Sample lesson plan

Topic: Respiration

Concept statement
Respiration is the release of energy from food substances in all living organisms.

Attitudes, skills and values
The learners will develop curiosity, open-mindedness, perseverance, a positive approach to failure and the skill of co-operating within a group.

Materials
- Stand
- Dissecting needle
- Peanuts
- Thermometer
- Test tube
- Water

Safety
The learners should handle fire with care, being careful not to burn themselves, others or objects in the environment.

Common mistakes
Learners must understand that respiration is not the same as breathing. Breathing is the physical work of the intercostal muscles and diaphragm in taking air in and out of the lungs. Respiration is the release of energy from food substances in all living organisms.

The four phases of the lesson

Process skills
Investigate
Demonstrate
Observe

Phase 1: Exploration
The learners explore the concepts of combustion, oxidation and respiration.

The learners will investigate the process of respiration. They will begin this by demonstrating how a peanut burns and what happens when the burning peanut is submerged in a test tube of water. The learners will then observe that the temperature of the water increases due to the burning peanut.

The teacher asks the learners to:	The learners will:
• Assemble the apparatus • Read and record the initial temperature of the water in the test tube • Heat the peanut until it is burning and place it under the test tube of water • Take the temperature of the water again and record it.	• Design and carry out the experiment • Demonstrate how the peanut is oxidized • Take the temperature of the water and record it • Observe what happens to the temperature of the water as the peanut burns • Discuss the results • Draw a conclusion about the results.

Phase 2: Explanation

The learners explain why the temperature of the water increased when the burning peanut was placed beneath it.

In this phase, the learners are investigating the concept of respiration. Respiration is the process by which food is turned into energy in the cells of the body. This process can be likened to what happens when the peanut burns: energy is released. The important outcome of this phase is that learners must conclude from their experiment that energy is released during oxidation.

Process skills
Observe
Infer
Measure
Communicate

Phase 3: Expansion

The learners extrapolate their findings to understand and explain other phenomena relating specifically to the concept statement.

During this phase, you will need to ask the learners challenging questions to help them to understand and extrapolate their findings to generate new knowledge of the process of respiration.

Here are some challenging questions you can ask:

Question	Possible answer
Explain what will happen if you use two peanuts instead of one.	The temperature will increase more because twice the energy is being released.
Where in your body does a similar process take place?	In every living cell.
How does it happen?	Food (glucose) is oxidized to release energy.
Define the process by which glucose is oxidized in the cells to release energy.	The process if called respiration. Respiration is the release of energy from food substances in all living cells.

Question	Possible answer
Write the balanced chemical equation in both words and symbols.	

Once the learners have understood the concept, they need to recognise its importance. Once again, this can be done by asking leading questions, for example:

Question	Possible answer
Why is the concept important in the body?	Respiration releases energy for the body.
What are the uses of the energy that is released when glucose is oxidized?	The energy is used by the organism to make the heart beat, to obtain food and digest it, to move, etc.
Why is the concept important for personal development?	Respiration is important to keep us alive. Understanding the concept helps us to understand how our own bodies work.
Why is the concept important for academic growth?	Understanding the concept helps us to identify new concepts such as combustion, aerobic respiration and oxidation.
Why is the concept important for science, technology, and society?	Doctors, farmers and individuals such as sports people can use the concept to understand how the body works and how it can function better or be helped when it is not functioning optimally. Food technologists and nutritionists can identify energy-rich foods.
Why is the concept important for career awareness?	Possible careers include becoming a doctor, human physiologist, nutritionist, food technologist, research scientist, etc.

Phase 4: Evaluation

The learners show what they have learned for the purposes of assessment and self-assessment.

During this phase, the learners should be able to:
a) define respiration
b) define aerobic respiration
c) state the balanced equation for aerobic respiration in both words and symbols
d) describe the uses of energy in the body.

Teachers should remember that the use of visual and pictorial teaching aids enhance effective teaching and meaningful learning since learners visualize the real rather than the abstract. Teachers are also reminded not to rely heavily on textbooks as the tools for instructions, but should explore avenues such as primary sources and self-designed materials. This could make their lessons more exciting and interesting.

The common evaluation tool used to determine whether instructional objectives are achieved is a teacher-made test. The types of items used in Namibia Senior Secondary Certificate (NSSC) are multiple-choice, structured questions, and practical-based questions. The multiple-choice items should cover assessment objectives A and B (refer to the syllabus). The structured questions should cover assessment objectives A, B and C. Practical-based questions should cover assessment domain C (refer to the syllabus for details). Teachers must ensure that the teacher-made tests are up to standard and that they assess ABC assessment objectives.

It is important for teachers to give feedback for every teacher-made test in order for the learners to identify their strengths and weaknesses. It is a good idea for the learners to get their feedback as soon as possible, while the test is still fresh in their memory. The sooner the learners get feedback after the test, the more effective will it be. Test scripts should be accompanied by comments and positive criticisms about each learner's work to enhance their understanding of areas requiring improvement. Learners' performance in the test will determine whether there is a need for revision or if instructional objectives were achieved. Tests will also be a good tool to identify common misconceptions of ideas, principles, and key-concepts.

One of the many challenges is possible misconceptions and alternative conceptions of biological concepts prevailing among the learners. Learners find it difficult to understand biological key concepts. Be on the lookout for these misconceptions and alternative conceptions at all times. For example, when introducing the concept of respiration, ask them to explain how they understand this concept. Most of them will tell you that respiration means "breathing". It is very important to clear this misunderstanding at an early stage, as it will adversely affect learners' subsequent learning. Evidence from empirical studies shows that misconceptions have many origins, ranging from learners' prior interaction with knowledge presentation in the classroom, age, ability, gender, culture, personal experience and perception, language proficiency, as well as the teachers' explanation and instructional materials. Teachers should remember that textbooks, which are regarded as strong tools for instructions, could also carry misconceptions. Once identified, these misconceptions should be rectified before they become entrenched.

Learners have a tendency to believe that whatever is published and documented is correct and there is no way that it could be wrong. It is the teacher's responsibility to convince them that books and other documents can also carry mistakes and misconceptions.

Misconceptions and alternative conceptions present serious obstacles to learning in Biology. Unfortunately, they are difficult to diagnose and time-consuming to rectify. As a result, most of them go unidentified, interfering with learners' learning and understanding of Biology. It is very important to identify these misconceptions and alternative conceptions to ensure effective teaching and meaningful learning.

Your teaching approach and/or methodology will also have a serious impact on the way in which your learners learn Biology. The teacher-centered approach is strongly condemned as it has been proven to produce nothing other than to encourage memorization and rote learning. There is a slogan by a certain educational philosopher that says, "teaching is not a synonym of learning and teaching can take place without learning taking place". You can be a good teacher but this does not guarantee that learning will take place if not learner-centred. Teachers are expected to cultivate a culture of constructivist teaching at all costs. Constructivism is a theory of learning which was developed from Jean Piaget's theory of cognitive development. This theory assumes that knowledge is not passively received from the environment or the teacher but rather actively constructed by the learners themselves. Furthermore, knowledge of new ideas is built on learners' previous knowledge and experience of the world outside the classroom. Constructivism opposes the traditional behaviorist theory of teaching, which assumes that knowledge can be transferred intact from the teacher to the learners. Learners are regarded as passive recipients of knowledge, empty vessels to be filled or blank papers on which the teacher can write.

The constructivist teaching strategy has been proven by many educational researchers to be effective in teaching science and mathematics, and Biology is not an exception. Most teachers mistakenly believe that they are already using constructivism in their classrooms. Use the continuum below to evaluate yourself to determine the extent to which you apply constructivism in your teaching.

	Teacher	Learner
Who identifies the lesson or issue?		
Who asks questions?		
Who identifies needed resources?		
Who locates printed resources?		
Who plans the investigations or activities?		
	Yes	**No**
Are the learners' preferences and interests considered?		
Is the learners' experience considered?		
Do the learners link previous knowledge with new knowledge?		
Are various evaluation techniques used?		
Do learners practice evaluating themselves?		
Are concepts and process skills applied and process skills applied to new situations?		
Are learners encouraged to take action on what they have learned?		
Do Biology concepts and principles emerge from the topics studied because they are needed?		
Is there evidence that Biology learning is being extended beyond the walls of the school?		

If the learners themselves do most of the activities in the continuum, then you claim to be a constructivist teacher. The role of a constructivist teacher is to facilitate or "coach" and create an environment conducive to learning. Lesson objectives that support constructivist principles contain verbs such as discuss, describe, explain, deduce, compare, interpret, predict, identify, suggest, determine and the like. These objectives are achievable and measurable. Teachers should avoid using terms such as understand, know, appreciate and the like because these objectives are vague and difficult to measure.

One of the most interesting and effective teaching strategies in Biology is the use of concept maps. The concept map is a diagrammatic representation of the relationship between different concepts. Two or more concepts are linked together by words that provide information on relationships or describe connections between different concepts. It can be compared to a road map that links main places together. Concept maps promote meaningful learning and enhance the learner's ability to remember what he or she has learned and link new knowledge with prior knowledge because they provide visual images of the concepts. They promote active learning since learners are actively involved in the construction of concept maps. Teachers are cautioned not to allow learners to memorize pre-prepared concept maps since this will promote rote learning rather than encouraging learning with understanding.

Train learners to construct their own concept maps using key Biology concepts. They should be able to arrange biological key concepts in an organizational hierarchy, with the broader concepts on top and specific ones at the bottom. Concept maps could be used in teaching/instruction, note-taking, summarizing, studying, revision, examination preparation, reinforcing of understanding, identifying misconceptions, evaluation, etc.

The following are brief steps to be followed when constructing a concept map:

1. identify the key concepts
2. arrange the key concepts from the broader and abstract to the specific and concrete
3. group the key concepts that work at similar level and those that are closely related
4. arrange the key concepts to form a diagram
5. use lines and labels to link the key concepts together.

SCHEME OF WORK
NSSC BIOLOGY

Year one: Grade 11

Term 1

- • Indicates ordinary level
- ❖ Indicates higher level

Syllabus section	Topic	Learner activities	Number of periods	Work completed
Section I Characteristics and classification of living organisms	1. Characteristics of living organisms	• list and describe characteristics of organisms • define nutrition, excretion, respiration, sensitivity, reproduction, growth and movement		
	2. Classification and simple key	• explain the use of hierarchical classification system • classify living organisms into kingdoms, phyla, orders, classes, genera and species • use and describe the binomial system • use simple dichotomous keys ❖ construct dichotomous keys		
	3. Diversity of living organisms	• list the main features used to classify kingdoms • outline the structure of a virus ❖ consider the arguments for and against classifying viruses as living organisms • list the main diagnostic features of flowering plants, cnidarians, nematodes, molluscs, annelids and arthropods • describe the visible diagnostic features of vertebrates and their survival in the environment		
Section II Organization and maintenance of the organisms	1. The microscope	• identify and state the functions of the parts of the microscope • calculate the magnification and size of biological specimen using millimetres as units		

	2. Cell structure and organization	• describe the structure of a prokaryotic and eukaryotic cell • identify and describe the structure of plant cell (palisade) and animal cell (liver cell) • relate the structures of plant cell and animal cell to their functions • describe the structural differences between plant and animal cells ❖ describe the structure of the cell surface membrane (fluid mosaic model) and describe its role in the regulation of the passage of substances		
	3. Levels of organization	• define tissue • state examples of tissues and relate different tissues to their functions and locations • define organs • define organ systems ❖ discuss the advances in level of organization from cnidarians to annelids, arthropods and chordates		
	4.1 Diffusion	• define diffusion • describe importance of diffusion ❖ describe facilitated diffusion		
	4.2 Osmosis	• define osmosis using water potential (ψ) • describe the importance of osmosis • describe the effects of osmosis on plant and animal tissues		
	4.2 Active transport	• define active transport and understand its importance		
	5. Enzymes	• define enzymes ❖ describe enzymes ❖ explain enzyme activity in the "lock-and-key" model • describe the effect of changes in temperature and pH on enzyme activity • describe the role of enzymes in germinating seeds, and their uses in biological washing products and food industry		

Term 2

Syllabus section	Topic	Learner activities	Number of periods	Work completed
	6. Nutrition	• define nutrition • compare and distinguish between autotrophic and heterotrophic nutrition		
	6.1 Nutrients	• list the chemical elements that make up proteins, carbohydrates and fats • describe the synthesis of large molecules from smaller basic units ❖ explain glycocidic bonds ❖ outline the structure of polypeptides and proteins ❖ describe the roles of globular and fibrous proteins ❖ outline the structure of fats ❖ describe the structure of phospholipids • explain the role of water • outline the role of carbohydrates, fats and proteins in living organisms • describe and carry out food tests		
	6.2.1 Leaf structure	• identify the structures of a dicotyledonous leaf ❖ discuss adaptations for photosynthesis		
	6.2.2 Mineral requirements	• describe the importance of iron, phosphate, nitrate and magnesium ions in plants ❖ explain the uptake of these ions by active transport • explain the effects of lack of nitrate and magnesium ions in plants		
	6.2.3 Photosynthesis	• define photosynthesis • state the equation for photosynthesis using words and symbols • describe how plants get their raw materials for photosynthesis • define limiting factors • explain the use of greenhouse systems ❖ outline the processes in the presence and absence of light		