-colonial times. This is aligned with the 'glocal' nature of this curriculum, connecting with Ghana's past to create confident citizens who can engage effectively in a global world. Digitalisation, automation, technological advances and the changing nature of work globally mean that young people need a new set of skills, knowledge and competencies to succeed in this dynamic and globalised labour market.

Critical Thinking and Problem-Solving Competency

- Ability to question norms, practices, and opinions, to reflect on one's values, perceptions, and actions.
- Ability to use reasoning skills to come to a logical conclusion.
- Being able to consider different perspectives and points of view
- Respecting evidence and reasoning
- Not being stuck in one position
- Ability to take a position in a discourse
- The overarching ability to apply different problem-solving frameworks to complex problems and develop viable, inclusive, and equitable solution options that integrate the above-mentioned competencies, promote sustainable development,

Creativity

- Ability to identify and solve complex problems through creative thinking.
- Ability to generate new ideas and innovative solutions to old problems.
- Ability to demonstrate originality and flexibility in approaching tasks and challenges.
- Collaborating with others to develop and refine creative ideas
- Ability to incorporate feedback and criticism into the creative process
- Utilising technology and other resources to enhance creativity
- Demonstrating a willingness to take risks and experiment with new approaches
- Adapting to changing circumstances and further information to maintain creativity

- Integrating multiple perspectives and disciplines to foster creativity
- Ability to communicate creative ideas effectively to a variety of audiences

Collaboration

- Abilities to learn from others; to understand and respect the needs, perspectives, and actions of others (empathy)
- Ability to understand, relate to and be sensitive to others (empathic leadership)
- Ability to deal with conflicts in a group
- Ability to facilitate collaborative and participatory problem-solving
- Ability to work with others to achieve a common goal.
- Ability to engage in effective communication, active listening, and the ability to compromise.
- Ability to work in groups on projects and assignments.

Communication

- Know the specific literacy and language of the subjects studied
- Use language for academic purposes
- Communicate effectively and meaningfully in a Ghanaian Language and English Language
- Communicate confidently, ethically, and effectively in different social contexts.
- Communicate confidently and effectively to different participants in different contexts
- Ability to communicate effectively verbally, non-verbally and through writing.
- Demonstrate requisite personal and social skills that are consistent with changes in society
- Ability to express ideas clearly and persuasively, listen actively, and respond appropriately
- Ability to develop digital communication skills such as email etiquette and online collaboration.
- Ability to engage in public speaking, debate, and written communication.

Learning for Life

- Understand subject content and apply it in different contexts
- Apply mathematical and scientific concepts in daily life
- Demonstrate mastery of skills in literacy, numeracy, and digital literacy.
- Develop an inquiry-based approach to continual learning.
- Be able to understand higher-order concepts and corresponding underlying principles.
- Participate in the creative use of the expressive arts and engage in aesthetic appreciation.
- Use and apply a variety of digital technologies
- Be digitally literate with a strong understanding of ICT and be confident in its application.
- Be equipped with the necessary qualifications to gain access to further and higher education and the world of work and adult life
- Ability to apply knowledge practically in the workplace so that they are able to utilise theory by translating it into practice.
- Develop their abilities, gifts and talents to be able to play a meaningful role in the development of the country
- Be able to think critically and creatively, anticipate consequences, recognise opportunities and be risk-takers
- Ability to pursue self-directed learning with the desire to chart a path to become effective lifelong learners.
- Independent thinkers and doers who show initiative and take action.
- Ability to innovate and think creatively, building on their knowledge base so that they take risks to achieve new goals
- Ability to think critically and solve problems so that they become positive change agents at work, in further study and in their personal lives.
- Be motivated to adapt to the changing needs of society through self-evaluation and ongoing training
- Be able to establish and maintain innovative enterprises both individually and in collaboration with others.
- Be able to ethically prioritise economic values to ensure stability and autonomy
- Show flexibility and preparedness to deal with job mobility
- Be committed towards the improvement of their quality of life and that of others
- Feel empowered in decision-making processes at various levels e.g., personal, group, class, school, etc.

- Be able to seek and respond to assistance, guidance and/or support when needed.
- Ability to make and adhere to commitments.
- Adopt a healthy and active lifestyle and appreciate how to use leisure time well.
- Be enthusiastic, with the knowledge, understanding and skill that enable them to progress to tertiary level, the world of work and adult life.
- Ability to transition from school to the world of work or further study by applying knowledge, skills and attitudes in new situations.
- Be independent, have academic and communication skills such as clarity of expression (written and spoken), and the ability to support their arguments.
- Be innovative and understand the 21st Century skills and competencies and apply them to everyday life.

Global and Local (Glocal) Citizenship

- Appreciate and respect the Ghanaian identity, culture, and heritage
- Be conscious of current global issues and relate well with people from different cultures
- Act in favour of the common good, social cohesion and social justice
- Have the requisite personal and social skills to handle changes in society
- Appreciate the impact of globalisation on the society.
- Ability to be an honest global citizen displaying leadership skills and moral fortitude with an understanding of the wider world and how to enhance Ghana's standing.

Systems Thinking Competency

- Ability to recognise and understand relationships
- Ability to analyse complex systems
- Ability to think of how systems are embedded within different domains and different scales
- Ability to deal with uncertainty

Normative Competency

- Ability to understand and reflect on the norms and values that underlie one's actions
- Ability to negotiate values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions

Anticipatory Competency

- Ability to understand and evaluate multiple futures – possible, probable, and desirable
- Ability to create one's vision for the future.
- Ability to apply the precautionary principle
- Ability to assess the consequences of actions
- Ability to deal with risks and changes

Strategic Competency

- Ability to collectively develop and implement innovative actions that further a cause at the local level and beyond.
- Ability to understand the bigger picture and the implications of smaller actions on them

Self-Awareness Competency

- The ability to reflect on one's role in the local community and (global) society
- Ability to continually evaluate and further motivate one's actions
- Ability to deal with one's feelings and desires

Social Emotional Learning (SEL): Five Core Competencies with Examples

1. *Self-Awareness*

Understanding one's emotions, thoughts, and values and how they influence one's behaviour in various situations. This includes the ability to recognise one's strengths and weaknesses with a sense of confidence and purpose. For instance:

- *Integrating personal and social identities;*
- *Identifying personal, cultural, and linguistic assets;*
- *Identifying one's emotions;*
- *Demonstrating honesty and integrity;*
- *Connecting feelings, values, and thoughts;*

- *Examining prejudices and biases;*
- *Experiencing self-efficacy;*
- *Having a growth mindset;*
- *Developing interests and a sense of purpose;*

2. *Self-Management*

The capacity to control one's emotions, thoughts, and actions in a variety of situations and to realise one's ambitions. This includes delaying obtaining one's desires, dealing with stress, and feeling motivated and accountable for achieving personal and group goals. For instance:

- *Managing one's emotions;*
- *Identifying and utilising stress-management strategies;*
- *Demonstrating self-discipline and self-motivation;*
- *Setting personal and group goals;*
- *Using planning and organisation skills;*
- *Having the courage to take the initiative;*
- *Demonstrating personal and collective agency;*

3. *Social Awareness*

The capacity to comprehend and care for others regardless of their backgrounds, cultures, and circumstances. This includes caring for others, understanding larger historical and social norms for behaviour in different contexts, and recognising family, school, and community resources and supports. For instance:

- *Recognising others' strengths*
- *Demonstrating empathy and compassion*
- *Caring about others' feelings*
- *Understanding and expressing gratitude*
- *Recognising situational demands and opportunities*
- *Understanding how organisations and systems influence behaviour*

4. *Relationship Skills*

The capacity to establish and maintain healthy, beneficial relationships and adapt to various social situations and groups. This includes speaking clearly, listening attentively, collaborating, solving problems and resolving conflicts as a group, adapting to diverse social and cultural demands and opportunities, taking the initiative, and asking for or offering assistance when necessary. For instance:

- *Communicating effectively;*
- *Building positive relationships;*
- *Demonstrating cultural competence;*
- *Working as a team to solve problems;*
- *Constructively resolving conflicts;*
- *Withstanding negative social pressure;*
- *Taking the initiative in groups;*
- *Seeking or assisting when needed;*
- *Advocating for the rights of others.*

5. *Responsible Decision-Making*

The capacity to make thoughtful and constructive decisions regarding acting and interacting with others in various situations. This includes weighing the pros and cons of various personal, social, and group well-being actions. For example:

- *Demonstrating curiosity and an open mind;*
- *Solving personal and social problems;*
- *Learning to make reasonable decisions after analysing information, data, and facts;*
- *Anticipating and evaluating the effects of one's actions;*
- *Recognising that critical thinking skills are applicable both inside and outside of the classroom;*
- *Reflecting on one's role in promoting personal, family, and community well-being;*
- *Evaluating personal, interpersonal, community, and institutional impacts*

Learning and Teaching Approaches

Learning and teaching should develop learners as self-directed and lifelong learners. Learners must be helped to build up deep learning skills and competencies to develop the ability to acquire, integrate and apply knowledge and skills to solve authentic and real-life problems. Learners need to be exposed to a variety of learning experiences to enable them to collaborate with others, construct meaning, plan, manage, and make choices and decisions about their learning. This will allow them to internalise newly acquired knowledge and skills and help them

to take ownership of their education. The 21st Century skills and competencies describe the relevant global and contextualised skills that the SHS curriculum is designed to help learners acquire in addition to the 4Rs (Reading, wRiting, aRithmetic and cReativity). These skills and competencies, as tools for learning and teaching and skills for life, will allow learners to become critical thinkers, problem-solvers, creators, innovators, good communicators, collaborators, digitally literate, and culturally and globally sensitive citizens who are life-long learners with a keen interest in their personal development and contributing to national development.

Given the diverse needs of learners, teachers need to have a thorough grasp of the different pedagogies as they design and enact meaningful learning experiences to meet the needs of different learners in the classroom. The teaching-learning techniques and strategies should include practical activities, discussion, investigation, role play, problem-based, context-based, and project-based learning. Active learning strategies have become increasingly popular in education as they provide learners with meaningful opportunities to engage with the material. These strategies emphasise the use of creative and inclusive pedagogies and learner-centred approaches anchored on authentic and enquiry-based learning, collaborative and cooperative learning, differentiated teaching and learning, holistic learning, and cross-disciplinary learning. They include experiential learning, problem-based learning, project-based learning, and talk-for-learning approaches. Some of the pedagogical exemplars to guide learning and teaching of the SHS curriculum include:

- **Experiential Learning:** Experiential learning is a hands-on approach to learning that involves learners in real-world experiences. This approach focuses on the process of learning rather than the result. Learners are encouraged to reflect on their experiences and use them to develop new skills and knowledge. Experiential learning can take many forms, including internships, service learning, and field trips. One of the main benefits of experiential learning is that it allows learners to apply what they have learned in the classroom to real-world situations. This can help them develop a deeper understanding of the material and make connections between different concepts. Additionally, experiential learning can help learners develop important skills such as critical thinking, problem-solving and communication.
- **Problem-Based Learning:** Problem-based learning is an approach that involves learners in solving real-world problems. Learners are presented with a problem or scenario and are asked to work together to find a solution. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking and problem-solving. One of the main benefits of problem-based learning is that it encourages learners to take ownership of their learning. By working together to solve problems, learners can develop important skills such as collaboration and communication. Additionally, problem-based learning can help learners develop a deeper understanding of the material as they apply it to real-world situations.
- **Project-Based Learning:** Project-based learning is a hands-on approach to learning that involves learners in creating a project or product. This approach allows learners to take an active role in their learning and encourages them to develop important skills such as critical thinking, problem-solving, collaboration, and communication. One of the main benefits of project-based learning is that it allows learners to apply what they have learned in the classroom to real-world situations. Additionally, project-based learning can help learners develop important skills from each other and develop a deeper understanding of the material.
- **Talk for Learning Approaches:** Talk for learning approaches (TfL) are a range of techniques and strategies that are used to encourage learners to talk by involving them in discussions and debates about the material they are learning. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking, collaboration and communication and also makes them develop confidence. One of the main benefits of TfL is that it encourages learners to think deeply about the material they are learning. By engaging in discussions and debates, learners can develop a deeper understanding of the material and make connections between different concepts.
- **Initiating Talk for Learning:** Initiating talk for learning requires the use of strategies that would encourage learners to talk in class. It helps learners to talk and participate meaningfully and actively in the teaching and learning process. Apart from developing skills such as communication and critical thinking, it also helps learners to develop confidence. Some strategies for initiating talk among learners are Activity Ball; Think-Pair-Share; Always, Sometimes, Never True; Matching and Ordering of Cards.
- **Building on What Others Say:** Building on what others say is an approach that involves learners in listening to and responding to their classmates'

ideas. This approach encourages learners to take an active role in their learning and helps them develop important skills such as critical thinking and communication. One of the main benefits of building on what others say is that it encourages learners to think deeply about the material they are learning. By listening to their classmates' ideas, learners can develop a deeper understanding of the material and make connections between different concepts. Additionally, building on what others say can help learners develop important skills such as collaboration and reflection. Some of the strategies to encourage learners to build on what others say are brainstorming, concept cartoons, pyramid discussion, and 5 Whys, amongst others.

- **Managing Talk for Learning:** Managing talk for learning requires the use of various strategies to effectively coordinate what learners say in class. Effective communication is a crucial aspect of learning in the classroom. Teachers must manage talk to ensure that learners are engaged, learning, and on-task in meaningful and purposeful ways. Some strategies for managing learners' contributions are debates, think-pair-share, sage in the circle etc.
- **Structuring Talk for Learning:** One effective way to shape learners' contributions is to structure classroom discussions. Structured discussions provide a framework for learners to engage in meaningful dialogue and develop critical thinking skills. Teachers can structure discussions by providing clear guidelines, such as speaking one at a time, listening actively, and building on each other's ideas. One popular structured discussion technique is the "think-pair-share" method. In this method, learners think about a question or prompt individually, and then pair up with a partner to discuss their ideas. Finally, the pairs share their ideas with the whole class. This method encourages all learners to participate and ensures that everyone has a chance to share their thoughts. Another effective way to structure talk for learning is to use open-ended questions. Open-ended questions encourage learners to think deeply and critically about a topic. They also promote discussion and collaboration among learners. Teachers can use open-ended questions to guide classroom discussions and encourage learners to share their ideas and perspectives. Other strategies that can be used are Concept/Mind Mapping, "Know," "Want to Know," "Learned" (KWL); Participatory Feedback; and the 5 Whys.
- **Diamond Nine:** The Diamond Nine activity is a useful tool for managing talk for learning in the classroom. This activity involves ranking items or ideas in order of importance or relevance. Learners work in groups to arrange cards or sticky notes with different ideas or concepts into a diamond shape, with the most important idea at the top and the least important at the bottom. The Diamond Nine activity encourages learners to think critically about a topic and prioritise their ideas. It also promotes collaboration and discussion among group members. Teachers can use this activity to introduce a new topic, review material, or assess student understanding.
- **Group Work/Collaborative Learning:** Group work or collaborative learning are effective strategies for managing talk for learning in the classroom. These strategies encourage learners to work together to solve problems, share ideas, and learn from each other. Group work and collaborative learning also promote communication and collaborative skills that are essential for success in the workplace and in life. To implement group work effectively, teachers must provide clear guidelines and expectations for group members. They should also monitor group work to ensure that all learners are participating and on-task. Teachers can also use group work as an opportunity to assess individual student understanding and participation.
- **Inquiry-Based Learning:** Learners explore and discover new information by asking questions and investigating.
- **Problem-Based Learning:** Learners are given real-world problems to solve and must use critical thinking and problem-solving skills.
- **Project-Based Learning:** Learners work on long-term projects that relate to real-world scenarios.
- **Flipped Classroom:** Learners watch lectures or instructional videos at home and complete assignments and activities in class.
- **Mastery-Based Learning:** Learners learn at their own pace and only move on to new material once they have mastered the current material.
- **Gamification:** Learning is turned into a game-like experience with points, rewards, and competition.

These strategies provide learners with opportunities to engage with the material in meaningful ways and develop important skills such as critical thinking, problem-solving, collaboration, and communication. By incorporating these strategies into their teaching, teachers can help learners develop a deeper understanding of the material and prepare them for success in the real world. Effective communication is essential for learning in the classroom. Teachers must manage talk to ensure that learners are engaged in learning and on-task. Strategies such as structuring

talk for learning, using Diamond Nine activities, and implementing group work/ collaborative learning can help teachers manage talk effectively and promote student learning and engagement. By implementing these strategies, teachers can create a positive and productive learning environment where all learners can succeed.

Universal Design for Learning (UDL) in the SHS Curriculum

The design of the curriculum uses UDL to ensure the creation of flexible learning environments that can accommodate a wide range of learner abilities, needs, and preferences. The curriculum is designed to provide multiple means of engagement, representation, and action and expression, so teachers can create a more inclusive and effective learning experience for all learners. UDL is beneficial for all learners, but it is particularly beneficial for learners needing special support and learners who may struggle with traditional teaching approaches. The integration of UDL in the pedagogy is aimed at making learning accessible to everyone and helping all learners reach their full potential. For instance, teachers need to:

- incorporate multiple means of representation into their pedagogy, such as using different types of media and materials to present information.
- provide learners with multiple means of action and expression, such as giving them options for how they can demonstrate their learning.
- consider incorporating multiple means of engagement into their choice of pedagogy, such as incorporating games or interactive activities to make learning more fun and engaging.

By doing these, teachers can help ensure that the curriculum is accessible and effective for all learners, regardless of their individual needs and abilities.

Curriculum and Assessment Design: Revised Bloom's Taxonomy and Webb's Depth of Knowledge

The design of this curriculum uses the revised Bloom's Taxonomy and Webb's Depth of Knowledge (DoK) as frameworks to design what to teach and assess.

The Revised Bloom's Taxonomy provides a framework for designing effective learning experiences. Understanding the different levels of learning, informed the creation of activities and assessments that challenge learners at the appropriate level and help them progress to higher levels of thinking. Additionally, the framework emphasises the importance of higher-order thinking skills, such as analysis, evaluation, and creation, which are essential for success in today's complex and rapidly changing world. This framework is a valuable tool for educators who want to design effective learning experiences that challenge students at the appropriate level and help them develop higher-order thinking skills. By understanding the six levels of learning and incorporating them into their teaching, educators can help prepare students for success in the 21st century. The six hierarchical levels of the revised Bloom's Taxonomy are:

1. **Remember** – At the foundation is learners' ability to remember. That is retrieving knowledge from long-term memory. This level requires learners to recall concepts—identify, recall, and retrieve information. Remembering is comprised of identifying, listing, and describing. Retrieving relevant knowledge from long-term memory includes, recognising, and recalling is critical for this level.
2. **Understand** – At understanding, learners are required to construct meaning that can be shown through clarification, paraphrasing, representing, comparing, contrasting and the ability to predict. This level requires interpretation, demonstration, and classification. Learners explain and interpret concepts at this level.
3. **Apply** – This level requires learners' ability to carry out procedures at the right time in a given situation. This level requires the application of knowledge to novel situations as well as executing, implementing, and solving problems. To apply, learners must solve multi-step problems.
4. **Analyse** – The ability to break things down into their parts and determine relationships between those parts and being able to tell the difference between what is relevant and irrelevant. At this level, information is deconstructed, and its relationships are understood. Comparing and contrasting information and organising it is key. Breaking material into its constituent parts and detecting how the parts relate to one another and an overall structure or purpose is required. The analysis also includes differentiating, organising and attributing.
5. **Evaluate** – The ability to make judgments based on criteria. To check whether there are fallacies and inconsistencies. This level involves information evaluation, critique, examination, and formulation of hypotheses.
6. **Create** – The ability to design a project or an experiment. To create, entails learners bringing something new. This level requires generating information—planning, designing, and constructing.

Webb's Depth of Knowledge (DoK) is a framework that helps educators and learners understand the level of cognitive engagement required for different types of learning tasks. The framework includes four levels. By understanding the four DoK levels, educators can design learning activities that challenge students to engage in deeper thinking and problem-solving. DoK is an essential tool for designing effective instruction and assessments. By understanding the different levels of DoK, teachers can design instruction and assessments that align with what they intend to achieve. DoK is a useful tool for differentiating instruction and providing appropriate challenges for all learners. Teachers can use DOK to identify students who need additional support or those who are ready for more advanced tasks. The four levels of Webb's' DoK assessment framework are:

- **Level 1: Recall and Reproduction –** Assessment at this level is on recall of facts, concepts, information, and procedures—this involves basic knowledge acquisition. Learners are asked specific questions to launch activities, exercises, and assessments. The assessment is focused on recollection and reproduction.
- **Level 2: Skills of Conceptual Understanding –** Assessment at this level goes beyond simple recall to include making connections between pieces of information. The learner's application of skills and concepts is assessed. The assessment task is focused more on the use of information to solve multi-step problems. A learner is required to make decisions about how to apply facts and details provided to them.
- **Level 3: Strategic Reasoning** – At this level, the learner's strategic thinking and reasoning which is abstract and complex is assessed. The assessment task requires learners to analyse and evaluate composite real-world problems with predictable outcomes. A learner must apply logic, employ problem-solving strategies, and use skills from multiple subject areas to generate solutions. Multitasking is expected of learners at this level.
- **Level 4: Extended Critical Thinking and Reasoning –** At this level of assessment, the learner's extended thinking to solve complex and authentic problems with unpredictable outcomes is the goal. The learner must be able to strategically analyse, investigate, and reflect while working to solve a problem, or changing their approach to accommodate new information. The assessment requires sophisticated and creative thinking. As part of this assessment, the learner must know how to evaluate their progress and determine whether they are on track to a feasible solution for themselves.

The main distinction between these two conceptual frameworks is what is measured. The revised Bloom's Taxonomy assesses the cognitive level that learners must demonstrate as evidence that a learning experience occurred. The DoK, on the other hand, is focused on the context—the scenario, setting, or situation—in which learners should express their learning. In this curriculum, the revised Bloom's taxonomy guided the design, and the DoK is used to guide the assessment of learning. The taxonomy provides the instructional framework, and the DoK analyses the assignment specifics. It is important to note that Bloom's Taxonomy requires learners to master the lower levels before progressing to the next. So, suppose the goal is to apply a mathematical formula. In that case, they must first be able to identify that formula and its primary purpose (remember and understand). The cognitive rigour is therefore presented in incremental steps to demonstrate the learning progression. When measuring assessments in DoK, learners move fluidly through all levels. In the same example, while solving a problem with a formula, learners recall the formula (DoK 1) to solve the problem (DoK 2 and DoK 3). Depending on the difficulty of the problem to be solved, the learner may progress to DoK 4.

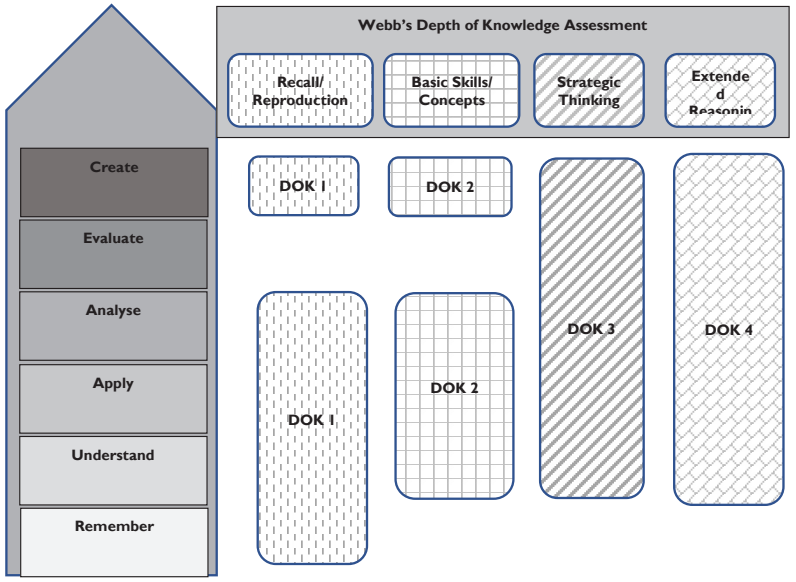

Figure 1: Revised Bloom Taxonomy combined with Webb's Depth of Knowledge for Teaching and Assessment

The structure of teaching and the assessment should align with the six levels of Bloom's knowledge hierarchy and DoK shown in Figure 1. Each level of DoK should be used to assess specific domains of Bloom's Taxonomy as illustrated in the table below:

Depth of Knowledge (DoK) Assessment	Bloom's Taxonomy applied to DoK
• Level 1: Recall and Reproduction	• Remembering, Understanding, Application, Analysis and Creation
• Level 2: Basic Skills and Concepts	• Understanding, Application, Analysis and Creation
• Level 3: Strategic Thinking	• Understanding, Application, Analysis, Evaluation and Creation
• Level 4: Extended Reasoning	• Understanding, Application, Analysis, Evaluation and Creation

In line with the National Pre-Tertiary Learning and Assessment Framework, the Secondary Education Assessment Guide (SEAG) requires that classroom assessments should cover **Assessment as learning (AaL), Assessment of learning (AoL) and Assessment for learning (AfL).** Therefore, teachers should align the Revised Bloom's Taxonomy with the DoK framework of assessment. Formative assessments should include classroom discussions, project-based assignments, and self-reflection exercises, while summative assessments should include standardised tests and rubric-based evaluations of learners' work. It is important to seek feedback from learners themselves, as they may have unique insights into how well they are developing these skills in the classroom.

To assess 21st Century skills and competencies in the classroom, teachers will have to use a combination of both formative and summative assessments to evaluate learners' acquisition of these skills and competencies. For instance:

- Identify the specific 21st Century skills and competencies to be assessed. For instance, you might want to assess *critical thinking, problem-solving, or creativity*.
- Align the skills and competencies with the DoK levels. For example, lower DoK levels might be more appropriate for assessing basic knowledge and comprehension, whereas higher DoK levels might be more appropriate for assessing more complex skills such as *analysis, synthesis, and evaluation*.
- Develop assessment items that align with the DoK levels and the skills and competencies you want to assess. These items should be designed to elicit evidence of learning across the different levels of the DoK framework.
- Administer the assessment and collect data. Analyse the data to gain insights into student learning and identify areas where learners may need additional support or instruction.

The DoK framework is a powerful tool for assessing the acquisition of 21st Century skills and competencies in the classroom, helping teachers to better understand how learners are learning and identify areas for improvement.

Educational success is no longer about producing content knowledge, but rather about extrapolating from what we know and applying the knowledge creatively in new situations.

The overall assessment of learning at SHS should be aligned with the National Pre-Tertiary Learning and Assessment Framework and the Secondary Education Assessment Guide. Formative and summative assessment strategies must be used.

Definition of Key Terms and Concepts in the Curriculum

- **Learning Outcomes:** It is a statement that defines the knowledge, skills, and abilities that learners should possess and be able to demonstrate after completing a learning experience. They are specific, measurable, attainable, and aligned with the content standards of the curriculum. It helps the teachers to determine what to teach, how to teach, and how to assess learning. Also, it communicates expectations to learners and helps them to better master the subject.
- **Learning Indicators:** They are measures that allow teachers to observe progress in the development of capacities and skills. They provide a simple and reliable means to evaluate the quality and efficacy of teaching practices, content delivery, and attainment of learning outcomes.
- **Content Standards:** It is a statement that defines the knowledge, skills, and understanding that learners are expected to learn in a particular subject area or grade level. They provide a clear target for learners and teachers and help focus resources on learner achievement.
- **Pedagogical Exemplars:** They are teaching examples used to convey values and standards to learners. Pedagogical Exemplars are usually demonstrated through teacher behaviour.
- **Assessment:** It is the systematic collection and analysis of data about learners' learning to improve the learning process or make a judgement on learner achievement levels. Assessment is aimed at developing a deep understanding of what learners know, understand, and can do with their knowledge because of their educational experiences. Assessment involves the use of empirical data on learners' learning to improve learning. Assessment is an essential aspect of the teaching and learning process in education, which enables teachers to assess the effectiveness of their teaching by linking learner performance to specific learning outcomes.
- **Teaching and Learning Resources:** Teaching and learning resources are essential tools for teachers to provide high-quality education to their learners. These resources can take various forms, including textbooks, audiovisual materials, online resources, and educational software. It is also important to avoid stereotypes and use inclusive language in teaching and learning resources. This means avoiding language that reinforces negative stereotypes and using language that is respectful and inclusive of all individuals regardless of their background. Using a consistent tone, style, and design is very important.

PHILOSOPHY, VISION AND GOAL OF BIOMEDICAL SCIENCE

Philosophy

Every Learner can be equipped to excel in pursuit of further studies and/or working life in the biomedical science domain through comprehension of foundational concepts, problem-based inquiry, experimentation and ethical development of clinically translatable solutions to healthcare delivery in a well-supported teacher-learner environment.

Vision

Learners equipped with 21st century skills and competencies as well as understand the core biomedical science principles and research techniques required to define healthcare challenges and develop interventions and innovations to human health conditions.

Goal

To produce lifelong learners with the requisite knowledge, skills, and attitudes in biomedical science necessary to contribute to the local and global body of knowledge and the field of work.

Contextual Issues

Traditionally, many learners at the high school level think the only way they can contribute to healthcare delivery is through the route of medicine, nursing and pharmacy.

However, Biomedical Science provides an exciting domain where learners can explore scientific principles and technological advancement to improve healthcare delivery, offering a myriad of career opportunities. Thus, the introduction of biomedical science in the Ghanaian space can offer avenues for the synergistic application of foundations of Biology, Physical Science and Technology to healthcare.

Rationale

The study of biomedical science will enable learners to advance in the knowledge of living systems with a focus on understanding specific disease processes, discovering the underlying molecular mechanisms responsible for disease development, and finding a cure or intervention for specific health conditions.

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SCOPE AND SEQUENCE

Biomedical Science Summary

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1.	Biomedical Science In Society	Biomedical Science Practice	1	1	3	1	1	3	1	1	3
2.		Biosafety	1	1	3	1	1	3	1	1	3
3.	Human Body System	Anatomy and Physiology	1	1	3	1	1	3	1	1	4
4.		Diseases and Disorders	1	1	3	2	2	8	1	1	4
5.	Biomedical Intervention	Diagnostic Devices	1	1	3	1	1	3	1	1	3
6.		Therapeutic Devices	1	1	3	1	1	3	1	1	3
7.	Biomedical Innovations	Research and Design In Biomedical Science	1	1	4	1	1	2	1	1	2
Total			**7**	**7**	**22**	**8**	**8**	**25**	**7**	**7**	**22**

Overall Totals (SHS 1 – 3)

Content Standards	22
Learning Outcomes	22
Learning Indicators	69

YEAR ONE

Subject **BIOMEDICAL SCIENCE**
Strand **1. BIOMEDICAL SCIENCE IN SOCIETY**
Sub-Strand **1. BIOMEDICAL SCIENCE PRACTICE**

Learning Outcomes	21st Century Skills and Competencies	GESI[1], SEL[2] and Shared National Values
1.1.1.LO.1		
Describe what biomedical science is and how scientific investigation is applied in biomedical science.	**Critical Thinking:** • As learners watch videos and interact with other learners, they critically observe, analyse and relate the roles biomedical scientists play in their environment to what was observed in the videos. • As learners research on the various ways of solving problems related to biomedical science, they critically apply the knowledge to biomedical science problems in society. **Collaboration:** • Learners work in mixed-ability groups and relate their observations to peers, brainstorm and come out with agreed answers. Learners learn to accept constructive feedback from peers. • Learners work in gender-balanced and culturally diverse groups and take turns to relay the information they have gathered to their peers. The right ambience should be created to allow each and every learner to collaborate with others, building on points raised and agreeing on the collective observations while amicably resolving issues of differences in opinions.	**GESI:** • Learners work in mixed-ability groups. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they share their personal experiences with biomedical scientists in their environment. • Learners embrace different opinions as they share their personal experiences to solve problem with the acquired knowledge in biomedical science. • All learners will be given the opportunity to provide oral contributions confidently and effectively to different participants in different contexts.

[1] Gender Equality and Social Inclusion

[2] Socio-Emotional Learning

	Communication: • Learners get the opportunity to write their observations and communicate ideas to peers. • Learners brainstorm and share their views in an encouraging environment. **Leadership:** Roles and responsibilities for various tasks can be assigned to individual group members. **Digital Literacy:** Learners research and gather information from the Internet using technological tools such as phones, computers, etc. **Problem Solving:** Learners use several information sources and pick out useful information as applicable to their work.	**National Core Values:** • Tolerance • Patience

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.1.1.CS.1	1.1.1.LI.1	1.1.1.AS.1
Demonstrate an understanding of Biomedical Science.	**Explain what biomedical science is and what it is not.** **Digital Learning:** Watch videos and pictures of biomedical scientists in practice as well as the products of biomedical science. **Talk for Learning:** Through a whole class session, discuss observations made and relate them to personal experiences with biomedical scientists and/or products of biomedical science. **Collaborative Learning:** Through think-pair-share, identify the key features of biomedical science as a field of study and outline some misconceptions about the subject.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.2	1.1.1.AS.2
	Identify problems in the society that can be solved by applying biomedical science. **Problem-Based Learning:** In groups, identify and research into problems within the society and explain how biomedical science can be applied to solve these problems. **Talk for Learning:** Through a class discussion, identify other issues or problems outside the local society that can be addressed through biomedical science.	**Level 1 Recall** Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.1.1.LI.3	1.1.1.AS.3
	Explain how the scientific method can be applied to undertake investigations or address problems in biomedical science. **Structuring Talk for Learning:** In a group discussion, initiate an interactive talk session on how a local problem could be addressed through the scientific method, focusing on the main steps of the scientific method. **Problem-Based Learning:** In mixed-ability groups develop a hypothesis on a local/societal problem that falls under the field of biomedical science. Develop a PowerPoint/poster presentation on how the hypothesis can be investigated using the scientific method.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Video • Documentaries • Pictures	• Online resources • Glocal articles	• Reports • Pictures	• Charts • Textbook

Subject **BIOMEDICAL SCIENCE**
Strand **1. BIOMEDICAL SCIENCE IN SOCIETY**
Sub-Strand **2. BIOSAFETY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.1.2.LO.1		
Describe various biohazards and critically analyse their routes of exposure.	**Critical Thinking:** Through observing, analysing and identifying the various risk level of biohazards. **Decision Making and Information Literacy:** Learners think through the information that has been acquired in order to justify the risk level of biohazards. **Collaboration:** Learners are mixed in groups and brainstorm to justify the use of biohazardous symbols as well as the risk level. Learners learn to accept constructive feedback from peers. **Critical Observation:** Learners critically examine the stained surfaces and suggest the various routes of pathogen exposure to the human body. **Creativity:** Learners creatively use their knowledge to create a mind map for the various routes of pathogen exposure. **Curiosity:** Learners' curiosity and level of awareness are aroused as they see teacher shake hands while they walk in and see stains transferred to surfaces. **Decision Making:** Learners determine the inappropriate representation of safety in the laboratory and how to represent safety in the laboratory properly.	**GESI:** • Learners work in mixed-gender and mixed-ability groups. • Embrace diversity and practice inclusion as they discuss the topics. • Avoid discriminating against persons from different backgrounds in terms of religion, gender, ethnicity or ethnicity. • Give more time to slow learners to complete tasks. • Give exceptional learners additional tasks. **National Core Values:** • Discipline • Obedience • Respect

	Self-Awareness: Learners conduct themselves in good manner by following the dos and don'ts of safety in the laboratory.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.1.2.CS.1	1.1.2.LI.1	1.1.2.AS.1
Demonstrate an understanding of biohazards and analyse their routes of exposure.	**Discuss the various biohazards as well as the risk groups.** **Initiating Talk for Learning:** With the aid of flashcards or pictures showing various biohazards, engage learners to identify and discuss the peculiar features. **Collaborative Learning:** In large groups, identify and group a set of randomised biohazards according to their risk levels (Level 1, 2, 3 and 4). Explain the reasons behind the groupings (of the randomised symbols) through class presentations. **Activity-Based Learning:** Identify various hazards in varied scenarios within the community (or through the use of videos or pictures), sketch the representative symbol and determine potential negative outcome(s) of a given hazard and the frequency of occurrence (i.e., "risk"). Learners assess if the risk is acceptable.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.2.LI.2	1.1.2.AS.2
	Explain the routes of exposure of pathogens to humans. **Demonstrative Learning:** Ask volunteers to apply a dye or coloured powder on bare hands and shake hands with different people to demonstrate how pathogens spread. **Structuring Talk for Learning:** Brainstorm on how humans are exposed to pathogens, for example through direct contact, inhalation, ingestion, and inoculation. **Collaborative Learning:** Work in pairs to create mind maps on ways humans are exposed to pathogens.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.2.LI.3	1.1.2.AS.3
	Analyse laboratory-acquired infections (LAIs), including some case studies. **Initiating Talk for Learning:** Watch videos on a case study of LAI (e.g., "Outbreak") or listen to summarised conversations on LAI and write down at least three items or practices observed that may have been inaccurate or are interesting representations of safety in the laboratory.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning

	Exploratory Learning: Engage on a field trip to a laboratory for a talk on LAIs or invite a resource person to the class. **Collaborative Learning:** Through think-pair-share, write down examples, sources and prevention of LAIs			Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Flashcards • Pictures • Sticky Notes/Flip charts	• Standards and regulatory documents • Glo germ/dye/coloured powder	• Chart • Picture Video	• Chart • Computer

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **1. ANATOMY AND PHYSIOLOGY**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
1.2.1.LO.1		
Identify the various human body systems and establish the interrelations between the systems for life.	**Critical Observation:** Learners critically observe diagrams and models and group them together under the various body systems. **Communication:** Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation. **Literacy:** Learners by critically studying models, diagrams and watching videos, learn the characteristics of the organs that make up the body system by making critical observations of how the various organs are adopted for their various functions. **Attention to Detail:** Learners by critically observing the features of the organs that make them adopted for their functions learn how to pay attention to details to make critical observations. **Collaboration:** • Learners work in mixed-ability groups and relate their observations on the interconnectedness of the human body system to peers and come out with agreed answers. Learners learn to accept constructive feedback from peers. • In mixed-ability groups, learners relate their observations on the interconnectedness of the human body system and come out with a mind map of how the body systems work together to support life. Learners learn to accept constructive feedback from peers.	**GESI:** • Learners work in mixed-gender and mixed-ability groups. • Embrace diversity and practice inclusion as they discuss the topics. • Avoid discriminating against persons from different backgrounds in terms of religion, gender, ethnicity or ethnicity. • Give more time to slow learners to complete tasks. • Give exceptional learners additional tasks. • Be conscious of your personal biases. **National Core Values:** • Respect • Punctuality • Discipline

	Creativity: Learners use their knowledge to create a mind map of the interconnectedness of the human body system. **Critical Thinking:** Learners use the homeostasis knowledge to achieve the homeostasis effect to the human body system. **Problem Solving:** Learners acquire problem-solving skills as they observe multiple sources of information and creating their own maps and tables to illustrate the interconnectedness of the systems for good health.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.2.1.CS.1	1.2.1.LI.1	1.2.1.AS.1
Demonstrate an understanding of the human body systems and how they are interconnected.	**Explore the structure, functions and parts of the major human body systems involved in communication, power, movement, protection, and homeostasis.** **Collaborative Learning:** Work in groups to study various human body systems such as the nervous, respiratory, circulatory, digestive, endocrine and musculoskeletal systems for group presentations in class. **Exploratory Learning:** Using charts, models or videos, assist learners to identify the parts and functions of each of the human body systems discussed.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.1.LI.2	1.2.1.AS.2
	Explain the interconnections between the human body systems and how these systems work together to maintain health and homeostasis. **Collaborative Learning:** Work in groups to establish the relationship among body systems in performing specific body functions (e.g., how the digestive system affects the muscle and skeletal systems) using available resources (e.g., videos, PowerPoint presentations, textbooks or webpages). **Activity-Based Learning:** Create concept maps to link different body systems that work together to perform various functions. **Initiating Talk for Learning:** Engage learners in a class discussion to explain homeostasis and how the body achieves homeostasis. Learners identify systems working together to maintain homeostasis and health of an individual.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.2.1.LI.3	1.2.1.AS.3
	Evaluate how the interconnections and interactions of multiple body systems are necessary for life. **Project-Based Learning:** Learners work in groups to create a map of the interconnectedness of the body systems and how they work together to support life. Using an appropriate table/figure as a reference, learners illustrate how injury (e.g., compound fracture with bone protruding through the skin, reflex action etc.) or an unfavourable condition elicits responses in other organ systems for health.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning

				Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Textbook • Anatomical models	• Anatomical diagrams • Virtual anatomical visualization platforms	• Videos • Charts	

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **2. DISEASES AND DISORDERS**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.2.2.LO.1		
Explain what a disease is with examples, identify the symptoms of common diseases and illustrate how the symptoms of diseases lead to diagnosis.	**Communication:** • Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation. • Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation and also learn public speaking skills as they take turns to present their work. **Critical Thinking:** • Learners by critically studying models, diagrams and watching videos learn the characteristics of the organs that make up the body system by making critical observations of how the various organs are adopted for their various functions. • As learners watch the videos and contribute to the discussion. Based on their personal experiences, they are able to relate their previous knowledge and experiences to what is being learnt. **Digital Literacy:** As learners research and use technological tools to prepare their presentations, they gain experiential training on how illnesses are diagnosed and treated. **Leadership:** As learners work in groups to research and prepare their presentations, they create and share tasks and responsibilities among themselves. **Information and Technology Literacy:** As learners watch videos and understand the graph chart of sickle cell disease over the period of years,	**GESI:** • Learners embrace different opinions as they share their personal experiences to unravel the mystery behind diseases and their symptoms. • Learners understand and embrace people living with sickle cell disease and the lifestyle of the sickle cell disease patients. • Learners work in mixed-gender and mixed-ability groups. • Embrace diversity and practice inclusion as they discuss the topics. • Avoid discriminating against persons from different backgrounds in terms of religion, gender, ethnicity or ethnicity. • Give more time to slow learners to complete tasks. • Give exceptional learners additional tasks. **National Core Values:** • Tolerance • Respect

	learners are able to contribute their knowledge on how the spread of sickle cell disease and how it can be reduced drastically. **Critical Observation:** Learners can critically identify a sickle cell patient as the learner has gained knowledge of the symptoms and behavioural characteristics of a sickle cell patient.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.2.2.CS.1	1.2.2.LI.1	1.2.2.AS.1
Show an understanding of common diseases and conditions that can disrupt the functioning of cells, tissues and organs within the body.	**Explain what a disease is.** **Managing Talk for Learning:** Learners share their personal experiences of symptoms experienced when they are unwell. Watch a video on the different types of diseases and write down key observations. **Activity-Based Learning:** Create posters on diseases in terms of their explanations, features, and symptoms. Classify diseases as acute or chronic.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.2.LI.2	1.2.2.AS.2
	Explore how initial symptoms of an illness lead to diagnosis and treatment. **Demonstrative Learning:** Learners are put in groups to do a role-play on diagnosing and treating illness. **Exploratory Learning:** • After the role-play, review the whole process of how diagnosis and treatments are deduced from initial symptoms. • Learners are made to further research how this is done in real-life settings and present their findings to the class.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.2.2.LI.3	1.2.2.AS.3
	Explore the symptoms and factors contributing to sickle cell disease and its impact on humans. **Inquiry-Based Learning:** In groups, research from various sources about how sickle cell disease occurs in humans and the symptoms of the disease. **Activity-Based Learning:** Learners undertake the cross-mapping for the sickle genes to show how it is transferred from parents to offspring. Based on the crossings, deduce how the disease can be curtailed in humans.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Computer • Projector	• Video • Flash cards with names of a common diseases	• Tablets or mobile phones • Online resources	• Textbooks

Subject	**BIOMEDICAL SCIENCE**
Strand	**3. BIOMEDICAL INTERVENTION**
Sub-Strand	**1. DIAGNOSTIC DEVICE**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
1.3.1.LO.1		
Explain medical intervention. Identify and describe various diagnostic medical interventions.	**Communication:** • Learners learn communication skills by talking about the knowledge acquired on the various forms of medical interventions, without discrimination and intimidation. • Learners contribute to the discussion by expressing their thoughts among their peers about the experience each member has gained on using diagnostic devices through the videos watched and the field trip organised. **Critical Observation:** • Learners critically observe and categorise the various forms of medical interventions. • As learners watch videos and embark on a field trip, they critically observe and learn how the various diagnostic devices are used in the hospital, clinics and laboratory. **Oral Communication:** Learners learn to freely express themselves freely without intimidation and teasing from colleagues and teachers. **Critical Thinking, Curiosity and Digital Literacy**: As learners use the Internet to look for information, critique data by inquiry and present their findings. **Leadership:** As learners work in groups to research and prepare their presentations, they create and share tasks and responsibilities among themselves.	**GESI:** • Learners embrace different opinions as they share their personal knowledge on the various medical interventions. • Learners appreciate both the local and foreign resources that are used to advance the primitive diagnostic devices into modern diagnostic devices. • Learners appreciate the uniqueness of each gender through male and female participation in the operation of the diagnostic devices. • Avoid discriminating against persons from different backgrounds in terms of religion, gender, or ethnicity. • Give more time to slow learners to complete tasks. • Give exceptional learners additional tasks. **National Core Values:** • Patience • Respect • Honesty

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.3.1.CS.1	1.3.1.LI.1	1.3.1.AS.1
Explore medical interventions and their relevance to diagnosis.	**Explain medical intervention in relation to diagnosis, therapy and prevention.** **Initiating Talk for Learning:** Teacher leads a discussion on the essence of medical intervention and how it is needed for the diagnosis and therapy or treatment of diseases as well as the preventive measures of diseases. **Digital Learning:** Based on the discussion, work in groups to create word clouds or create online journals on medical interventions in terms of diagnosis, prevention and therapy.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.3.1.LI.2	1.3.1.AS.2
	Compare and contrast primitive diagnostic medical interventions and modern diagnostic devices. **Structuring Talk for Learning:** Show a video or invite a resource person to give a presentation on developments in medical diagnostic devices and interventions from ancient to modern times. **Talk for Learning:** Discuss the challenges with the primitive diagnostic medical intervention and research on the steps that were taken to advance the primitive form into modern diagnostic devices. **Activity-Based Learning:** Create a flow chart on the various stages in the advancement of diagnostic devices from ancient to modern times. In pairs, create a table on the similarities and differences between primitive and modern modes of medical diagnosis.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.3.1.LI.3	1.3.1.AS.3
	Explore the significance of the various diagnostic devices used for medical intervention. **Experiential Learning:** Embark on a field trip and watch videos on how the various diagnostic devices are used in medical practice for the treatment of diseases. **Project-Based Learning:** In groups, present a report on how the various diagnostic devices are used as well as how the troubleshooting is done in order to yield a positive test result for the patients.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning**

				Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Textbooks • Charts	• Pictures • Online resources	• Videos • Pictures	• Internet

Subject **BIOMEDICAL SCIENCE**
Strand **3. BIOMEDICAL INTERVENTION**
Sub-Strand **2. THERAPEUTIC DEVICE**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
1.3.2.LO.1		
Identify the forms of therapy and describe the roles of various therapists and the tools they use in healthcare delivery.	**Digital Literacy:** • Learners gain some mastery using digital tools through use of online resources and computing resources. • Learners have the opportunity to design, prepare and present their presentations using ICT tools. **Curiosity:** • Learners develop their sense of curiosity as they recount the experiences themselves and loved ones and asked questions. • Learners become aware their environment as they view videos or visit health facilities. Learners are required to carefully observe scenes and identify devices. **Communication:** • Learners learn to articulate their observations and opinions to the colleagues. • Learners learn to express their opinions and ideas in a supported environment. • Learners communicate their works to the class using visual aids. **Collaboration:** • Learners appreciate the diversity in persons and learn to work together to accomplish tasks. • Learners work with their peers to produce required outcomes.	**GESI:** • Use of both local and global examples. • Devoting more time to identified slow learners. • Not laughing or teasing learners to boost their morale to contribute meaningfully to discussions. • Providing positive feedback from colleagues and teachers. • Gender-balanced grouping of learners. • Ensuring formation of mixed-ability groups. • Assigning roles to members of the group to promote inclusion and responsibility. • Use videos that are not skewed against a particular gender. **National Core Values:** • Unity • Punctuality • Discipline

	Creativity: Leaners learn to identify and classify items using mind maps **Tolerance/Emotional Intelligence:** Learners learn to tolerate their peers as they present and also criticise their presentations.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.3.2.CS.1	1.3.2.LI.1	1.3.2.AS.1
Demonstrate an understanding of the use of therapeutic devices for medical intervention.	**Identify the various forms of therapy.** **Experiential Learning:** Invite a resource person to give a talk or teacher should deliver a PowerPoint presentation on various forms of therapy. **Collaborative Learning:** Based on the talk, work in groups to identify the different types of therapies, and consult books and other relevant sources to categorise them into the various forms of therapy. **Activity-Based Learning:** Individually write short notes on the various forms of therapy based on the presentation and the sources contacted.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.3.2.LI.2	1.3.2.AS.2
	Investigate who a therapist is and enumerate the various specialties. **Experiential Learning:** Embark on a visit to a therapist or listen to a presentation by a therapist about their profession and job schedule. **Activity-Based learning:** In groups, role-play the duties of the various professionals involved in the provision of therapy.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	1.3.2.LI.3	1.3.2.AS.3
	Identify the various therapeutic devices used by the therapist. **Experiential Learning:** Embark on a field trip to a hospital or watch videos/pictures showing examples of therapy being undertaken, to observe and document the various therapeutic devices used in therapy. **Project-Based Learning:** In groups, create charts on various therapeutic devices and their uses.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Textbook • Pictures	• Online resources • Medical devices	• Videos • Computer	• Projector

Subject **BIOMEDICAL SCIENCE**
Strand **4. BIOMEDICAL INNOVATIONS**
Sub-Strand **1. RESEARCH AND DESIGN IN BIOMEDICAL SCIENCE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.4.1.LO.1		
Use credible online resources to research and propose solutions to healthcare problems.	**Communication:** Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation and also learn public speaking skills as they take turns to share their ideas. **Information and Technology Literacy:** As learners research and use technological tools to prepare their presentations, they gain experiential training on how to assess credible information on the internet. **Collaboration:** • Learners work with their peers in mixed-ability groups to come out with the desired outcome.. **Digital Literacy**: • Learners learn to use the Internet to search for credible information. • Learners learn to use the Internet for research. **Critical Thinking:** • Learners apply assessment criteria to indicate the credibility of an Internet source and justify the choice of judgment. • Learners identify health problems in the society, consult others and critically analyse the remedies published or recommended to churn out proposed solutions to identified problems.	**GESI:** • Learners embrace diverse opinions as they share their ideas. • Assign roles to members in the group and work together in peace and harmony to promote inclusion and responsibility. • Use of mixed-ability and/or gender-balanced groupings. • As learners use the worldwide web, they appreciate global and cross-cutting themes. • All learners given the opportunity to provide written and/or oral communication of ideas and thoughts. **National Core Values:** • Unity • Punctuality • Discipline

	Problem Solving: Learners use online and media resources to review the solutions of others to specified health problems and formulate their own solutions.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
1.4.1.CS.1	1.4.1.LI.1	1.4.1.AS.1
Demonstrate knowledge on how to access and use information from credible sources.	**Analyse website content and assess overall credibility of the information.** **Managing Talk for Learning:** Engage in a class discussion on how to assess the credibility of information on websites (reputation of the host, relevance of information, currency of date, asking experts, check supporting sources, consideration of personal biases, etc.) Brainstorm on the implication of false information on research and science. **Project-Based Learning:** Break learners into groups and let learners research about a given topic on the Internet (e.g., treatment of sickle cell). Each group assesses the credibility of the information based on the criteria provided. Groups present their findings to the class.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.4.1.LI.2	1.4.1.AS.2
	Use online search engines and journal databases to locate reliable scientific articles. **Exploratory Learning:** Learners use online search engines like Google to search for credible information and give reasons they think the information is credible.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.4.1.LI.3	1.4.1.AS.3
	Use different approaches to propose solutions to healthcare problems in the country. **Project-Based Learning:** Learners work in pairs to identify a healthcare problem in their environment and consult online resources, resource persons, books or libraries to search for possible remedies to the identified problem. Learners then propose solution using the information derived from the various sources.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	1.4.1.LI.4		1.4.1.AS.4
	Make an effective presentation of scientific information on a healthcare issue. **Activity-Based Learning:** Individually, prepare a PowerPoint presentation to the class on an identified healthcare problem, its causes, effects/symptoms and possible solutions.		Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning:
Teaching and Learning Resources	• Computer • Phone	• Projector • Internet connection	

YEAR TWO

Subject BIOMEDICAL SCIENCE
Strand 1. BIOMEDICAL SCIENCE IN SOCIETY
Sub-Strand 1. BIOMEDICAL SCIENCE PRACTICE

Learning Outcomes	21st Century Skills and Competencies	GESI[3], SEL[4] and Shared National Values
2.1.1.LO.1		
Describe various roles of biomedical scientists in the society.	**Creativity/Critical Thinking:** Learners watch videos/images or observe biomedical scientists at work. They critically observe, analyse and relate the various biomedical science careers and relate these observations to the prevention, diagnosis and treatment of diseases. **Collaboration:** Learners work in mixed-ability/ gender groups and relate their observations to peers, brainstorm and come out with agreed answers. Learners learn to accept constructive feedback from peers. **Curiosity/Critical Thinking:** Learners watch videos/images or observe the work of biomedical scientists in forensics. They critically observe, analyse and relate the knowledge acquired to a criminal investigation. **Tolerance:** Learners learn to accept constructive feedback from peers. **Communication:** Learners communicate their thoughts and opinions on videos watched on the role biomedical science play in medical device production among their peers, and brainstorm with the guide of the teacher.	**GESI:** • Learners work in mixed-ability groups (different gender with diverse backgrounds). • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they share their personal experiences with biomedical science professionals in their environment. • Learners embrace different opinions as they build on what others say on the role biomedical science professionals play in the area of medical device production. **National Core Values:** • Respect • Patience • Friendliness

[3] Gender Equality and Social Inclusion

[4] Socio-Emotional Learning

	Information Literacy: By watching video documentaries/pictures as they learn to relate these documentaries to what is being studied in the classroom.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.1.1.CS.1	2.1.1.LI.1	2.1.1.AS.1
Explore the various roles of biomedical scientists in the society.	**Investigate and discuss a variety of biomedical science careers that relate to the prevention, diagnosis, and treatment of diseases.** **Experiential Learning**: Learners visit the workplace of selected biomedical scientists or watch videos of biomedical scientists at work or observe pictures of biomedical science professionals. Learners make notes of their observations and discuss the various careers in biomedical science. **Activity-Based Learning**: Work in groups to role-play the various professionals and how they work daily in relation to the prevention, diagnosis and treatment of diseases.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.1.LI.2	2.1.1.AS.2
	Discuss and describe the role of biomedical science professionals in forensics. **Digital Learning**: Watch videos on the roles played by biomedical scientists in forensics and summarise conversations observed in the video. Engage in a discussion on the topic in class using the videos watched and students' notes as a starting point. **Experiential Learning**: Visit the workplace of forensic scientists to make observations on the roles of biomedical scientists in the field of forensics.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.1.1.LI.3	2.1.1.AS.3
	Explore any two/three biomedical career fields related to clinical or research studies and describe these career fields. **Exploratory Learning:** Prior to the lesson, research individually about the biomedical career fields relating to clinical or research studies such as microbiologist, clinical laboratory technician, toxicologist, biomedical scientist, biotechnologist, etc. in relation to core duties, skills requirements and educational pathways. **Project-Based Learning:** Conduct personal research and create a mind map/chart on any three biomedical career fields and associated responsibilities and training required.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

Teaching and Learning Resources	• Videos • Documentaries and pictures of the various biomedical scientist professionals • Documentaries and pictures of the biomedical scientists in relation to forensic • Documentaries and pictures of the biomedical scientists in medical device production and regulation

Subject **BIOMEDICAL SCIENCE**
Strand **1. BIOMEDICAL SCIENCE IN SOCIETY**
Sub-Strand **2. BIOSAFETY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.1.2.LO.1		
Explain the need for protection from biohazard exposure.	**Communication:** • Learners communicate their knowledge among themselves through oral presentation on the biosafety level. • Learners learn to articulate their observations and opinions on ways to reduce risks of hazards to their colleagues. **Creativity:** Learners identify the biosafety in the environment and create diagrams for the biosafety within their environment. **Critical Observation:** Learners critically examine the donning and removal of PPEs to avoid cross-contamination. **Curiosity:** • Learner's curiosity and level of awareness are aroused as they go through the whole process and donning and removal of the PPEs. • Learners develop their sense of curiosity as they identify the various hazards in a typical lab. **Collaboration:** • Learners appreciate the diversity in persons and learn to work together to accomplish tasks. • Learners by watching the video gain information literacy as they learn to relate these real-life scenarios to what is being taught.	**GESI:** • Avoid laughing or teasing mates who make mistakes in answering/talking. • Both male and female learners are given equal opportunities to practice the donning and removing of PPEs. • Through the creation of respectful atmosphere for all, both males and females feel secure in each other's company. • Learners learn to tolerate each other's attitudes as they practice the wearing and removing their PPEs. • As learners work in pairs, they value and work in favour of a democratic and inclusive societal balance. • As learners work in pairs, they are made aware of their personal biases and stereotypes as well as learn how to embrace diversity and practice inclusion. **National Core Values:** • Tolerance • Respect

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.1.2.CS.1	2.1.2.LI.1	2.1.2.AS.1
Demonstrate an understanding of the essence of protection from biohazard exposure.	**Describe features of the biosafety levels and proper practice.** **Managing Talk for Learning**: The teacher leads the class to identify the pathogens (virus, bacteria, fungi, etc.) and toxins that present risks to humans. Learners discuss and group the risks by aligning them to the biosafety levels. **Collaborative Learning**: From the discussion, learners define biological safety level as a description of the minimum set of standard practices, safety equipment, and facility requirements that provide protection to personnel, the environment, and community when working with biological hazards. **Activity-Based Learning**: Work together to group risks and create diagrams to represent the various biosafety levels (BSL) and justify the basis for the groupings. **Talk for Learning**: Discuss the features of the BSLs and corresponding proper lab practice. NB: Learners need to be aware of the high risk associated with BSL-3 and BSL-4 facilities	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.1.2. LI.2	2.1.2.AS.3
	Demonstrate proper setup of biosafety cabinet and its environment. **Structured Learning:** Learners visit labs or watch videos of a typical lab setting to identify hazards (pathogens, spillage, toxins, sharp objects etc.) in a typical lab and describe some potential negative outcome(s) of a given hazard and the frequency of occurrence (risk). **Collaborative Learning:** Learners work in pairs to proffer solutions to reduce risk of hazards such as proper disposal, proper labelling, proper arrangement of items, facility design that avoids moving contaminated and uncontaminated materials through the same space. **Demonstrative Learning:** Observe an expert or resource person as they set up biosafety cabinet. Take turns to demonstrate the proper setup of the biosafety cabinet.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

	2.1.2.LI.3			2.1.2.AS.2
	Demonstrate proper methods for donning and removal of personal protective equipment (PPE) such as gloves, lab coats, eye protection and respiratory protection. **Demonstrative Learning**: Learners fully wear their PPEs (lab coat, face masks, gloves, face shields, close-toed shoes, etc.) and cover them with Glo Germ or other dyes. Afterwards, let learners remove the PPEs and check for the dye contamination. Demonstrate proper procedures for removing PPEs so that there is no cross-contamination.			**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Textbooks • Chats • Writing boards	• Projector • PPEs • Dye	• Lab space • Videos • Notebooks	• Textbooks • Whiteboards

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **1. ANATOMY AND PHYSIOLOGY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.2.1.LO.1		
Identify the various regions of the brain, describe their functions and their interconnectedness with some body systems for communication.	**Creativity/Critical Thinking:** Learners use materials to create a picture map of the brain and critically analyse parts of the human brain. **Communication:** Learners share ideas among their peers as they work in groups. **Collaboration:** Learners work in groups and accept diverse views from each individual, then work together to bring about team results. **Tolerance:** Learners accept the different opinions from one another and never condemn anyone's opinion as they work in groups. **Digital Literacy:** Learners access and interpret data collected from the EEG using their computer literacy. **Global Citizenship:** Learners become fit globally as they can operate on the EEG and perform the troubleshooting, which is used in hospitals in every part of the world.	**GESI:** • Learners work in mixed-ability groups (different gender with diverse backgrounds). • Learners embrace different opinions as they create a picture map of the distinct structural and functional characteristics of each region of the brain. • Learners embrace diverse opinions as they share their ideas. • Assign roles to members in the group and work together in peace and harmony to promote inclusion and responsibility. **National Core Values:** • Trustworthiness • Unity • Patience

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.2.1.CS.1	2.2.1.LI.1	2.2.1.AS.1
Demonstrate an understanding of the interconnectedness of some body systems for communication.	**Explain the role the brain and brain mapping play in the communication system of the human body.** **Experiential Learning**: Using charts, diagrams or 3D models, learners discuss and note major regions of the brain and their general functions. Learners sketch and colour the various regions with unique colours. **Activity-Based Learning**: Learners work in groups with their given illustrations/models and other literature to create a picture map of the distinct structural and functional characteristics of each region of the brain. Learners also investigate and document the specific functions of the lobes of the cerebral cortex (motor, sensory, auditory and visual cortexes).	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.2.1.LI.2	2.2.1.AS.2
	Determine how communication works in the body and its effects. **Digital Learning**: The teacher uses a video or picture or a 3D model to illustrate how the neurons use electrical impulses and chemical signals to transmit information to different brain areas, and between the brain and the rest of the nervous system. **Collaborative Learning**: Brainstorm on how specific impulses are transmitted, including reflex actions. In groups, investigate how membrane potentials are generated in neurons and how changes in the membrane potential of individual neurons generate action potential by neuron's plasma membrane permeability changes for communication with other neurons and cell types. Learners to present their findings to their colleagues for feedback.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.2.1.LI.3	2.2.1.AS.3
	Describe the importance of technological tools in biomedical sciences to measure parameters associated with communication in the human body. **Experiential/Digital Learning**: Learners visit a hospital or watch a video to see how the electrical activity of the brain (electroencephalogram [EEG]) can be monitored using external electrodes. Learners note the differences in the frequency and amplitude of electrical patterns (brain waves) observed.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning**

	Collaborative Learning: Teacher leads a discussion on the types of brain waves (alpha, beta, theta and delta), their characteristics and the respective states of consciousness they represent. Discuss the EEG of clinical conditions with peculiar brain wave patterns such as seizure. Observe samples of EEG to identify and indicate the clinical significance of the brain waves.			**Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Anatomical textbook • Pictures	• Projector • Anatomical models	• Charts Projector • EEG recording facility	• Flip charts

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **2. DISEASES AND DISORDERS**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.2.2.LO.1		
Describe how malfunctions in the nervous and endocrine systems affect other body systems and lifestyle.	**Problem Solving:** Learners identify solutions to the disorder of the nervous system through the use of appropriate literature articles and community interactions. **Collaboration:** • Learners work in groups as they interact and share ideas among themselves to bring about a good team result. • Learners work with their peers in mixed-ability groups to come out with the desired outcome. **Tolerance:** Learners accept diverse knowledge from one another without criticism giving good feedback to one another's ideas as they work in groups. **Problem Solving, Critical Thinking and Communication:** Learners contribute to the discussion by critically thinking and expressing their thoughts among their peers in an environment that is free from fear or intimidation and also learn public speaking skills as they take turns to share their ideas. **Leadership/Followership:** As learners work in groups to research and create maps of endocrine malfunction, they create and share tasks and responsibilities among themselves. **Communication:** Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation and also learn public speaking skills as they take turns to contribute to the discussion.	**GESI:** • As learners work in groups, they are made aware of their personal biases and stereotypes and learn to embrace diversity and practice inclusion. • Learners assign roles to members in the group and work together in peace and harmony to promote inclusion and responsibility • Use of mixed-ability and/or gender-balanced groupings • Learners embrace different opinions as they unravel the mystery behind diagnosis, prevention and treatment of diabetes. • Learners appreciate, value, and embrace diversity as well as appreciate the opinions of others as they investigate the connection between insulin and blood glucose. **National Core Values:** • Patience • Respect

	Curiosity: Learners develop their sense of curiosity as they go through the process of diagnosing diabetes using fasting blood sugar.	• Humility
2.2.2.LO.2		
Understand how the structure of bacteria and virus dictates treatment protocols, concept of immune response and the impact of infections in the society.	**Problem Solving:** Learners determine the suitable treatment for diseases that are caused by bacteria and virus. **Creativity:** Learners use materials within their environment to make the model of bacteria and virus. **Communication:** • Learners share their findings of the work they have done to one another in the class through presentation. • Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation. • Learners contribute to the discussion by expressing their thoughts among their peers in an environment that is free from fear or intimidation and also learn public speaking skills as they take turns to share their ideas. Learners work in group and share ideas together about their personal experience on signs and symptoms they showed when sick and how they were able to prevent it. **Information Literacy:** As learners critically analyse the contributions of their peers, they to understand the mechanism of antibiotics. **Emotional Intelligence:** Learners develop their emotional intelligence as their submissions are critiqued by other learners. **Creative Thinking:** Learners are guided on how the body responds to foreign invasions and immune response. **Information and Technology:** Literacy: As learners watch videos and punctures, they gain experiential training on how to use these technological tools to identify antigens and understand immunity.	**GESI:** • Not laughing or teasing learners to boost their morale to contribute meaningfully to discussions. • Providing positive feedback to all learners. • Gender-balanced grouping of learners. • Forming mixed-ability groups. • Learners appreciate, value and embrace diversity as they share and learn from one another's contributions in a friendly environment. **National Core Values:** • Unity • Friendliness • Patience

	Tolerance: Learners accept the diverse views from one another about their own experiences of the diseases that they have encountered as they work in groups. **Collaboration:** Learners work together in groups and share ideas to bring about a good teamwork result.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.2.2.CS.1	2.2.2.LI.1	2.2.2.AS.1
Apply knowledge of human body systems to indicate how damage to one system can impact function in another system.	**Explain how serious nervous system disorders impact quality of life.** **Managing Talk for Learning**: With the aid of pictures and videos, learners discuss conditions, diseases, and injuries that can cause nervous system problems (cerebral palsy, multiple sclerosis, stroke, vascular disorders, injuries, especially injuries to the head and spinal cord, etc.). **Project-Based Learning**: Learners work in groups, referring to appropriate literature and engaging in community interactions (experiences) to enumerate diseases and injuries that can cause structural, biochemical, or electrical abnormalities in the brain, spinal cord, or other nerves and the resulting symptoms (paralysis, muscle weakness, poor coordination, loss of sensation, seizures, confusion, pain, altered levels of consciousness, etc.).	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.2.2.LI.2	2.2.2.AS.2
	Interpret the symptoms and physical characteristics of a given patient to determine an endocrine system malfunction (e.g., Hyperthyroidism**).** **Digital Learning**: Watch a video or listen to a PowerPoint presentation on the endocrine system, its functions, defects and symptoms of its malfunctioning. **Talk for Learning:** • Brainstorm on how the body makes and releases hormones that control mood, development and growth; enumerate the functions of hormones (at least two each) that control mood, development and growth. • Based on the previous discourse on the functions of hormones, learners suggest and discuss possible symptoms and characteristics of a patient with specified endocrine system malfunction.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.2.2.LI.3	2.2.2.AS.3
	Identify and discuss the causes, symptoms, treatments, effects and impact of diabetes on the human body and human lifestyle. **Managing Talk for Learning**: Learners go through the diagnosis of diabetes using fasting blood sugar level values. Learners investigate the connection between insulin and blood glucose and how feedback systems in the body regulate the function of key hormones. Learners discuss and note the	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning**

	causes (genetic, drugs, lifestyle, etc.), symptoms (weight loss, frequent urination, blurry vision, extreme fatigue, sores that do not heal and effects of diabetes on the body), treatment options (medication, diet, exercise, etc.) and effects on lifestyle (damage to blood vessels, which can lead to heart attack, stroke, and problems with the kidneys, eyes, gums, feet and nerves, erectile dysfunction, etc). **Experiential Learning:** Learners gather different kinds of vegetables, fruits, whole grains, meat and meat products. Learners apply their knowledge of the digestive system to state the digestive end products of these foods. Learners are guided by the teacher to understand why they should choose non-fat dairy and lean meats and also limit foods that are high in sugar and fat. Remember carbohydrates turn into sugar. **Activity-Based Learning:** Individually, create mind maps on diabetes, its causes, symptoms, prevention and treatment.			**Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Projector • Anatomical model	• Pictures • Charts sample blood sugar tests	• Glucometer • Anatomical models	• Pictures • Charts

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.2.2.CS.2	2.2.2.LI.1	2.2.2.AS.1
Demonstrate knowledge of bacteria and viruses as causative agents of infectious diseases.	**Identify the structural differences between bacteria and viruses.** **Project-Based Learning**: Learners observe specimens of bacteria and viruses in videos or glass slides, and document the structural differences between bacteria and videos. The learners then produce models/drawings of a specified bacterium and a virus particle. Using appropriate literature, learners investigate the treatment protocols for bacterial and viral diseases. Learners present their findings to the class and receive feedback.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.2.2. LI.2	2.2.2.AS.4
	Explore the symptoms, prevalence, and treatment of bacterial and viral infections considering infections of the reproductive system **Collaborative Learning:** With the aid of charts and resources, identify the commonalities between bacterial infections in terms of their symptoms and treatment. Share experiences on symptoms, prevalence and treatment of viral infections in groups. **Digital Learning**: Research and develop PowerPoint presentations on the social and global impact of infectious diseases (e.g., COVID) for class presentations and feedback. **Project-Based Learning**: Learners design and produce a public health campaign to educate peers about the dangers and prevention of infectious diseases on posters.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.2.2.LI.3	2.2.2.AS.3
	Explore the immune response in relation to the introduction of antigens. **Managing Talk for Learning**: Teacher leads a discussion with the class on ways they think the body responds to the invasion of foreign and harmful materials. Engage in a discussion on immune response and the meaning of the term "antigens" **Activity-Based Learning**: Learners watch videos and pictures (or refer to books and other sources) to group identified antigens as exogenous (foreign to the host immune system), endogenous	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

	(produced by intracellular bacteria and virus replicating inside a host cell), and autoantigens (produced by the host).		
	2.2.2.LI.4		2.2.2.AS.2
	Analyse how antibiotics are used to treat infections and explain how the effectiveness depends on the causative bacteria. **Experiential Learning**: Using pictures/charts/videos, the teacher guides the class to brainstorm the mechanisms of antibiotic action in killing of bacterial cells or stoppage of bacterial multiplication. Learners should discuss the dependence of the efficacy of an antibiotic in relation to the bacteria type (gram positive vs gram negative bacteria).		**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.2.2.LI.5		2.2.2.AS.5
	Discuss the global and social impact of an infectious disease that is caused by bacteria and viruses **Collaborative Learning:** With the aid of charts and resources, identify the commonalities between bacterial infections in terms of their symptoms and treatment. Share experience on symptoms, prevalence, and treatment of viral infections in groups**.** **Digital Learning:** Research and develop PowerPoint presentations on social and global impact of infectious diseases(e.g, COVID) for class presentation and feedback. **Project-Based Learning:** Learners design and produce a public health campaign to educate peers about the dangers and prevention of infectious diseases on posters.		**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Videos • Stained slides	• Pictures • Charts	• Projector

Subject **BIOMEDICAL SCIENCE**
Strand **3. BIOMEDICAL INTERVENTION**
Sub-Strand **1. DIAGNOSTIC DEVICE**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
2.3.1.LO.1		
Describe the importance of technology in clinical diagnosis, the composition of diagnostic medical devices and explain basic principles relating to diagnostic medical device design.	**Digital Literacy:** Learners understand the technologies used in diagnosis. This builds up the computer literacy of the learner. **Communication:** • Learners share ideas of the biomedical instrumentation they have seen in the hospitals and how it was operated. • Learners discuss the step-by-step approach of disassembling and assembling of the diagnostic devices and how each part functions. **Problem Solving:** Learners can clearly identify and group the various medical instruments under diagnostic device and therapeutic device. **Collaboration:** Learners work in mixed-ability groups and share their research findings with their group members, brainstorm and come out with agreed answers. **Curiosity:** Learners inquire a lot from the teacher as the learner watch the step-by-step approach in disassembling and assembling of a diagnostic medical device. **Critical Thinking:** • Learners observe and analyse how the various components of the medical diagnostic device work together to yield one result or function. • Learners develop their critical thinking ability as they brainstorm the requirements of medical device design.	**GESI:** • Learners work in mixed-ability groups. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they share their research and brainstorm. • Learners appreciate gender from diverse background as they take turns to contributing to the disassembling and assembling of a diagnostic medical device. • Learners embrace different opinions as they brainstorm on the bioinstrumentation principles. **National Core Values:** • Humility • Truthfulness • Honesty

	Attention to Detail: Learners learn to pay attention to details as they curiously observe the whole process. **Information Literacy:** Learners brainstorm to gather information and analyse and synthesise the information to make meaning. **Oral Communication:** Learners learn to articulate their opinions on the bioinstrumentation principles. **Emotional Intelligence:** Learners develop emotional intelligence as their submissions are critiqued by other learners.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.3.1.CS.1	2.3.1.LI.1	2.3.1.AS.1
Demonstrate an understanding of the concepts applied to build diagnostic devices.	**Investigate the application of technology in the provision of healthcare.** **Talk for Learning**: Learners engage in a discussion on technologies available for the diagnosis, treatment and prevention of diseases in humans. **Exploratory Learning**: Visit a hospital to observe a variety of biomedical instruments or watch pictures and videos of these resources. **Activity-Based Learning:** Work in groups to categorize biomedical instruments into diagnostic and therapeutic devices. Examples of diagnostic medical devices to include ECG monitor, EEG monitor, sphygmomanometer, pulse oximeter, endoscope, ophthalmoscope, thermometer, imaging equipment (X-ray, ultrasound etc.), microscope, etc. Therapeutic devices include ventilator, artificial heart, pacemaker, infant incubator, muscle/nerve stimulator electrosurgery machine etc. **Talk for Learning:** Explore the various physiological measures (blood pressure, heartbeat, temperature, blood sugar level, morphology by imaging, etc.) for diagnosis and how patterns and recorded values may be indicative of abnormalities.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.3.1.LI.2	2.3.1.AS.2
	Identify the components of a diagnostic device and its functions. **Experiential Learning:** With the help of a technician, learners disassemble a diagnostic medical device (e.g., glucometer, ECG monitor etc.) and try to identify the various components under the type of measurand, electrode or sensor, signal processing unit and display or recording unit. The device is then re-assembled as a unit. Learners discuss the functions of the various components and brainstorm how the individual components work together to achieve the overall objective of the device.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.3.1.LI.3	2.3.1.AS.3
	Discuss the bioinstrumentation principles used in the construction of a diagnostic device.	**Level 1 Recall** **Level 2 Skills of conceptual understanding**

	Initiating Talk for Learning: The teacher starts brainstorming sessions on the requirements of medical device design and construction to be effective for the intended purpose and confirm prescribed safety principles in order not to compromise public safety. **Exploratory Learning:** With the aid of realia, models or pictures, learners explore how access to measure and, accuracy, sensitivity and specificity affect the performance of medical devices. Inaccessible measure and may require invasive procedures.			**Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Online resources • Articles • Reports	• Pictures • Videos	• Charts • Diagnostic medical device	• Flip chart • Textbooks

Subject **BIOMEDICAL SCIENCE**
Strand **3. BIOMEDICAL INTERVENTION**
Sub-Strand **2. THERAPEUTIC DEVICE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.3.2.LO.1		
Describe some treatment and management strategies for cancer, disabilities, damaged tissues and organs.	**Information Literacy**: • Learners brainstorm the mechanism of therapeutic remedies and synthesise the information to make meaning by relating it to chemotherapy and cancer treatment. • Learners catalogue their results from their personal research and format them to prepare their presentations. **Critical Thinking:** • Learners develop their critical thinking ability as they brainstorm therapeutic remedies. • Learners critically analyse and prepare their research findings for presentation. • As learners watch these videos/documentaries and interact with the other learning materials, they critically observe and analyse the applications of regenerative medicine in their communities. **Oral Communication:** Learners learn to articulate their opinions on the physical, mental and emotional effects of chemotherapy. **Emotional Intelligence:** Learners develop emotional intelligence as their submissions are critiqued by other learners and also appreciate the emotional and mental effects of radiation therapy and chemotherapy. **Critical Observation:** As learners watch videos and pictures, they critically observe and acquire knowledge on how prosthesis and orthotics restore function to the limbs.	**GESI:** • Consciously ensuring that learners who make mistakes while talking are not laughed at or mocked but are corrected in a manner that will encourage them for trying. • Encourage learners to attempt questions a couple of times while the teacher provide constructive criticism for improvement to boost learner confidence. • Learners appreciate, value, and embrace diversity as they are made to work in groups. • Learners learn to amicably resolve conflicts and embrace differing opinions. • Learners develop emotional intelligence as their submissions are critiqued by others for the betterment of the group. **National Core Values:** • Humility • Truthfulness • Honesty

	Communication: Learners contribute to the discussion by expressing their thoughts among their peers about the experience each member has gained on the use of the prosthesis through the videos, pictures and personal experiences. **Collaboration**: Learners sit in well mixed (gender-balanced and culturally diverse) groups and take turns to relay their individual research findings to their peers. **Leadership:** As learners work in groups to research on a common topic, they create and share tasks and responsibilities among themselves to achieve the set goals for the group.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.3.2.CS.1	2.3.2.LI.1	2.3.2.AS.2
Explore how therapies are used in health facilities to address health problems.	**Explain the use of prostheses and orthoses to manage, correct and treat disabilities.** **Exploratory Learning**: Individually, conduct a research on the Internet about the usage of prostheses and orthoses. **Cooperative Learning:** Engage in a class discussion to arrive on the definition and functions of prothesis and orthosis, using examples from videos, pictures and experiences of learners. Discuss the pathological effects of disease, trauma, malformation and loss of the lower and upper limbs and relate them to functional loss. Talk about examples of prostheses and orthoses and their sites of application. **Project-Based Learning:** Learners research and identify examples of functional losses of the limbs, deduce whether these effects are as a result of pathological effects, trauma, malformation or loss of upper/lower limbs and propose solutions to these effects using prosthesis or orthoses. **Collaborative Learning:** Make group presentations to the class based on the findings.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	2.3.2.LI.2	2.3.2.AS.1
	Investigate the treatments and therapies available to treat cancer and its physical, mental and emotional effects. **Digital Learning**: With the aid of videos, pictures and PowerPoint presentations, explore the mechanisms of therapeutic remedies such as chemotherapy, radiation therapy and stem cell implant to treat cancer. **Collaborative Learning:** Learners discuss the physical, mental and emotional effects of chemotherapy and radiation therapy such as hair loss, vomiting, fatigue, nausea, headache, memory and concentration problems.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

	2.3.2.LI.3	2.3.2.AS.3
	Explore the future application of regenerative medicine for patients with disabilities. **Structured Talk for Learning**: Learners are introduced to the strategies for regenerative medicine such as cell therapy (injection of stem cells at diseased sites), implantation of tissue constructs and artificial organs through a PowerPoint presentation or a video. **Experiential Learning:** Learners watch pictures or documentaries on regenerative medicine and suggest ways it could be applied to solve medical problems in the communities. **Digital Learning:** Design group word clouds on regenerative medicine.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Videos • Pictures	• Charts • Projector

Subject **BIOMEDICAL SCIENCE**
Strand **4. BIOMEDICAL INNOVATION**
Sub-Strand **1. RESEARCH AND DESIGN IN BIOMEDICAL SCIENCE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.4.1.LO.1		
Use scientific literature and statistics to design experiments and analyse results.	**Critical Thinking:** • Learners critically analyse the credibility, accuracy and reliability of scientific journals. • As learners contribute and participate in the discussion, they think critically. **Collaboration:** Learners brainstorm in their groups to come out with their research topics. **Communication:** Learners make their contributions to their peers in an environment that is free from fear or intimidation. **Information Literacy:** • As learners go through their projects, they develop research skills. • Learners draw information from the textbooks and the various online resources available to them. **Leadership:** As learners sit in groups to brainstorm, they create and share tasks and responsibilities among themselves to achieve set goals for the group. **Initiative:** • Learners are given the opportunity to initiate and control their own experiments leading them to the discovery of underlining scientific knowledge. • Learners are given the opportunity to initiate and control their own research.	**GESI:** • As learners work in groups, they are made aware of their personal biases and stereotypes, embrace diversity and practice inclusion. • Consciously ensuring that learners who make mistakes while talking are not laughed at or mocked but are corrected in a manner that will encourage them. • Learners develop emotional intelligence as their submissions are critiqued by others. • Form mixed-ability and mixed-gender groups where applicable. **National Core Values:** • Respect • Discipline • Unity

	Problem Solving Skills: Learners research and draw their own mind maps/charts of biomedical career fields related to clinical or research studies so they can make their own deductions and draw their own conclusions.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
2.4.1.CS.1	2.4.1.LI.1	2.4.1.AS.1
Demonstrate understanding and application of a variety of biomedical experimental designs.	**Critique and compare science data presented in popular media with data presented in scientific journals.** **Collaborative Learning:** The teacher presents learners with two articles (one from public media and another from a scientific journal) on a similar or same topic (e.g., homeopathy, infection, etc.) and let the learners read. Working in groups, learners comment on the credibility, accuracy, and reliability based on the source (trustworthiness of the author or organization), truthfulness and correctness of the information backed by evidence, how current the information is). **Activity-Based Learning:** Teacher moderates a discussion on the review process of scientific articles. Learners then compare science data presented in popular media and in scientific journals in terms of credibility and substantiated or unsubstantiated claims using a checklist.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.4.1.LI.2	2.4.1.AS.2
	Apply knowledge of specified statistical analysis methods to analyse the results of experimental studies. **Structured Talk for Learning**: Engage in a discussion on the explanation and identification of dependent and independent variables of a sample biomedical study. Discuss statistical measures and the effect of sample size on the representation of a population. **Activity-Based Learning**: Using data from the study, learners calculate measures of central tendency (mean, median, and mode) and measures of variability (range, variance and standard deviation). On scatter plots or histograms, learners are tasked to change scales on the y-axis (ordinate) for the plot of the same data and observe how changes in scale may exaggerate or diminish an outcome.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Printed articles • Internet • Projector • Writing boards • Projector	

YEAR THREE

Subject **BIOMEDICAL SCIENCE**
Strand **1. BIOMEDICAL SCIENCE IN SOCIETY**
Sub-Strand **1. BIOMEDICAL SCIENCE PRACTICE**

Learning Outcomes	21st Century Skills and Competencies	GESI[5], SEL[6] and Shared National Values
3.1.1.LO.1		
Explain actions that can constitute malpractice, liability and/or negligence and how the biomedical scientist can guard against them.	**Critical Thinking/Observation:** Learners critically observe as they watch videos/images of various acts of malpractice. They critically analyse and relate these observations to identify the various acts of malpractice and professional wrongdoing. **Collaboration:** • Learners work in mixed-ability groups and relate their observations to peers, brainstorm and come out with agreed answers. • Learners work in mixed-ability groups to brainstorm and practice informed consent for medical treatment. **Tolerance:** • Learners learn to accept constructive feedback from peers. • Learners accept diverse knowledge from one another without criticism, giving good feedback to one another's ideas. **Communication:** • Learners share their thoughts on informed consent for a medical treatment and its consequences as they practice it in groups. • Learners share their thoughts on the code of ethics and conduct that is carried out by biomedical professionals.	**GESI:** • Learners work in mixed-ability groups. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they share their personal experiences with biomedical science professionals in their environment. • Learners embrace different opinions as they share their thought on the code of ethics and code of conducts required for a biomedical profession. • Not laughing or teasing learners to boost their morale to contribute meaningfully to discussions. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. **National Core Values:** • Respect

[5] Gender Equality and Social Inclusion

[6] Socio-Emotional Learning

	Ethical Reasoning: Learners identify the code of ethics and code of conduct that is required for biomedical professionals.	• Unity

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.1.1.CS.1	3.1.1.LI.1	3.1.1.AS.1
Demonstrate knowledge of good professional practice as biomedical scientists.	**Explain common practices that could result in malpractice, liability and/or negligence in the field of biomedical science.** **Initiating Talk for Learning**: Discuss possible sources and causes of malpractice of professionals in the field of biomedical science, e.g., professional wrongdoing (being careless or breaking the law or the rules of their profession) that results in injury or damage. Discuss examples of malpractice including failure to diagnose a patient's medical condition (misdiagnosis), patient injury during treatment, often resulting in disability or death, failure to treat a patient's condition, medication errors, defective medical devices, inappropriate use of medical device and poor documentation. **Exploratory Learning**: Brainstorm on the difference between malpractice and negligence, and the definition of medical liability. Watch videos or pictures or listen to hypothetical scenarios on different events involving medical malpractices and then identify the various cases of malpractice/negligence and the possible liabilities. **Activity-Based Learning**: Create posters on different acts of malpractice or negligence in the field of biomedical science.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.1.1.LI.2	3.1.1.AS.2
	Describe the purpose of Informed Consent from the patient and healthcare provider perspective. **Managing Talk for Learning**: With the aid of informed consent forms, the teacher discusses and explains informed consent to the learners. The teacher should also explain that an informed consent form is a legal document that ensures smooth ongoing communication between the client and the provider. **Collaborative Learning**: Discuss the benefits of informed consent to the patient/participant (improved patient welfare, increased patient empowerment, etc.) and provider (reduction of medical errors, reduced liabilities, etc.).	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Activity-Based Learning: • Learners work in groups to develop an informed consent form comprising of a description of the clinical problem, the proposed treatment, and alternatives including no treatment; discussion of the risks and benefits of the proposed treatment with comparisons to the risks and benefits of alternatives, and discussion of medical/clinical uncertainties regarding the proposed treatment; assessment of the patient's understanding of the information provided by the medical provider; and solicitation of the patient's preference and consent for treatment. • After the design of the consent form, learners play the roles of provider and patient to the class, as they present their work.	
	3.1.1.LI.3	3.1.1.AS.3
	Identify and explain personal and long-term consequences of unethical or illegal behaviour in the workplace. **Managing Talk for Learning**: Discuss what is meant by the code of ethics and the code of conduct of biomedical professionals. The teacher leads the discussion on the implications of unethical or illegal behaviours in the workplace.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Videos, documentaries and pictures of the various acts of malpractice and negligence. • Videos and documentaries on how informed consent is carried out. • Sample consent forms	

Subject **BIOMEDICAL SCIENCE**
Strand **1. BIOMEDICAL SCIENCE IN SOCIETY**
Sub-Strand **2. BIOSAFETY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.1.2.LO.1		
Apply the principles of biosafety to setup experiments.	**Collaboration:** • Learners work in mixed-ability groups to brainstorm and develop a mitigation plan to avoid accidents for a selected biological agent. • Learners work in mixed-ability groups and relate their observations to peers, brainstorm and come out with agreed answers. Learners learn to accept constructive feedback from peers. **Critical Thinking/Observation:** • Learners critically observe as they watch images of various wrongdoings in the picture. They critically analyse and relate these observations to identify the various acts of risks and develop a mitigation plan for it. • Learners critically analyse to segregate the various forms of waste streams collected for proper disposal. **Oral Communication:** Learners learn to articulate their opinions on how waste is collected and properly disposed of at home and school. **Information Literacy:** Learners by reviewing literature and brainstorming gain information literacy.	**GESI:** • Learners appreciate, value, and embrace diversity as they are made to work in groups. • Learners embrace diverse opinions as they share their ideas. • Not laughing or teasing learners to boost their morale to contribute meaningfully to discussions. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. • Learners embrace different opinions as they discuss the role of biosafety officers in biomedical research laboratories. **National Core Values:** • Tolerance • Respect • Patience

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.1.2.CS.1	3.1.2.LI.1	3.1.2.AS.1
Demonstrate knowledge and understanding of the principles of biosafety in setting up experiments.	**Undertake proper planning of experiments to avoid accidents.** **Experiential Learning:** In mixed-ability groups, plan an experiment by selecting a biological agent, a procedure to work with, identify risks, develop a mitigation plan and evaluate risk mitigation plans and carry out the experiment. **Exploratory Learning:** Teacher shows several pictures of scenarios in a laboratory setup and learners identify what is wrong in the pictures in relation to safety in the laboratory.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.1.2.LI.2	3.1.2.AS.2
	Identify the correct waste stream and demonstrate proper disposal of hazardous waste in the laboratory. **Digital Learning:** Watch online videos or pictures on various waste streams that are generated in the hospital and how they can be properly disposed of. **Collaborative Learning:** Share experiences on the various waste streams that are collected at homes, schools, etc, and how to properly dispose of them. Brainstorm to agree on how best the various hazardous waste streams can be properly disposed in the laboratories.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.2.LI.3	3.1.2.AS.3
	Identify and describe the role of biosafety professionals in biomedical research laboratories. **Exploratory Learning**: Embark on a visit to a biomedical laboratory or invite a biosafety professional to give a talk on the role of biosafety officers in minimizing infectious disease risks to persons. **Project-Based Learning:** Work individually to write a report based on the interaction with the resource person (and also be researching from other sources) about the role of biosafety officers in ensuring compliance with safety policies and procedures.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Internet • Pictures	• Different biological agent • Videos	• Textbooks • Projector	• Flip charts

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **1. ANATOMY AND PHYSIOLOGY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.2.1.LO.1		
Describe the role of enzymes in digestion and explain how food, water and oxygen is transported by the cardiovascular and respiratory systems.	**Communication:** Learners make contributions towards a mutual goal among their peers in an environment that is free from fear or intimidation. **Critical Thinking:** • As learners critically analyse their experiences and share with the class. • Learners analyse their heart rate and critically express their thought on how to regulate their heart rate. • Learners critically analyse the five joints and are able to use materials within their society to build joints and the associated skeletal muscles. **Collaboration:** • Learners sit in well-mixed (gender-balanced and culturally diverse) groups and take turns to relay their individual research findings to their peers. The right ambience should be created to allow each and every learner to collaborate with others, building on points raised and putting down their collective findings while amicably resolving conflicting findings. • Learners work in mixed-ability groups and take turns to relay their observation on the transport of food, water and oxygen carried out by the cardiovascular and the respiratory system. **Leadership:** As learners work in groups to research and create maps to show the transport of products of digestion, water, oxygen and the how cardiovascular and respiratory system helps in	**GESI:** • Learners work in mixed-ability groups (different gender with diverse backgrounds). • Learners embrace different opinions as they relate their personal experience of how the key unlocks specific locker to the way enzymes are specific to substrate. • Learners appreciate, value, and embrace diversity as they work with other group members. • Assign roles to members in the group and ensure they work together in peace and harmony to promote inclusion and responsibility. **National Core Values:** • Respect • Humility • Tolerance • Patience

	the circulation, they create and share tasks and responsibilities among themselves. **Creativity:** Learners are able to use different materials within their society to build the five joints and the associated skeletal muscle.	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.2.1.CS.1	3.2.1.LI.1	3.2.1.AS.1
Demonstrate an understanding of the interconnectedness of the body systems in energy generation and use (digestive, circulatory and musculoskeletal systems).	**Explain what enzymes are and their role in the digestive system.** **Initiating Talk for Learning:** Learners discuss what enzymes are and the role of digestive enzymes in the breaking down of food for absorption. **Experiential Learning:** Working in mixed-ability groups, use sets of lock and key, or spanner and bolt analogy to explain why only certain keys or spanners can unlock a given lock or bolt. The class brainstorms how different enzymes are specific to certain substrates similar to the lock-and-key model. **Managing Talk for Learning:** Learners discuss how enzymes break down food, and the subsequent use of enzymes in laundry detergents to digest food stains in clothing.	**Level 1 Recall** **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.2.1.LI.2	3.2.1.AS.2
	Explain the transport of oxygen, food, and water to all cells in the body through the connection between the respiratory and cardiovascular systems. **Initiating Talk for Learning:** Learners think-pair-share their views on the importance of oxygen, food and water to the functioning and survival of humans. Discuss the role played by the connection of the respiratory and cardiovascular system when food, water and oxygen are taken in. **Digital Learning:** Watch a video or animation, anatomical illustration, models, chart or cartoon illustration of how food, water and oxygen get into the bloodstream and are transported by the cardiovascular system and note the key observations. **Activity-Based Learning:** Learners work in mixed-ability groups to create mind maps or illustrations to show how the products of digestion, water and oxygen from the lungs get into the cardiovascular system and are circulated throughout the human body. Learners then present their sketches to the class and receive feedback.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.2.1.LI.3	3.2.1.AS.3
	Describe how the interconnectedness of the body systems aid in energy generation.	**Level 1 Recall** **Level 2 Skills of conceptual**

	Activity-Based Learning: In mixed-ability groups and using stethoscopes or palpations, learners note the variations in heart rate among group members. **Talk for Learning:** Brainstorm on why heart function varies and describe the factors that can cause heart function variability.			**understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.2.1.LI.4			3.2.1.AS.4
	Demonstrate an understanding of how joints and muscles use energy to contribute to the movement of the human body. **Collaborative Learning:** Learners working in groups identify, at least, five joints in the body and discuss the role of a joint in locomotion. **Project-Based Learning**: Groups then build a joint and associated representative skeletal muscle using local materials to demonstrate to the class how movement occurs at the joint. Learners also show how muscles use molecular energy (ATP) for movement using library resources or Internet.			Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Textbooks • Anatomical diagrams of the digestive system • Pictures or charts showing enzyme action	• Map of enzymes and substrates • Online resources etc. • Anatomical models	• Pictures • Videos • Projector	• White boards • Models

Subject **BIOMEDICAL SCIENCE**
Strand **2. HUMAN BODY SYSTEMS**
Sub-Strand **2. DISEASES AND DISORDERS**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.2.2.LO.1		
Describe the different types of lipids in the body, explain how cholesterol-lipoprotein complexes affect risk of heart diseases and how risk of heart diseases may be assessed.	**Communication:** • Learners share their ideas orally as they discuss their thoughts on the structure and the properties of the different types of lipid molecules. • Learners share their ideas orally as they discuss their thoughts on food products that contain cholesterol and its economic importance to the human body system. **Creativity:** Learners use different materials to design the structures of the different types of lipids molecules. **Collaboration:** Learners work in groups as they share their ideas on the LDL and HDL to come out with a finalised solution for the work. **Leadership:** As learners work in groups to research and prepare their presentations, they create and share tasks and responsibilities among themselves. **Information Literacy:** As learners analyse information from online resources and they begin to synthesise the information gathered and make meaning to solve the task assigned.	**GESI:** • Learners not laughing or teasing their mates who make mistakes in answering/talking. • Learners appreciate, value, and embrace diversity as they work in pairs. • Assign roles to members in the group and ensure they work together in peace and harmony to promote inclusion and responsibility. • Learners embrace different opinions as they discuss why cholesterol is necessary in the body and how it is transported as lipoprotein-cholesterol. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. **National Core Values:** • Tolerance • Humility • Truthfulness

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.2.2.CS.1	3.2.2.LI.1	3.2.2.AS.1
Demonstrate an understanding of the function of cholesterol in the body and its role in heart disease.	**Describe the different types of lipid molecules and their different physical properties and functions.** **Structuring Talk for Learning**: The teacher shows the structure of the different types of lipid molecules (fatty acids, fats, steroids and complex lipids) using stick and ball models and sketches. Learners are engaged to discuss what properties lipid molecules share and how a lipid molecule is defined. **Activity-Based Learning**: Learners work in pairs to document examples of the different types of lipids in humans and their primary functions from relevant literature. For each lipid type, learners sketch and model using stick and ball.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.2.2.LI.2	3.2.2.AS.2
	Explain how cholesterol is transported in the blood by high density lipoprotein (HDL) and low-density lipoprotein (LDL) and the role each of them plays in the body. **Talk for Learning**: With the aid of charts, videos or information graphs, engage in a class discussion on why cholesterol is necessary in the body and how cholesterol is transported as lipoprotein-cholesterol. **Collaborative Learning**: Learners work in mixed-ability groups to do a write-up on the differences between high density lipoprotein (HDL) and low-density lipoprotein (LDL) and their roles in the body and present to the class for comments.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	3.2.2.LI.3	3.2.2.AS.3
	Describe how the concentrations of these complexes (HDL and LDL) affect a person's risk of heart disease. **Initiating Talk for Learning**: Invite a resource person to give a talk or show a video or a summarized writeup on a chart on how HDL and LDL are measured and the normal concentrations of these complexes. Class discuss how high levels of LDL cholesterol or low levels of HDL cholesterol, raises risk for heart disease, blocked vessels and stroke.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	3.2.2.LI.4			3.2.2.AS.4
	Describe the function of an angiogram in diagnosing blocked vessels and discuss the risk factors for heart disease. **Structuring Talk for Learning**: Learners identify blocked vessels on sample angiograms or angiogram images. Then learners list the risk factors for heart disease and share their opinions about why they think the listed factors are risk factors.			Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Sticks and balls from local materials sketch boards or pads • Internet	• Textbooks • Writing board	• Projector • Sample cholesterol measurement results	• Sample angiograms or images

Subject **BIOMEDICAL SCIENCE**
Strand **3. BIOMEDICAL INTERVENTION**
Sub-Strand **1. DIAGNOSTIC DEVICE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.3.1.LO.1		
Design and construct some basic medical devices and pitch them to potential investors.	**Collaboration:** • Learners work in groups as they share their ideas on the production, procurement and maintenance of a diagnostic device for a final presentation in the class. • Learners work in groups as they share their ideas to develop a good marketing plan for a diagnostic device so as to attract investors. • Learners work in groups as they share their ideas on how to improve the existing diagnostic device. **Problem Solving:** Learners use several information sources and pick out useful information as applicable for improving the design and construction of the existing diagnostic device. **Leadership:** As learners work in groups to research online to advance a diagnostic device, they create and share tasks and responsibilities among themselves. **Digital Literacy:** Learners get hands-on experience with the technology used for the diagnostic device as they practice the assembling and disassembling of the diagnostic device. **Innovation:** Learners adopt new ideas that can be used to advance an existing diagnostic device into the modern form. **Critical Thinking:** Learners critically analyse to adopt the best marketing strategy for the diagnostic device to attract investors for their product.	**GESI:** • Learners embrace different opinions as they discuss the production, procurement and maintenance of diagnostic devices. • Learners learn to amicably resolve conflicts and embrace differing opinions as they work in groups. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners assign roles to members in the group and work together in peace and harmony to promote inclusion and responsibility. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. • Learners embrace different opinions as they discuss the best marketing plan to pitch the diagnostic device for investors. **National Core Values:** • Patience

		• Respect • Discipline

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.3.1.CS.1	3.3.1.LI.1	3.3.1.AS.1
Demonstrate understanding of the knowledge and skills required to design and construct some basic medical devices.	**Evaluate the role of biomedical engineers in the production, acquisition and maintenance of medical devices.** **Exploratory Learning**: In groups, visit various medical or production centres to learn about the activities in the production (e.g., medical need, design, prototyping, etc.), acquisition (e.g., advice on new medical technology, safety, efficacy, and cost-effectiveness) and maintenance (e.g., testing, software upgrade, repairs, calibration, etc.) of medical devices. Subsequently, the individual groups make presentations to the class for further discussion.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.3.1.LI.2	3.3.1.AS.2
	Design and construct a simple diagnostic device/assemble the units of a medical device. **Project-Based Learning:** Learners work in mixed-ability groups to design and build a diagnostic medical device such as a thermometer, heartbeat monitor, breath alcohol monitor, paper-based colorimetric sensors, etc. Learners may consult existing literature and experts, review existing devices and offer improvements, etc. Groups present their works at the end of the specified period. **Experiential Learning:** An invited resource person gives a talk about a specified diagnostic medical device. After the talk, the resource person leads the class to disassemble the device and identify the parts and functions. The device is then assembled. The resource person leads learners to repeat the disassembling and assembling processes to familiarize learners with the device.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.3.1.LI.3	3.3.1.AS.3
	Develop a marketing plan to pitch the designed device to potential investors. **Project-Based Learning**: Learners work in mixed-ability groups to develop a marketing plan to pitch a designed device or a specified device to the class. In this case, other members of the class would act as the potential investors. The groups present their plan to the class and receive feedback.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

Teaching and Learning Resources	• Projector • Internet	• Textbook • Medical device

Subject **BIOMEDICAL SCIENCE**
Strand **3. BIOMEDICAL INTERVENTION**
Sub-Strand **2. THERAPEUTIC DEVICE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.3.2.LO.1		
Identify constituent components of a therapeutic device, develop an operating manual for a medical device and describe the regulatory processes for medical devices.	**Digital Literacy:** Learners get hands-on experience on the technology used for the therapeutic device as they practice the assembling and disassembling of the therapeutic devices. **Collaboration:** Learners work in groups using online resources and develop an operating manual for a medical device as each member shares his or her opinion. **Leadership:** As learners work in groups to research online and brainstorm to develop an operating manual for a medical device, they share tasks and responsibilities among themselves. **Communication:** Learners learn to articulate their opinions on the work performed by the regulatory agencies and comment on the suggestions made. **Ethical Reasoning:** Learns identify the ethical rule used by the regulatory agencies for checking the fraudulent adverts on the medical devices.	**GESI:** • Consciously ensuring that learners who make mistakes while talking are not laughed at or mocked but are corrected in a manner that will encourage them for trying. • Encourage learners to attempt questions a couple of times while the teacher provide constructive criticism for improvement to boost learner confidence. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they develop an operating manual for a medical device. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. **National Core Values:** • Humility • Truthfulness • Honesty

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.3.2.CS.1	3.3.2.LI.1	3.3.2.AS.1
Demonstrate an understanding of the interconnections among components of therapeutic devices and explain the medical device regulation process.	**Disassemble and assemble components of the therapeutic device.** **Experiential Learning:** An invited resource person brings and gives a talk about a specified therapeutic medical device. After the talk, the resource person leads the class to disassemble the device and identify the parts and functions. The device is then assembled. The resource person leads learners to repeat the disassembling and assembling processes to familiarize learners with the device.	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.3.2.LI.2	3.3.2.AS.2
	Develop an operating manual for a therapeutic device. **Initiating Talk for Learning**: The teacher leads the discussion on the guidelines and requirements for writing an operating manual for a medical device. **Activity-Based Learning**: Learners work in mixed-ability groups to review relevant documents and brainstorm to develop an operating manual for a specified medical device.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
	3.3.2.LI.3	3.3.2.AS.3
	Discuss the role of regulatory agencies in the production and marketing of medical devices. **Structuring Talk for Learning**: Learners discuss the role of regulatory agencies such as Food and Drugs Authority and Ghana Standards Authority in ensuring that medical devices for sale and in use are safe and effective. Class brainstorms the effect of fraudulent adverts on equipment sales and how regulatory institutions can help.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Medical device • Projector • Internet • Textbook • Sample manual • Regulatory documents	

Subject **BIOMEDICAL SCIENCE**
Strand **4. BIOMEDICAL INNOVATION**
Sub-Strand **1.RESEARCH AND DESIGN IN BIOMEDICAL SCIENCE**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.4.1.LO.1		
Use scientific literature and statistics to design experiments and analyse results.	**Digital Literacy:** Learners get hands-on experience on the technology used for the therapeutic device as they practice the assembling and disassembling of the therapeutic devices. **Collaboration:** Learners work in groups using online resources and develop an operating manual for a medical device as each member shares his or her opinion. **Leadership:** As learners work in groups to research online and brainstorm to develop an operating manual for a medical device, they share tasks and responsibilities among themselves. **Communication:** Learners learn to articulate their opinions on the work performed by the regulatory agencies and comment on the suggestions made. **Ethical Reasoning:** Learns identify the ethical rule used by the regulatory agencies for checking the fraudulent adverts on the medical devices.	**GESI:** • Consciously ensuring that learners who make mistakes while talking are not laughed at or mocked but are corrected in a manner that will encourage them for trying. • Encourage learners to attempt questions a couple of times while the teacher provide constructive criticism for improvement to boost learner confidence. • Learners appreciate, value, and embrace diversity as they work with other group members. • Learners embrace different opinions as they develop an operating manual for a medical device. • All learners are given the opportunity to provide oral presentations confidently and effectively to other learners. **National Core Values:** • Humility • Truthfulness • Honesty

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century Skills and Competencies, and GESI	Assessment
3.4.1.CS.1	3.4.1.LI.1	3.4.1. AS.1
Demonstrate an understanding and application of a variety of biomedical experimental designs.	**Apply knowledge of specified statistical analysis methods to analyse the result of experimental studies**. **Structured Talk for Learning**: Learners engage in a discussion on the explanation of dependent and independent variables of sample biomedical study. Discuss statistical measures and the effect of sample size on representation of a population. Activity-Based Learning: Using data from a study, learners calculate measures of central tendency (mean, mode and median) and measures of variability (range, variance and standard deviation). On scatter plots or histograms, learners are tasked to change scales on the y-axis(ordinate) for the plot of the same data and observe how changes in the scale may exaggerate or diminish an outcome	Level 1 Recall **Level 2 Skills of conceptual understanding** **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.4.1.LI.2	3.4.1.AS.2
	Design and analyse an experimental study to answer a question relating to human health **Project-Based Learning:** Learners work in groups, proposing a research topic (for example, BMI of learner population, the effect of skipping breakfast on mood, blood pressure profile of learners, etc), designing an experiment for the proposed research and collecting experimental data. Consult textbooks and online resources for secondary data for the study. Finally, document your findings in a report.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Projector • Internet • Textbook • Sample manual • Regulatory documents	