ASSESSMENT OF BIOLOGY UNDERGRADUATE STUDENTS PERCEPTION OF THE USE OF EXPERIMENT IN THE TEACHING OF CELL BIOLOGY

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A RESEARCH WORK SUBMITTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE EDUCATION (B.Sc. Ed) DEGREE IN BIOLOGY EDUCATION. OF THE UNIVERSITY OF BENIN, BENIN CITY,

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CERTIFICATION

We, the undersigned, hereby certify that this project work was carried out by Elizabeth Motunrayo ADEMUWAGUN, a student of the department of Curriculum and Instructional Technology that it is adequate in scope and quality in partial fulfilment of Bachelor of Science Degree in Biology Education of the University of Benin, Benin City.

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DEDICATION

In profound reverence and awe, I humbly dedicate this project to God almighty,the source of all wisdom, inspiration and strength. His Unconditional love, Mercy and presence has been my constant companion throughout this Journey.

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ABSTRACT

Undergraduate students have different perceptions of the use of experiments in the teaching of cell biology. This study aimed to identify some of the student's opinions about the use of the use of experiments in the teaching of cell biology.

A descriptive survey research design was utilized and the study was guided by seven research questions. The research was conducted at the University of Benin in Edo state, Nigeria. A total of 150 undergraduate students were selected from three departments at the University of Benin. Plant Biology and Biotechnology (50 students), Animal and Environmental Biology (50 students), and Curriculum and Instructional Technology (50 students). The sampling technique employed was simple random sampling. The data were collected with a questionnaire instrument and analyzed using simple percentages and means.

The findings indicated that students expressed working with live cells and observing their behavior was enjoyable. The results also show that there are available materials in the experiment of bacterial cell-like cell culture dishes, Petri dishes, pipettes, etc. Also, results show that undergraduate cell biology students face challenges such as teaching methods used by the lecturer and lack of learning aids. Additionally, some factors influence students' perceptions such as the amount of time required to complete the experiment, the level of difficulty of the experiment, etc.

In conclusion, it is therefore recommended that teachers should adapt their teaching methods, increase their knowledge of conducting experiments, allocate sufficient time, and provide adequate learning aids. Additionally, researchers recommend that teachers ensure proper preparation and caution before conducting experiments.

CHAPTER ONE

INTRODUCTION

Background of the Study

The academic discipline of cell biology can be defined as the study of the structure, function, and molecular composition of cells. Cell biology can also be defined as the study of the molecules of life and how they interact in living systems (Max Delbruck). Also, there's Sydney Brenner, who defined cell biology as the study of the behavior of biological molecules within cells. Cell biology is a core subject for students of nursing, medicine, dentistry, pharmacy, nutrition, biology, physiotherapy, and veterinary medicine (ANECA 2012).

Learning cell biology presents three major challenges

- The abundant and increasing amount of information (Wright and Biggs 2002),
- Frequent changes in associated models and theories (Howard and Miskowski 2005) and
- The need for practice to understand content and acquire skills.

Laboratory practice has always been controversial. In the 1970s and early 1980s of the last century, some authors questioned the role and effectiveness of practice, arguing that the benefits were less evident than what was claimed (Bates 1978; Saunders and Dickinson 1979).

Subsequent studies, however, demonstrated the opposite (Lightburn 2002; Hofstein and Lunetta 2004).

Undergraduate biological sciences education has experienced a recent push toward providing students with laboratory-based experiences that more closely resemble the scientific research process. Handlesman et all coined the term " Scientific teaching" to represent the importance of teaching science in a way that accurately reflects the rigor and dynamic nature of the discipline. A scientific teaching approach can better prepare students for careers in science by facilitating a more meaningful connection between theory and practice.

Laboratory-based practicals are an essential part of the science curricula in higher education, as they engage students in active learning and help students to appreciate how science is conducted in a professional context. Although scientific and educational communities agree that undergraduate laboratories are " where science is done", there have been debates on how this should be performed in an undergraduate setting. Traditionally, laboratories have been set up as "recipe-based" or " cookbook" practicals where students follow a preset experimental method to arrive at an expected answer. Using different layouts and assessment requirements, all of these alternatives attempt to lead students toward " how to think like a scientist" and the development of cognitive and practical professional skills required for a broad range of science-based careers.

For the last several decades, educational research has suggested that laboratory courses and beneficial and make a unique contribution to science education. Freedman (1997) showed that students who experienced hands-on laboratory programs achieved higher scores on mid-term and final science examinations than those who did not participate in such courses. This implies that students who experienced the experiment in the teaching of cell biology will achieve higher scores than those who did not participate in the experiment.

The laboratory experience begins with the teachers' explanation, then there are student activities that are directed step by step by a script, and finally, come questions that are answered (Leonard 1991).

The experiment in the teaching of cell biology is usually organized as follows. The teacher starts by introducing the general topic and presenting the theoretical aspects of procedures. After that students receive the laboratory protocols and all materials needed for conducting the procedures indicated in the practice syllabus. In most cases, the students are organized into groups of two to four people to collaborate on their work. The instructor then supervises the student's work and corrects any potential mistakes, guiding them to achieve correct or expected results.

In science courses in general and cell biology courses in particular, laboratories are different environments from conventional classrooms. Laboratories (where experiments are carried out)

play an important role in scientific disciplines because activities are designed to be performed in them. Suitable physical facilities and psychosocial aspects increase student's social and problem-solving skills, positive attitudes toward science, learning and intellectual abilities, and understanding of scientific concepts (Arzi 1998)

Statement of the Problem

The effectiveness of using experiments in teaching cell biology to undergraduate biology students has not been thoroughly investigated, leading to a gap in understanding how students perceive the value and impact of environmental learning on their academic achievement and engagement in the subject. This makes the question remain unanswered: What are the factors that influence students' perception of the use of experiments in cell biology? How do students' perceptions of the use of experiments in cell biology change over time? Do students face any challenges during the process of the experiment?

The study aims to assess the perception of biology undergraduate students regarding the use of experiments in the teaching of cell biology, to identify areas for improvement, and to inform evidence-based teaching practices.

Purpose of the Study

This study was designed to investigate and analyze the solutions to the problems students are facing in the use of experiments in the teaching of cell biology.

1. To determine the factors that influence students' perception of the use of experiments in cell biology.

2. To determine whether student perception of the use of experiments in cell biology changes over time.

3. To determine whether student perception of the use of experiments in cell biology varies by demographic factors such as gender, race, or socioeconomic status.

4. To investigate whether student find the experiment of cell biology interesting

5. To investigate whether student face any challenges during the process of experiment in cell biology

Research Questions

1. Is there any benefits of conducting experiment in cell biology?

2. Is there a material needed for cell biology experiment?

3. What are the areas of cell biology that undergraduate students find most challenging?

4. Do student actively engage with materials for experiments as part of their cell biology education?

5. What are the challenges cell biology students face and how to overcome them?

6. What factors decisively influence students perception of the use of experiments in cell biology?

7. What is the level of satisfaction of student with experiment based teaching

Significance of Study

The findings of this study will have significant benefits for students, lecturers, institutions, and researchers. The study will help students understand the importance of using experiments in the teaching of cell biology, as it will expose them to real-world applications and give them confidence in studying live cells.

For lecturers, the findings will help them improve their teaching effectiveness by understanding students' perceptions and adapting their approaches. Additionally, the institution could create a more interactive learning environment based on the study's findings, enhancing student satisfaction.

The research data could also encourage university administrators to incorporate experiments into the teaching of cell biology to build real-world application knowledge for students.

Delimitation of the Study

This is the boundary of the study. The study will focus on biology undergraduate students only and not ; students in other disciplines or at other educational levels.

Definitions of Terms

To ensure clarity and understanding, the following key terms used in the study will be defined.

Assessment: refers to an idea or opinion about something.

Perception: The way you understand and interpret through our sense, experiences.

Experiments: a scientific test in which you perform a series of actions and carefully observe their efforts in order to learn about something.

Microscope: An instrument that makes small things look bigger, helping us to see details that are too tiny for the naked eyes.

Laboratory: A room or building with special equipment for doing scientific experiments and test.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter is design to review several literature that are related to this study. The literature to be reviewed will be discussed under the following sub-headings:

Cell Biology

Importance of Cell Biology

History of Cell Biology

Role of Experiments in Cell Biology Lab

Cellular Processes and Functions

Experiment Techniques

Perception of Laboratory Resources and Facilities

Perceived Barriers to Experimental Learning

The Role of Hands-on Experiment in Cell Biology Education

Summary of Literature Reviewed.

Cell Biology

Cell biology is defined as the study of the structure, functions and molecular composition of cells. It is also the subdiscipline of biology that focuses on the study of the basic unit of life, the cell. Cell biology can be defined as the study of the molecules of life and how they interact in living systems (Max Delbruck). Cell biology is the study of the behavior of biological molecules within cells.Cell biology is the scientific study of the structure, function and biochemical processes of cells and their environment. It examines the molecular machinery that enables cell to carry out biological functions and the mechanisms by which cells communicate and interact with their environment.

There are two fundamental classification of cells; prokaryotic and eukaryotic.

Prokaryotes are single celled organisms, whereas eukaryotes cean either be single celled or multicellular. Prokaryotic cells (which lack a nucleus but have a nucleoid region) are much smaller than eukaryotic cells (which possess a nucleus), making them the smallest form of life. Prokaryotic cells include Bacteria and Archaea while eukaryotic cells are found in plants, animals, fungi and protists.

Eukaryotic cells are composed of the following organelles;

- Nucleus: The nucleus of the cell functions as the genome and genetic information storage for the cell, containing all the DNA organized in the form of chromosomes.

• Nucleolus: This structure is within the nucleus, usually dense and spherical. It is the site of ribosomal RNA synthesis which is needed for ribosomal assembly.

• Endoplasmic reticulum: This functions to synthesize, store and secrete proteins to the Golgi apparatus etc.

• Golgi apparatus: A series of flattened membrane bound sacs that help modifies, sorts, and packages protein for transport to other parts of the cell or outside the cell.

• Lysosomes: Membrane bound organelles that contain enzymes that break down waste products, old cellular components and foreign material.

• Mitochondria: The cells power houses that convert energy from food into a form that the cell can use, called ATP.

• Ribosomes: Small organelles that synthesis proteins. They can be free floating in the cytoplasm or attached to the endoplasmic reticulum.

• Centrosome: A structure that contains the microtubules organizing center and helps organize the cells cytoskeleton during cell division.

• Microtubules: Hollow, rod like structures that help to maintain cell shape and provide structural support. They play a role in cell division.

• Vacuoles: Storage compartments found in plant cells that store water, enzymes and other substances.

• Chromosomes: The liquid inside the nucleus that contains DNA, RNA, proteins and other components

• Smooth Endoplasmic Reticulum (SER): Involved in lipid synthesis and detoxification

• Rough Endoplasmic Reticulum (RER): Site of protein synthesis

• Vesicles: Small, membrane bound sacs that transport substances within the cell.

Importance of Cell Biology

1. Biotechnology used techniques and information from cell biology to genetically modify crops to produce alternative characteristics: to clone plants and animals ; to produce and ensure high quality food is available at lower costs

2. Health and disease: Cellular processes is vital for studying diseases at the cellular level, leading to the development of treatment and therapies. For example, cancer research relies heavily on understanding aberrant cell behavior.

3. Basis of life: Cells are the smallest unit of life and are responsible for carrying out all biological processes essential for life, including metabolism, growth and reproduction.

4. Drug development: Cell biology provides insights into drug targets and mechanisms action, facilitating the development of new pharmaceuticals.

5. Food safety: Cell biology is used to develop food safety protocols and to detect the presence of harmful bacteria in food.

Cell biology is not just about disease. It has greatly assisted the human fertility programme. DNA testing has been used in archaeology to provide evidence that a living person is related to a long dead ancestor.

History of Cell Biology

The foundation of cell biology were formed in the 17th century with two of the most important advances of that period coming from the English man "Robert Hooke". In 1665, Robert Hooke reported that his observation when he examined very tiny slices of cork cut with a sharp knife, where he reported honey comb like nature of cork, the use of the term " cell" to describe the compactment he saw and concluded that each was a completely enclose spaces without interconnecting passing waste. What Hooke had observed were the empty cell wall of dead plant tissue. Hooke thought of the cell he observed as something similar to the vein and arteries of animals that were full of juice in living plants, but the microscope will not permit the observation of any intercellular structure and observation that should have dispelled the notion that cells are near partition channels for the passage of materials.

In 1674, Anton Van Leeuwenhoek was the first to analyze live cells in his examination of algae. First observed microscopic single celled organisms in apparently clean water.

In 1838 Matthias Schleden (plant scientist) concluded that regarded of the particular tissues appearance plants were made up of cell and that the plant embryo arose from a single cell. In 1839, published a report of cellular basis of the animal land. Theodor Schwann (animal scientist) proposed that all tissues whether they be muscles or nerve were composed of cells. Schwann further more concluded that all cell of plants and animals were entirely analogous structures and that as such cells were the functional units of all living organisms. Schwann realized that each cell was an individual, an independent whole which is somehow operated together with other cells in a harmonious manner. Theodor Schwann and Matthias Schleden argued convincingly that each cell is capable of maintaining an independent existence.The report of Schleden and Schwann led to the formation of cell theory.

In 1831, Robert brown discovers the cell nucleus, a structure of particular importance in cell function. In 1858, Rudolf Virchow published his classical textbook " cellular pathology", where he correctly asserted that every cell arose from a pre- existing cell and that as the functional unit of life , they are also the primary site of disease. Virchow's idea completed what has come to be known as the "cell concepts".

Viruses are not considered in cell biology - they lack the characteristics of a living cell and instead are studied in the microbiology subclass of virology. But bacteria are considered in cell biology.

In 1885, Walther Flemming describes mitosis, the process by which cells divide and reproduce.
In 1935, Hans Krebs and Kurt henseleit propose the citric acid cycle, which explains how cells produce energy.

In 1962, Alec Jeffrey develops the first DNA fingerprinting technique, which is used to identify individual by their unique genetic code.

Cell signaling or cell communication is important for cell regulation and for cells to process information from the environment and respond accordingly.

* Bengt lidforss coined the word "organells" which later became "organelle"

* Edmund Beecher Wilson known as America's first cellular biologist, discovered the sex chromosome arrangement in humans.

* In 1888, Theodor Boveri identified the centrosome and described it as the special organ of cell division.

Role of Experiments in Cell Biology Research.

Experiments play a crucial role in cell biology research, allowing scientists to investigate the structure, function, and behavior of cells.

1. Test Hypothesis: Experiments help scientists test Hypothesis about cellular processes and functions. By designing controlled experiments, researchers can manipulate variables and observe their effects on cell behavior, leading to a better understanding of biological mechanisms.

2. Innovation: Experiments can lead to new methods, techniques and tools in cell biology which can advance the field in new and exciting directions.

3. Validation of biological models: It validate biological models proposed based on theoretical frameworks or previous observations. Researchers can confirm hypotheses through experimentation.

4. Drug discovery and development: Cellular assays are used to screen potential drug candidate for efficacy and safety, helping identify compounds with therapeutic potential.

5. Investigation of disease mechanisms: It contribute to understanding the molecular underlying diseases.

Cellular Processes and Functions

Cellular processes and functions encompass a wide range of activities that occur within cells, enabling them to maintain homeostasis, grow, reproduce and respond to their environment. They include:

1. Metabolism: Metabolism involves the biochemical processes by which cells obtain, convert and utilize energy from nutrients to sustain life. It includes catabolic processes (breaking down molecules to release energy) and anabolic processes (building complex molecules from simple ones).

2. Photosynthesis: Photosynthesis is the process by which light energy is converted into chemical energy using carbon dioxide and water, releasing oxygen by living organisms.

3. Cellular Respiration: This is the process in which cells convert glucose and oxygen into ATP(adenosine triphosphate), the primary energy currency of cells, along with carbon dioxide and water as by products.

4. Protein synthesis: The process of converting genetic information into functional proteins, which are essential for cellular structure and function. It involves the transcription of DNA into RNA and the translation of RNA into proteins. Proteins play diverse roles in cells, including structural support, enzymatic activity and cell signaling.

5. Cell division: The process by which cells grow, divide and produce new cells, which is essential for growth, development and repair. It either through mitosis (producing two identical daughter cells) or meiosis (producing haploid gametes for sexual reproduction).

6. Membrane transport: It refers to the movement of molecules across cellular membranes including passive processes (e.g diffusion, osmosis) and active processes.

7. Cellular homeostasis: Cells maintain internal stability and equilibrium through mechanisms that regulate factors such as temp, PH, ion concentrations and osmotic pressure.

8. Cell differentiation: The process by which cells specialize to perform specific functions in the body, such as muscle cells or nerve cells.

Others include; cellular communication, signal transduction, cell migration etc.

All these are interconnected and coordinated to ensure the proper functioning of the body.

Cell Biology Experiment Techniques

For a successful experiments, all of these experiments are required.

1. Microscopy

2. Cell culture

3. Biochemical assays

4. Stains and dyes

5. Petri dishes

6. Cell incubator

7. Pipette etc

Microscopy: Microscope are used in laboratories, to see the structure that would not be possible to observe with the naked eye. It is important to understand that cells are very tiny. Most cells are too small to see the with the naked eye, this is where microscope comes in

There are two type of microscope namely;

* Light microscopy

* Electron microscopy

Light microscope are used in school to teach students. They are both used to visualize cells and their internal structures. Light microscopy is used to view tissues and cells. There are different type of light microscope. We have

* Bright field light microscopy

* Fluorescence light microscopy

The first and oldest microscope were developed about 400 years ago and used visible light from the sun, with glass to magnify the sample.

Electron microscopy is used to view cell organelles in detail.

Types of electron microscopes

* Transmission electron microscope

* Scanning electron microscope

About 80-100 years ago, we discussed that using electrons to image samples greatly increased both the magnification and resolution of the microscope.

Both light and electron microscopy are still in use.

Cell- culture: The use of artificial environments to grow cells outside of the body, which allows for the study of cell growth and behavior under controlled condition.

Advantages of Cell Culture Techniques

1. Control: Cell culture allows for precise control over the experimental conditions, including temperature, pH, nutrients, and other factors, which can be difficult to achieve in living organisms.

2. Efficiency: Cell culture is faster and more efficient than animal or plant experimentation, as cells can be grown and studied in vitro, eliminating the need for lengthy breeding or cultivation cycles.

3. High throughput: Cell culture allows for the study of many different cell types and conditions simultaneously, making it an ideal method for high-throughput screening and genetic analysis.

4. Versatility: Cell culture techniques can be adapted to study a wide range of biological systems and processes, including cancer, infectious diseases, and genetic disorders.

5. Safety: Cell culture experiments can be performed in a controlled environment, eliminating the risk of exposure to potentially harmful pathogens or toxic substances.

Disadvantage of Cell Culture Techniques

1. Cell culture techniques are usually capital intensive.

2. Limitations in cell type: Not all cell types are amenable to culture, which can limit the range of experiments that can be performed.

3. Artificial conditions: The in vitro environment is different from the natural environment in living organisms, which can affect the behavior and physiology of cells.

4. Loss of context: Cells grown in culture lack the normal tissue structure and environment found in living organisms, which can limit the interpretation of experimental results.

5. Lack of differentiation**:** Cells grown in culture may not undergo the same developmental processes as cells in vivo, which can limit the study of complex cellular interactions and differentiation.

Biochemical assays: The use of biochemical techniques such as Western blotting and ELISA to measure the levels of specific proteins or other molecules in cells.

Stains and dyes: are important tools for visualizing and studying cells. Examples of stain and dyes used in cell biology include:

* Hematoxylin and eosin: A common staining techniques that differentiate between different toxylin and eosin: A common staining techniques that differentiate between different types of cells in tissue samples, based on their color and morphology

* Nucleic acid stains: Stains that bind to DNA or RNA, which are used to visualize the nucleus and other cellular structures.

Fundamental Principles of Cell Biology

1. Cell theory: Proposed by Matthias Schleden and Theodor Schwann in the 19th century, the cell theory states that all living organisms are composed of cells and cells are the basic units of structure and function in living organisms

2. Cellular communication: Cells communicate with each other through chemical signals such as hormones and neurotransmittes, which allows them to coordinate their activities and respond to changes in their environment.

3. All cells share common features**:** All cells have a cell membrane, cytoplasm and DNA which encodes the genetic information necessary for life.

Perception of Laboratory Resources and Facilities.

1. Quality of technical support: The availability of skilled technical staff to operate equipment and provide training is highly valued.

2. Availability of Research funding: Adequate funding is necessary for machinery laboratory resources. Having a well funded laboratories can lead to a good comprehensive and impactful research.

3. Access to state-of-the-Art Equipment**:** Researchers value access to advanced laboratory equipment and technologies such as microscopes, mass spectrometers. State of the art facilities enhance the capacity for conducting cutting edge experiments and generating high-quality data.

4. Maintenance and organization: Well maintained laboratory spaces with organized storage facilities for reagents, samples and equipment contribute to efficiency and productivity.

Others include; Collaborative environment, flexibility, safety etc.

Perceived Barriers to Experimental Learning

1. Time constraints: Students may not have enough time to devote the experimentation which can limit their ability to explore different approaches or techniques.

2. Limited Access to Resources: Students may perceive a lack of access to laboratory equipment, materials and facilities in barrier to engaging in experimental learning activities.

3. Fear of failure: **S**tudents may be afraid to try new things or make mistakes, which can limit their ability to learn from their experiences.

4. Lack of motivation**:** Students may not be motivated to engage in experimental learning if they do not see the relevance or value of it to their lives or failure careers.

5. Accessibility issues: Students with disabilities or other accessibility needs may face barriers to participate fully in experimental activities due to physical, sensory or cognitive limitations.

6. Limited opportunities: Students may not have many opportunities to.engage in experimental learning, especially if they live in rural or poor areas.

The Role of Hands-on Experiment in Cell Biology Education.

Hands-on experiment plays an important role by providing students with w practical understanding of cell biology concepts and skills. They include;

1. Active learning: It engage students in active learning, allowing them to manipulate materials, make observations and draw conclusion, Active participation enhances comprehension and retention of cell biology concepts.

2. Skills development: Hands-on experiments provide students with the opportunity to develop practical skills, such as laboratory techniques, problem-solving and collaboration

3. Critical thinking: It promote critical thinking by challenging students to formulate hypotheses, design experiments and interpret results. Engaging in the scientific process cultivate analytical skills and scientific reasoning

4. Connection to real-world problems: Hands-on experiments can help students to understand how cell biology relates to real-world problems, such as disease and environmental issues which can increase their motivation and interest in the subject.

Challenges Cell Biology Students Encountered.

1. Interdisciplinary nature: Cell biology is interdisciplinary, drawing on concepts from biology, chemistry, physics and other fields, which can be challenging for students who are not familiar with these other areas.

2. Communication**:** Cell biology involves the interpretation and communication of complex information, which can be challenging for students who are not comfortable with communicating in a scientific context.

3. Laboratory work: Cell biology involves the use of specialized laboratory techniques which can be difficult for students to learn and perform correctly.

4. Time management**: C**ell biology courses often involve a heavy workload and tight deadlines, which can be challenging for students who have difficulty managing their time effectively.

5. Funding: Students may face difficulties in obtaining funding for research projects or internship in cell biology which can limit their opportunities for hands-on experience.

Factors that Influence Students Perception of the Use of Experiments in Cell Biology

There are several factors that can influence students perception of the use of experiment in cell biology.

1. Disabilities: Students with disabilities may face barriers to accessing and participating in cell biology experiment, which can impact their perceptions of these activities.

2. Cultural factors: Cultural values and attitudes towards science and education can also influence students perception of experiment in cell biology.

3. Prior experience: Students previous experiences with science or experiments can influence their attitude towards cell biology experiments.

4.Academic background**:** Students with a stronger background in biology or chemistry may have different attitude towards experiments than those with a weaker background in these subjects.

5. Learning styles: Students individual learning styles can influence their attitude towards experiments with some students preferring to learn through hands-on activities while others prefer lecture based learning.

6. Motivation: Students motivation and goals can influence their attitudes towards experiments, with students who are motivated by curiosity or a desire to learn often being more receptive to experimentation

7. Interest in the topic: Students interest in cell biology can influence their attitudes towards experiments with students who are passionate about the topic often being more willing to participate in hands on activities.

Improvement to Consider in the Teaching of Cell Biology

1. Greater emphasis on hands-on learning: To address the limitations of traditional lecture based teaching methods, a greater emphasis should be plac d on hands-on learning experience, such as labs and field trips to engage students and help them develoo practical skills.

2. Better integration of technology: The use of technology in cell biology education, such as virtual reality simulations and online resources, can help to make the subject more engaging and interactive

3. Increased exposure to real world applications: To show study the relevance of cell biology in real world situations, teachers should incorporate examples of how cell biology is used in fields such as medicine, agriculture and environmental science.

4. Enhanced laboratory infrastructure: Schools should invest in high- quality laboratory equipment and supplies to support effective hands-on learning experiences in cell biology

5. Greater collaboration between educators**:** Cell biology teachers should work together to share best practices, develop innovative teaching strategies and collaborate on research projects

6. Greater emphasis on interdisciplinary approaches: Cell biology should be taught in conjunction with other disciplines such as chemistry, physics and genetics, to give students a more holistic understanding of life sciences.

7. Increased use of open educational resources: Teachers should utilize freely available, high quality educational resources, such as online textbooks and video lectures, to reduce the cost of education and increase access to cell biology education.

Summary of Literature Reviewed

Based on achival materials, a review of related literature was conducted. Reference materials, books, articles, journals and theses are among them. The sources included both printed and digital content.

The growing trend of undergraduate student perception of the use of experiment and its impact in the teaching of cell biology have been thoroughly covered in the literature review.

The literature reviewed the meaning of cell biology, importance of cell biology, the history of cell biology (to know how cell biology comes about), role of experiment in cell biology research, the cellular processes and functions, the perceived barriers to experimental learning, the role of hands-on experiment in cell biology education and the improvement to consider in the teaching of cell biology.

HAPTER THREE

METHODOLOGY

This chapter described the method and procedure used by the research in conducting the study. It is presented under the following sub-headings;

- Research Design
- Population of the study
- Sample and sampling techniques
- Research instrument
- Validity of the instrument
- Reliability of the instrument
- Method of data collection
- Method of data analysis

Research Design

Survey research design will be adopted for this study. According to omoroguiwa (2006), survey research design is one in which a group of people or items is studied by collecting data from only a few people or items considered to be representative of the entire group. The survey research design is interested in the accurate of the characteristics of the entire population through the study of a sample considered to be representative of the population. It also provides appropriate methodology for investigating human behaviours, perception and opinions.

Population of the Study

The population for this study involved two hundred and twenty (220 students) four hundred level (400L) students offering cell biology in University of Benin. Animal and Environmental Biology (AEB) 60, Plant Biology and Biotechnology (PBB) 60 and Curriculum and Instructional Technology (CIT) 100

Sample and Sampling Techniques

A total of one hundred and fifty (150) respondents were selected and used for this study. This represented sixty percent of the total population of four hundred level (400L) students offering cell biology in the University of Benin. The Simple Random Sampling (SRS) procedures was used in the study to select fifty students form the department of Animal and Environmental Biology, 50 study from the department of Curriculum and Instructional Technology and 50 students from the department of Plant Biology and Biotechnology.

Research Instrument.

The study will collect data with the aid of a closed-ended questionnaire titled Assessment of Biology Undergraduate Students Perception of the Use of Experiments in the Teaching of Cell Biology. It is made up of two sections "A and B". Section A, covers the demographic background of the respondents while section B comprised of seven (7) research questions. Question one has six(6) items, question two has eight (8) items, question three has six(6) items, question four has six(6) items, question five has six(6) items, question six has seven(7) items and question seven has seven(7) items. In total, section B had 46 attitude items with response

structured into Modified Likert Format of four scared response mode of strongly agree (SA), Agree (A), Strongly disagree (SD) and Disagree (D), others scared response mode used are Frequently, Very frequently, Rarely, Available, not available.

Validity of the Instrument

The content validity of the instrument will be established after an intense screening by the supervisor and two experts from the Department of Curriculum and Instructional Technology, University of Benin. Their input and corrections in terms of clarity and appropriateness of language was used to develop the final draft.

Reliability of the Instrument

The reliability of the instrument will be established using splif half technique. The data would be correlated using spear man Brown correction formulae.

Method of Data Collection

The Instrument was administered by the reseacher herself directly to the respondents. She explained to the respondents how to fill it and after filling the instrument, she collected the instrument to ensure 100% return rate. A total of 150 questionnaire were distributed . The problem with this reseach is that it is time consuming and financially demanding. However, the researcher decided to use it due to the size of research population.

Method of Data Analysis

The data collected is properly organized and tabulated. The responses was statistically analyzed by the use of simple percentage and mean.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

Introduction:

This chapter deals mainly with the presentation, l analysis and interpretation of research findings through the data collection from the questionnaire. Raw scores were used in preparing the frequency distribution table weighted under strongly agree (SA)=4, Agree (A)=3, Disagree (D)=2, Strongly disagree (SD)=1.

Discussion of field and survey finding.

Table 1: Socio-Demographic Characteristics of Respondents

Demographic variable	Grouping	Frequency	Percentage (%)
Sex	Male	51	34%
	Female	99	66%
	Total	**150**	**100%**
Course Area	PBB	50	33.3%
	AEB	50	33.3%
	CIT	50	33.3%
	Total	**150**	**100%**

Source: Field Survey, 2024

Table 1. Above, shows the socio-demographic characteristic of the respondents in terms of sex and Course Area. The above table reveals that Fifty Eight 58 (38.7%) were male while Ninety Two 92 (61.3%) were females. This implies that majority of the respondents were females. From the table, 50 (33.3%) respondents in each of the three Course Areas (Animal and Environmental Biology, Plant Biology and Biotechnology and CIT) filled the questionnaire.

ANSWERING OF THE RESEARCH QUESTIONS

Research Question 1: Which of These is Most Likely Enjoyable Things About Conducting Experiments in Cell Biology.

Table 2: Descriptive Statistics on Enjoyable Things About Conducting Experiments in Cell Biology.

S/N	Items	SA	A	SD	D	N	M
1.	The opportunity to work with live cells and observe their behavior.	113(75.3%)	36 (24%)	1 (0.7%)		150	3.7
2.	The sense of accomplishment that comes from successfully completing an experiment.	94(62.7%)	55(36.7%)	1(0.6%)		150	3.6
3.	The collaborative nature of many experiments, which allows students to work with other and learn from each other.	76(50.7%)	73(48.7%)	1(0.6%)		150	3.5
4.	The ability to explore new ideas and test hypothesis.	61(40.7%)	55(36.7%)	26(17.3%)	8(5.3%)	150	3.1
5	Ability to see something that I have never seen before	97(64.7%)	52(34.7%)	1(0.6%)		150	3.6
6	Enjoying the problem-solving aspects of conducting experiments	104(69.3%)	45(3-%)	1(0.7%)		150	4.6

According to the results shown in the above table 3, 99.3% of respondents said that they enjoyed the opportunity to work with live cells and observe their behavior. 99.4% enjoyed the sense of accomplishment that comes from successfully completely an experiment. The collaboration nature of many experiments, which allows students to work with other and learn from each other (99.4%). The ability to explore new ideas and test hypothesis (77.4%). Ability to see something that I have never seen before (99.4%). Enjoying the problem-solving aspects of conducting experiments (99.3%). Conclusively all items were above the cut off mean of 2.5 and therefore accepted to the most enjoyable things about conducting experiments in cell biology.

Research Question 2: Which materials are available in the experiment of a bacterial cell
A- Available. NA- Not available

Table 3: Descriptive Statistics on Available Materials in Experiment of a Bacterial Cell

S/N	Items	A	NA	N	M
1	Microscopes				
	_ transmission electron microscopes	146.(97.3%)	4(2.7%)	150	1.9
	_ fluorescence microscopes	89(59.3%)	61(40.7%)	150	1.6
	_ confocal microscopes.	44(29.3%)	106(70.7%)	150	1.2
2	Cell culture dishes	142(94.6%)	8(5.3%)	150	1.9
3	Stains and dyes	147(98%)	3(2%)	150	1.9
4	Petri dishes	149(99.3%)	1.(0.6%)	150	2.6
5	Pipette	146(97.3%)	4(2.6%)	150	1.9
6	Centrifuges and incubators	137(91.3%)	13(8.6%)	150	1.9

According to the results shown in the above table 3: 97.3% of respondents said that transmission electron microscopes is among material that are available. Fluorescence microscopes (59.3%). Confocal microscopes (29.3%). Cell culture dishes (94.7%). Stains and dyes (98%). Petri dishes (99.3%). Pipette (97.3%). Centrifuges and incubators (91.3%). Conclusively all items except types of microscopes, 2, 3, 5, 6 were above the cut off mean of 2.5 and therefore accepted to be the material that are Available in the experiment of a bacterial cell.

Research Question 3: Which areas of cell biology are the most challenging for students. Areas of cell biology most challenging for students.

table 4: descriptive statistics on which area of cell biology must challenging for students

S/N	Items	SA	A	SD	D	N	M
1.	Learning the names and functions of the different organelles in a cell	49(32.6%)	22(16.6%)	73(48.7%)	6(4%)	150	2.8
2.	Understanding the structure of the cell membrane including it's different layers and components	19(12.6%)	43(28.6%)	78(52%)	10(6.7%)	150	2.5
3.	Cell division	51(34%)	38(25.3%)	59(39.3%)	2(1.3%)	150	2.9
4.	DNA replication, transcription and translation	44(29.3%)	66(44%)	38(25.3%)	2(1.3%)	150	3.0
5	Often find membrane transport and the cell cycle to be challenging	50(33.3%)	63(42%)	35(23.3%)	2(1.3%)	150	3.1
6	Understanding how cell signal	79(52.7%)	45(30%)	25(16.7%)	1(0.6%)	150	3.9

According to the results shown in the above table 4: 47.3% of respondents accepted that learning the names and functions of different organelles in a cell are the area. Understanding the structure of the cell membrane including it's different layers and components (41.3%). Cell division (59.3%). DNA replication, transcription and translation (73.3%). Often find membrane transport and the cell cycle to be challenging (75.3%). Understanding how cell signal (82.7%). Conclusively all items were above the cut off mean of 2.5 and therefore accepted to the areas of cell biology most challenging for students.

.**Research Question 4: How Frequently do Students Use Materials for Experiments in Cell Biology.**

Table 5: Descriptive Statistics on How Frequently Students Use Materials for Experiment in

S/N	Items	F	VF	R	N	M
1.	Students hardly visit laboratory for the experiment	3(2%)	28(18.7%)	119(79.3%)	150	1.2
2.	Students are restricted from using petri dishes	3(2%)	71(47.3%)	76(50.7%)	150	1.5
3.	Using of microscope in your environments	7(4.7%)	109(72.7%)	34(22.6%)	150	1.8
4	Students always find it difficult to understand cell division when using the material provided	53(35.3%)	66(44%)	31(20.7%)	150	2.1
5	Adequate uses of material when having the experiment	90(60%)	49(32.7%)	11(7.3%)	150	2.5
6	The material only available when there is light in case of microscope	64(42.7%)	52(34.6%)	34(22.7%)	150	2.1

According to the results shown in the above table 5: 20.7% of respondents said that students hardly visit laboratory for the experiment. Students are restricted from using petri dishes (49.3%). Using of microscope in your environments (77.4%). Students always find it difficult to understand cell division when using the material provided (79.3%). Adequate uses of material when having the experiment (92.7%). The material only available when there is light in case of microscope (77.3%). Conclusively all items except 1,2,3,4,6 were above the cut off mean of 2.5 and therefore accepted to how frequently students use materials for experiments in cell biology.

Research Question 5: What kinds of challenges do cell biology students face.

Table 6: Descriptive Statistics on the Kinds of Challenges Cell Biology Students Face

S/N	Items	SA	A	SD	D	N	M
1.	Method of teaching by lecturer	99(66%)	47(31.3%)	4(2.7%)		**150**	3.6
2.	Lack of learning aids	75(50%)	71(47.3%)		4(2.7%)	150	3.4
3.	Adequate time allocation	62(41.3%)	87(58%)	1(0.7%)		150	3.4
4.	It is a complex subject with many different concepts to understand	73(48.7%)	74(49.3%)	3(2%)		150	3.5
5	Too many terminology	72(48%)	71(47.3%)	7(4.7%)		150	3.4
6	Not having the idea of the materials provided	81(53%)	47(31.3%)	18(12%)	4(2.7%)	150	3.4

According to the results shown in the above table 6; 97.3% of respondents said that method of teaching by lecturer. Lack of learning aids (97.3%). Adequate time allocation (99.3%). It is a

complex subject with many different concepts to understand (98%). Too many terminology (95.3%). Not having the idea of the materials provided (85.3%). Conclusively all items were above the cut off mean of 2.5 and therefore accepted that this is the kinds of challenges cell biology students face.

Research Question 6: What are the factors that influence students perception of the use of experiments in cell biology.

Table 7: Descriptive Statistics on Factors that Influence Students Perception of the Use of Experiments in Cell Biology

S/N	Items	SA	A	SD	D	N	M
1.	The level of difficulty of the experiment	113(75.3%)	31(20.7%)	6(4%)		150	3.7
2.	The level of safety and risk involved in the experiment	110(73.3%)	39(26%)	1(0.6%)		150	3.7
3.	The amount of time required to complete the experiment	70(46.6%)	80(53.3%)			150	3.5
4.	The availability of materials and equipment needed for the experiment	74(49.3%)	76(50.6%)			150	3.5
5	Relevance of the experiment to real world application	91(60.7%)	58(38.6%)	1(0.6%)		150	3.6
6	Feeling more or less comfortable with the use of animals or human cells in experiment	99(66%)	47(31.3%)	4(2.6%)		150	3.6
7	The social and cultural context in which the experiment are performed	46(30.7%)	60(30%)	44(29.3%)		150	3.0

According to the results shown in the above table 7; 96% of respondents said the level of difficulty of the experiment. The level of safety and risks involved in the experiment (99.3%). The amount of time required to complete the experiment (99.9%). The availability of materials and equipment needed for the experiment (99.4%). Relevance of the experiment to real world

application (99.9%). Feeling more or less comfortable with the use of animals or human cells in experiment (97.3%). The social and cultural context in which the experiment are performed (70.7%). Conclusively all items were above the cut off mean of 2.5 and therefore accepted to the factors that influence students perception of the use of experiments in cell biology.

Research Question 7: How would you rate your overall satisfaction with the experiment -

Table 8: Descriptive Statistics on How Students Rate their Overall satisfaction with the Experiment Based Teaching.

S/N	Items	SA	A	SD	D	N	M
1.	I do enjoyed the experiment based teaching approach	91(60.7%)	51(34%)	5(3.3%)	3(2%)	150	3.5
2.	I hardly understand the experiment based teaching approach	6(4%)	45(30%)	92(61.3%)	7(4.7%)	150	2.3
3.	I have no other choice than to do the experiment	25(16.7%)	29(19.3%)	87(58%)	9(6%)	150	2.5
4.	I feel like always having the experiment based teaching approach.	62(41.3%)	72(48%)	14(9.3%)	2(1.3%)	150	3.3
5	The materials provided is more than enough	83(55.3%)	59(39.3%)	6(4%)	2(1.3%)	150	3.5
6	Not having any difficulties at the end of the experiment	97(64.7%)	42(28%)	8(5.3%)	3(2%)	150	3.5
7	I can explain everything about the experiment.	113(75.3%)	35(23.3%)	1(0.6%)	1(0.7%)	150	4.4

According to the results shown in the above table 8; 94.7% of respondents said that they enjoyed the experiment based teaching approach. I harldly understand the experiment based teaching approach (34%). I have no other choice than to do the experiment (36%). I feel like always having the experiment based teaching approach (89.3%). The materials provided is more than enough (94.6%). Not having any difficulties at the end of the experiment (92.7%). I can explain everything about the business (98.6%). Conclusively all items except 2 were above the cut off

mean of 2.5 and therefore accepted on how to rate their overall satisfaction with the experiment based teaching approach.

DISCUSSION OF FINDINGS

This section discusses the findings of the study.

Enjoyable Aspects of Conducting Experiments in Cell Biology

The first research question aimed to determine if there are any enjoyable aspects of conducting experiments in cell biology, according to the respondents. They expressed that working with live cells and observing their behavior was enjoyable. The sense of accomplishment from completing an experiment was also noted. The collaborative nature of many experiments, allowing students to work together and learn from each other, was mentioned. Additionally, the ability to explore new ideas and test hypotheses, the opportunity to observe something never seen before, and the enjoyment of the problem-solving aspects of conducting experiments were highlighted. Undergraduate students have a comprehensive understanding of the enjoyable aspects of conducting experiments in cell biology.

Available materials in the experiment of a bacterial cell

The research focused on the availability of materials for an experiment involving bacterial cells. The results indicated that respondents agreed that transmission and fluorescence microscopes are the most available, while confocal microscopes are not. Additionally, it was found that cell culture dishes, stains and dyes, Petri dishes, pipettes, centrifuges, and incubators are also

available for such experiments. In conclusion, all materials mentioned are available except for confocal microscopes.

Areas of cell biology most challenging for students.

The research question aimed to identify the most challenging areas of cell biology for undergraduate students. The results showed that some respondents found learning the names and functions of different organelles difficult, while others disagreed. Some believed that understanding the structure of the cell membrane, including its different layers and components, was the most challenging aspect, while others disagreed. Additionally, opinions vary on whether cell division is a challenging area of cell biology. Some respondents agreed that DNA replication, transcription, translation, membrane transport, and the cell cycle were challenging, while others disagreed. Overall, not all respondents agreed on the most challenging areas of cell biology for students as listed above.

How frequently students use materials for experiments in cell biology.

The research sought to determine how frequently students use materials for experiments in cell biology. The results showed that few respondents agreed that students hardly visit the laboratory for experiments, while some agreed that students rarely visit the laboratory. Few respondents agreed on how frequently students are restricted from using Petri dishes, while most agreed that students are rarely restricted from using Petri dishes. It was found that most students reported

frequently using microscopes in their experiments, while a few disagreed. Most respondents agreed that students often find it difficult to understand cell division when using the provided materials, using the materials adequately during experiments, and having access to the materials only when there is light for the microscope. In conclusion, not all respondents agreed on the same points.

Kinds of challenges cell biology students face

Research question five aimed to identify the challenges faced by cell biology students. The results indicated that the majority of students agreed that the teaching method used by the lecturer is a significant challenge, while a few disagreed. Additionally, most students mentioned the lack of learning aids as a challenge, whereas a minority disagreed. The survey also revealed that students feel time allocation is inadequate. Furthermore, the complexity of the subject, with its multitude of concepts and terminology, was identified as a major challenge, with only a few students expressing a different opinion.

Factors that influence students perception of the use of experiments in cell biology

Research question six sought to examine the factors that influence students' perception of the use of experiments in cell biology. The results showed that the respondents agreed that the level of difficulty of the experiment is one of the factors, while six of them disagreed that the level of difficulty of the experiment is not one of the factors. Respondents agreed with the level of safety

and risk involved in the experiment. All of the students agreed with the amount of time required to complete the experiment. The respondents also agreed that the availability of materials and equipment needed for the experiment is one of the factors. All of the respondents except one agreed on how the relevance of the experiment can be applied to the real world. All of the respondents except four said they felt more or less comfortable with the use of animals or human cells in the experiment. Mostly all the respondents agreed that the social and cultural context in which the experiments are performed, while few of them agreed that the social and cultural context in which the experiments are performed is not one of the factors that influence students' perception of the use of experiments in cell biology. In conclusion, most of the respondents agreed that these are the factors that influence students' perception of the use of experiments in cell biology, while a few disagreed.

Overall satisfaction with the experiment based teaching

Research question seven aimed to determine students' overall satisfaction with experiment-based teaching. The majority of students reported that they enjoyed the approach, although some disagreed. When it came to understanding the approach, half of the respondents said they found it challenging, while the other half did not. Few agreed that they had no choice but to experiment, while most disagreed. Additionally, most respondents expressed that they always preferred the experiment-based approach, found the provided materials more than sufficient, did not encounter

any difficulties at the end of the experiment, and could explain everything about the experiment, although some disagreed with these statements.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter focuses on the summary of the study, conclusion, and recommendation.

Summary of the Study.

This study focused on assessment of biology undergraduate students perception of the use of experiments in the teaching of cell biology. Seven research questions were raised for the study. The study adopted survey research design. The population of the study consists of all undergraduate student in the faculty of education and life science in university of Benin. 150 students formed the sample population for the study which was randomly selected to represent the total population of the study. The instrument for data collection was a questionnaire; it was built around the researchers supervisor. 150 copies of the questionnaire were printed and distributed to the sample population and was retrieved on the spot after filling to ensure 100% retrieval. Data collected were analyzed using sample percentage and mean. The major findings of the study are as follows.

1. Undergraduate students point of views on benefits of conducting experiments in cell biology.
2. Availability of materials in the experiment of a bacterial cell
3. Areas most challenging for students in cell biology
4. How frequently students use materials for experiments in cell biology
5. Other kinds of challenges cell biology students face

6. Factors that influence students perception of the use of experiments in cell biology includes; the level of difficulty of the experiment, the amount of time required to complete the experiment

7. How satisfied students are with the experiment based teaching.

Conclusion

Based on the findings of the study, the researcher concludes that students enjoyed conducting experiments in cell biology and that materials are available for these experiments. The study also aimed to identify the most challenging areas of cell biology for students, such as learning the names and functions of different organelles in a cell.

It was observed that cell biology students face challenges such as the teaching method used by the lecturer and the lack of learning aids, which can hinder their understanding of the subject. Additionally, factors such as the difficulty level of the experiment can influence students' perceptions of the use of experiments. Overall, students expressed satisfaction with the experiment-based teaching approach, finding it more interesting.

Recommendation

Based on the findings and conclusion, the following recommendations are made:

1. Ensure that undergraduate students fully understand the benefits of experimenting with cell biology. Therefore, teachers and school authorities should introduce innovative approaches to engage students in cell biology experiments.

2. Ensure the availability of materials required for bacterial cell experiments such as microscopes and cell cultures. If any materials are not available, teachers should make arrangements to acquire them.

3. Identify the areas of cell biology that are most challenging for students and provide additional support to help students overcome these challenges.

4. Encourage students to make frequent use of materials for cell biology experiments. Teachers should ensure that necessary materials are always available and improvise if needed.

5. Address challenges faced by students, such as the teaching method, lack of learning aids, and inadequate time allocation. Teachers should adapt their teaching methods, increase their knowledge of conducting experiments, allocate sufficient time, and provide adequate learning aids.

6. Identify factors influencing students' perception of using experiments in cell biology and ensure proper preparation and caution before conducting experiments.

7. Address the satisfaction of students with the experiment-based teaching approach. Provide special training for students who find it difficult to understand the approach, and avoid forcing experiments on students who struggle with them. Instead, seek to understand their capabilities and find alternative approaches.

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APPENDIX

UNIVERSITY OF BENIN, EDO STATE.

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY.

ASSESSMENT OF BIOLOGY UNDERGRADUATE STUDENTS PERCEPTION OF THE USE OF EXPERIMENTS IN THE TEACHING OF CELL BIOLOGY.

Dear Respondent.

I would like to thank you in advance for taking the time to complete this questionnaire. The questionnaire is all about students perception of the use of experiments in the teaching of cell biology. Your feedback will help shape the future of our educational approach.

Yours sincerely

_____

Elizabeth Motunrayo

SECTION A: Respondent profile

In the space provided, please tick (✓) where appropriate in relation to your school.

1. Sex: Male ( ) Female ( )

2. Course Area: PBB ( ) AEB ( ) CIT ( )

SECTION B:. Research Questions

Instructions: Please tick appropriately the response that most likely reflect your opinion.

SA - Strongly Agree A - Agree SD- Strongly Disagree D- Disagree

Research Question 1: Which of these is most likely enjoyable things about conducting experiments in cell biology.

S/N	Items	SA	A	SD	D
1.	The opportunity to work with live cells and observe their behavior.				
2.	The sense of accomplishment that comes from successfully completing an experiment.				
3.	The collaborative nature of many experiments, which allows students to work with other and learn from each other.				
4.	The ability to explore new ideas and test hypothesis.				

5	Ability to see something that I have never seen before				
6	Enjoying the problem- solving aspects of conducting experiments				

Research Question 2: Which materials are available in the experiment of a bacterial cell

A- Available. NA- Not available

S/N	Items	A	NA
1	Microscopes		
	_ transmission electron microscopes		
	_ fluorescence microscopes		
	_ confocal microscopes.		
2	Cell culture dishes		
3	Stains and dyes		
4	Petri dishes		
5	Pipette		
6	Centrifuges and incubators		

Research Question 3: Which areas of cell biology are the most challenging for students.

Areas of cell biology most challenging for students.

S/N	Items	SA	A	SD	D
1.	Learning the names and functions of the different organelles in a cell				
2.	Understanding the structure of the cell membrane including it's different layers and components				
3.	Cell division				
4.	DNA replication, transcription and translation				
5	Often find membrane transport and the cell cycle to be challenging				
6	Understanding how cell signal				

Research Question 4: How frequently do students use materials for experiments in cell biology

F- Frequently VF- Very Frequently R- Rarely

S/N	Items	F	VF	R
1.	Students hardly visit laboratory for the experiment			
2.	Students are restricted from using petri dishes			
3.	Using of microscope in your environments			
4	Students always find it difficult to understand cell division when using the material provided			
5	Adequate uses of material when having the experiment			
6	The material only available when there is light in case of microscope			

Research Question 5: What kinds of challenges do cell biology students face.

S/N	Items	SA	A	SD	D
1.	Method of teaching by lecturer				
2.	Lack of learning aids				
3.	Adequate time allocation				
4.	It is a complex subject with many different concepts to understand				
5	Too many terminology				
6	Not having the idea of the materials provided				

Research Question 6: What are the factors that influence students perception of the use of experiments in cell biology.

Kindly tick the appropriate answers.

S/N	Items	SA	A	SD	D
1.	The level of difficulty of the experiment				
2.	The level of safety and risk involved in the experiment				
3.	The amount of time required to complete the experiment				
4.	The availability of materials and equipment needed for the experiment				
5	Relevance of the experiment to real world application				
6	Feeling more or less comfortable with the use of animals or human cells in experiment				
7	The social and cultural context in which the experiment are performed				

Research Question 7: How would you rate your overall satisfaction with the experiment - based teaching approach.

S/N	Items	SA	A	SD	D
1.	I do enjoyed the experiment based teaching approach				
2.	I hardly understand the experiment based teaching approach				
3.	I have no other choice than to do the experiment				
4.	I feel like always having the experiment based teaching approach.				
5	The materials provided is more than enough				
6	Not having any difficulties at the end of the experiment				
7	I can explain everything about the experiment.				