ANALYSIS OF IN-SERVICE BIOLOGY TEACHERS' UNDERSTANDING OF THE CONCEPT OF GENETICS.

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A PROJECT SUMMITED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, UNIVERSITY OF BENIN IN PARTIAL FULFILMENT OF THE REQUIREMENT OF THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE EDUCATION (B.Sc.Ed) BIOLOGY, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.

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CERTIFICATION

We, the undersigned, certify that this research work was carried out by Promise OKHUOMARUYI in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin.

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DEDICATION

This work is dedicated to God Almighty, the giver of life.

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ABSTRACT

The investigation of Students Understanding of the concepts of Reproductive system in Biology (A case study of University of Benin), Two (2) research questions served as it's guidelines, and it used a descriptive survey study design. It sought to find out the common misconceptions among students regarding asexual and sexual reproduction in different organisms? How does the behaviour of specific anatomical features, such as the gular fold in lizards, influence their mating and territorial strategies?

The study employed a sample of undergraduate Biology students in University of Benin, Edo State and a total of (100) respondents which were collected from four departments. The researcher developed questionnaire titled Questionnaire on "Students Understanding of the concept of reproductive system in Biology" was used as the data collection tool. There are twenty (20) items on the questionnaire. To analyze the data collected, descriptive statistics such as Simple percentage and frequency were used.

The study find reveals the varying degrees of understanding and misunderstanding among Biology Students as regards to Reproduction concept.

Across different items, the analysis indicates fluctuations in the percentages of correct understanding and misunderstanding. Notably, while some items witness relatively higher levels of correct understanding, others show a prevalent misunderstanding among Students. It was suggested that the government should hire skilled and experienced Biology instructors with adequate knowledge of Reproduction concept for schools in order to effectively teach and learn Reproductive system.

CHAPTER ONE

INTRODUCTION

Background to the Study

Science is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. It involves gathering data through observation and experimentation, forming hypotheses, and conducting studies to support or refute those hypotheses. Ultimately, science aims to understand the natural world and how it works Cohen, Eliel (2021).

Biology is the scientific study of life. Although it is a large-scope natural science, it is united by a number of themes that make it a cohesive field. For example, every living thing is composed of cells that process genetic information that is encoded in genes and can be passed on to subsequent generations Hillis, David M.; Heller et al (2020).

Biology is important to mankind in numerous ways. It helps us understand how our bodies function, allowing for advancements in medicine and healthcare. Through the study of biology, we can also learn about the environment and the impact of human activity on ecosystems. Additionally, biology plays a crucial

role in agriculture, genetics, and the conservation of species. Overall, biology is essential for improving the quality of human life and ensuring the sustainability of our planet.

Biology is a prerequisite to many field of study like Medicine, Research Scientist, Biochemist, Environmental Scientist, Pharmacist, Biotechnologist, Forensic Scientist etc.

There has been consistent decline in the performance of students in Biology examinations conducted by the west African Examination Council (WAEC) and the National Examination Council (NECO) across the country over the years (Agogo, 2021; Samba & Eriba, 2022). According to WAEC Chief examiner's Report 2018, 2019 and 2020, despite the popularity of Biology, results of research studies always revealed the poor performance of students in Biology subject. Results from findings revealed that a vast number of factors are responsible for the students poor performance: difficult biological concepts. Çimer (2021) argued that many concepts or topics in biology, including genetics, Mendelian genetics, genetic engineering, water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation,

oxygen transport and the central nervous system can be perceived as difficult to learn by secondary school students.

Teachers often encounter various problems while teaching biology which include Complex Terminology, Vast Amount of Information, Abstract Concepts, Practical Components, Memorization, Interdisciplinary Nature, Critical Thinking, Time Management etc.

According to Moli and Allen (2024), genetics is the study of genes, genetic variation, and heredity in living organisms. It is typically regarded as a branch of biology. Gregor Mendel, an Augustinian monk and scientist from the late 19th century, is regarded as the father of genetics. Mendel researched how traits are inherited and passed down from parents to children. He noticed that characteristics are passed down to organisms through distinct units of heredity.

In the twenty-first century, the fundamental concepts of genetics remain trait inheritance and the molecular inheritance mechanisms of genes; however, the study of modern genetics has extended beyond inheritance to include the behavior and function of genes. Variation, distribution, and the structure and function of genes are examined in relation to the cell, the organism (for example, dominance), as well as in relation to a population. Numerous subfields, such as

population genetics and epigenetics, have emerged from genetics. The wide range of living forms researched in this discipline include people, animals, plants, and microorganisms. Nature versus nurture refers to how genetic processes influence behavior and development in conjunction with an organism's experiences and surroundings. Gene transcription can be switched by a cell's or organism's extracellular or intracellular environment. (Dillon, 2013).

Statement of the Problem

According to Waec Chief examiner's Report in (2015 and 2018) alot of Students had difficulty in answering genetic questions. A lot of Students performed poorly in test crossing and also explanation of terms in genetics. despite the fact that students' performance in genetics has been subpar in university of Benin due to weak knowledge. Studies conducted thus far have only revealed that genetics is a challenging course to teach and learn. In this study, this information gap needs to be filled.

Research Questions

The following research Questions were raised for the study

1. What extent are in-service Biology teachers able to answer questions on Genetics Concepts?

2. How do in-service Biology teachers perceives difficult Concept in Genetics

Purpose of the Study

The purpose of this study is to examine in-service Biology teachers understanding and perception of difficult concepts in genetics.

Significance of the Study

It was anticipated that the findings from this study would generate knowledge which could minimise the existing knowledge gap about how genetics was taught in University of Benin. It was also anticipated that the information generated by this study could be used by prospective teachers of Biology, Lecturers, heads of Departments (HOD's) for natural sciences, teacher educators, textbook writers and curriculum development officers to improve teaching and Students learning of genetics in University of Benin. Data generated could also be useful to other researchers.

Scope and Delimitation of the study

To examine in-service Biology teachers understanding of genetic concept and also to specially investigate genetic concept taught in university of Benin, Edo State.

Definition of Terms

The following terms were operationally defined:

Prospective teacher: These are undergraduate student teachers who are undergoing teaching profession training in instutution of higher learning.

Biology: This is the study of living things, which is broken down into a variety of specialist subjects that examine their morphology, physiology, anatomy, behavior, origin, and distribution.

Genetic: Genetics is the scientific study of genes and heredity of how certain qualities or traits are passed from parents to offspring as a result of changes in DNA sequence.

Knowledge: Knowledge is the accumulation of information and skills, while understanding involves comprehension and application of that knowledge. Understanding provides a deeper level of insight than knowledge and can be more difficult to measure or acquire.

Understanding: in the context of learning or cognition, refers to the ability to grasp, interpret, and make sense of information, concepts, ideas, or experiences. It involves going beyond mere memorization or recognition of facts and instead involves internalizing, integrating, and applying knowledge in a meaningful way. Understanding is a higher-level cognitive process that involves connecting new information to prior knowledge, making connections between different concepts, and being able to explain, analyze, or solve problems related to the subject matter.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of related Literature is presented under the following sub-headings:

- Nature of Science
- The Concept of Biology
- Biology Teaching in Nigerian Schools
- Genetics Concept Taught in Nigerian Universities
- Prospective Biology teachers in the understanding of Genetic Concept
- Challenges of Prospective Biology Teachers understanding of Genetics
- Ways of learning Genetic Concepts
- Summary of Reviewed Literature

Nature of Science

There are many different definitions for science. Many adults identify it with odoriferous substances kept in an amazing and odd chamber used for a variety of mysterious experiments (Solomon, Scott, & Duveen, 1996). Many times, the phrase "science" evokes visions of exciting new discoveries (Mathews, 1994).

There isn't a single, universal definition of science, despite what many experts have asserted, but various attempts have been made to describe how science differs from other global research fields.The entire spectrum of scientific inquiry encompasses "observation, identification, description, experimental investigation, and theoretical justification of the phenomenon." (English translation of the 2001 American Heritage Dictionary). Rather than accumulating fresh evidence, science advances through the continuous generation of new conceptions (Licht, 1988). As stated by Pedro (1999), there are four components to science: a body of information, a set of abilities, a scientific mindset, and a particular language. It implies that the topic is a composite, with these four aspects interacting. Therefore, the best definition of science takes into account three distinct aspects of the fields. A procedure, a collection of concepts, and a mindset can all be used to explain science. The portion of the definition that refers to science as a process has significant implications for "scientific ideas."

Understanding scientific concepts reveals science's true essence. By means of observation, experimentation, and replication scientist gathers concepts about the natural world which are referred as ‘scientific concepts(Lemke, 1990).

These scientific concepts or ideas consist of definitions and understandable explanations of natural phenomena. Most high school science books and textbooks are overflowing with these understandings about the natural world (Zietsman & Clement, 1997).A few research have looked into the characteristics of secondary school students' NOS and science learning views. For instance, Driver et al. (1996) claimed that three different methods of knowing contributed to students' formation of their beliefs about the nature of science. The first presumption is that science's goal is to redescribe a notion, an event, or a phenomena (Symington & Tyler, 2004). It is the method of knowing, the growth of scientific knowledge, and the scientific epistemology. The second idea is that a source of knowledge that serves as the foundation for science is required. The third is the conviction that science is learned through empirical investigation. Other viewpoints on the NOS include the following: scientific knowledge is inherently uncertain, scientific knowledge relies heavily on observation, experimental evidence, rational arguments and skepticism (Koch et.al. 2000). in simple words there is no one way to do science. Mainly science is an attempt to explain natural phenomena.

Evolutionary and revolutionary hypotheses have been put forth throughout

the history of science by members of almost every culture. However, they all agree that scientific information must be published in an open and transparent manner, that accurate recordkeeping, peer review, and reliability are essential for scientists, that observations are theory-heavy, and that scientists are creative (Ibanez-Orcajo, & Martinez-Aznar, 2007). In order to cultivate civically engaged and scientifically knowledgeable citizens, the Science-Technology-Society (STS) teaching philosophy has traditionally placed a strong emphasis on include NOS in school curricula. This method can be examined from two angles: first,'social concerns' that illustrate STS linkages and cover subjects like pollution and the environment, genetic engineering, nuclear energy, resource management, etc. The second is "Social aspects of science," which refers to science as it is understood from the viewpoints from several academic fields, including philosophy, sociology, history, politics, economics, and more. In other words, the character of scientific conceptualizations influences how scientific knowledge is interpreted and used to inform decisions about socio-scientific challenges (Sadler et al., 2004). While the dissemination of scientific knowledge, or science teaching, is important in laying the groundwork for scientific understandings.

The Concept of Biology

Science's study of life is called biology. Biologists are experts in the field of biology. Biology is the study of living things and their interactions with one another and their surroundings, according to Wikipedia (2011). It investigates the composition, purpose, development, genesis, evolution, and genetics of both living and nonliving entities. The same source claims that biology is the study of the classification and description of organisms, their roles, and the emergence of new species. Biology aims to instill in its students a conscious set of abilities, attitudes, knowledge, values, and conventions.

The aim of biology is to produce scientifically educated, rationally thinking and acting citizens whose purpose is to pass on the same ideals to the following generation. In general, biology has two distinct goals: first to serve the individual, secondly to serve the society. Biology achieves its individual and societal roles through the inculcation of the right type of values and attitudes for the survival of both the individual and the society. The acquisition of appropriate skills, abilities and competencies by utilizing Science Equipment, will enable the student to contribute to societal development. The objectives of biology are aimed at enabling the students who are adequately trained to acquire

the following skills: Observing carefully and thoroughly.

Drawing and labeling accurately observed materials., Reporting completely and accurately what is observed, Organizing information acquired by the above processes, Generalizing on the basis of the acquired information, Predicting as a result of these generalizations, Designing experiments (including control where necessary), Using models or other resource materials to explain phenomena where appropriate. Continuing the process of enquiry where new data does not conform to prediction. (Onimisi 2006).

Based on the above objectives, a trained biology student invariably is a scientist since all the scientific processes (state the problem; gather information; form hypothesis; perform experiments; analyze data; draw conclusions; form theories and laws) are hierarchically performed in the biology laboratory. These cannot be achieved if the resources in the laboratories are not adequately utilized. Biology as an indispensable part of human activity is important to man and the society. the following are the usefulness of biology to man.Helps the individual to understand himself, the parts of his body and its functions, Enables the individual to question

superstition due to sustained interest from a comprehension of the causes of events, Brings into focus, the need to maintain good health such as clean water, clean air, good sanitation, vaccination against infectious diseases, exercise, adequate rest, and balanced diet, Promotes understanding of the relation of man to his environment, Prepares the individual for vocational selection such as medicine, dentistry, agriculture, teaching and so forth, Prepares the individual for higher education, Inculcates scientific attitudes and skills in solving personal and social problems, Increases the individual's interest and aesthetic appreciation of nature, Also stimulates interest in biologically based hobbies such as growing flowers, collecting insects' etc thereby encouraging leisure activity for individual enjoyment.

Improves the individual factual knowledge and stimulates scientific reflective thinking so as to produce a better informed individual. Biology has also contributed immensely to the development of the society in the following ways: control of human population, control of diseases, environmental conservation, human genetics as well as control of alcohol, smoking and drug addiction. If not for the introduction of biology education

the above listed factors could have affected the human race negatively. The scope of biology is broad and therefore contains many branches and sub disciplines. Biologists may pursue one of those sub disciplines and work in a more focused field. For instance, molecular biology studies biological processes at the molecular level, including interactions among molecules such as DNA, RNA, and proteins, as well as the way they are regulated. Microbiology is the study of the structure and function of microorganisms. It is quite a broad branch itself, and depending on the subject of study, there are also microbial physiologists, ecologists, and geneticists, among others.

Another field of biological study, neurobiology, studies the biology of the nervous system, and although it is considered a branch of biology, it is also recognized as an interdisciplinary field of study known as neuroscience. Because of its interdisciplinary nature, this sub discipline studies different functions of the nervous system using molecular, cellular, developmental, medical, and computational approaches. Paleontology, another branch of biology, uses fossils to study life's history. Zoology and botany are the study of animals and plants, respectively. Biologists can also specialize as

biotechnologists, ecologists, or physiologists, to name just a few areas. Biotechnologists apply the knowledge of biology to create useful products. Ecologists study the interactions of organisms in their environments. Physiologists study the workings of cells, tissues and organs. This is just a small sample of the many fields that biologists can pursue. From our own bodies to the world we live in, discoveries in biology can affect us in very direct and important ways. We depend on these discoveries for our health, our food sources, and the benefits provided by our ecosystem. Because of this, knowledge of biology can benefit us in making decisions in our day-to-day lives.

The development of technology in the twentieth century that continues today, particularly the technology to describe and manipulate the genetic material, DNA, has transformed biology. This transformation will allow biologists to continue to understand the history of life in greater detail, how the human body works, our human origins, and how humans can survive as a species on this planet despite the stresses caused by our increasing numbers. Biologists continue to decipher huge mysteries about life suggesting that we have only begun to understand life on the planet, its history, and our relationship to it. For this and other reasons, the knowledge of biology gained through this textbook

and other printed and electronic media should be a benefit in whichever field you enter. Forensic science is the application of science to answer questions related to the law.

Biologists as well as chemists and biochemists can be forensic scientists. Forensic scientists provide scientific evidence for use in courts, and their job involves examining trace material associated with crimes. Interest in forensic science has increased in the last few years, possibly because of popular television shows that feature forensic scientists on the job. Also, the development of molecular techniques and the establishment of DNA databases have updated the types of work that forensic scientists can do. Their job activities are primarily related to crimes against people such as murder, rape, and assault. Their work involves analyzing samples such as hair, blood, and other body fluids and also processing DNA found in many different environments and materials. Forensic scientists also analyze other biological evidence left at crime scenes, such as insect parts or pollen grains. Students who want to pursue careers in forensic science will most likely be required to take chemistry and biology courses as well as some intensive math courses.

Biology Teaching in Nigerian Schools

A popular scientific course taught in senior secondary schools is biology. Educating students about biology's concepts, rules, ideas, and principles is one of its main goals. Teaching Biology, according to Gbamanja (1991), entails giving students many chances to comprehend various ideas and concepts as well as introducing them to tangible things that would help them make sense of their cognitive framework. It follows that in order to accomplish its objectives, biology education needs to be both worthwhile and successful. Nwagbo (2008) emphasized that biology education not only provides students with the professional skills of a biology teacher, but also exposes them to processes and attitudes. Therefore, biology teachers possess both biological knowledge and the ability to convey that knowledge as well as skills for impartation of such knowledge to the students. This makes them the implementers of the curriculum, a role that places the teachers at very strategic positions in the entire educational and societal development programmes.

The teaching of Biology according to Urevbu (1990) should help the student comprehend the world around him and also better prepare him to improve on it. Ogunniyi; Okebukole and Fafunwa (1990) further stated that

biology teaching enables the child among others to acquire basic scientific knowledge and also help him to discover the order and complex of the universe. Based on this, they further believed that the child should be given first hand familiarity with the variety of biological, physical and man-made phenomena in the world around him. The current Nigerian Secondary School Biology Curriculum is developed to provide students with the knowledge of the concept in Biology to ensure that students learn biological concepts meaningfully to promote their understanding of the world around them. Meaningful learning results when a learner consciously and explicitly relates new knowledge to relevant concepts and propositions which he already possesses. The Biology curriculum as a teaching syllabus has four main objectives derived from the National Policy on Education, (FGN, 2004). These objectives include;

1. Adequate laboratory and field skill in Biology.
2. Meaningful and relevant knowledge.
3. Ability to apply scientific knowledge to everyday life on matters of personal and community health and agriculture.
4. Reasonable and functional scientific attitudes.

The Biology Curriculum also aims at developing broadly applicable skills,

such as: problem solving, communication, critical thinking and objective reasoning abilities to enable them prepare for work place and self-sustainability in the world economy. With these objectives in mind, students are expected to be useful and productive members of the society.

The need for Biology education cannot be over emphasized. Due to knowledge explosion all over the world via the internet, biological knowledge has also expanded (Nwagbo, 2008). Recent advances recorded in fields, such as: biochemistry, physiology, ecology, genetics and molecular biology have made the subject a central focus in most human activities including problems like food scarcity, pollution, population, radiation, disease, health, hygiene, family life, management and conservation of natural resources. In recent years, biotechnology has entered a new era with the advent of genetic engineering. The aim of this modern biotechnology when applied to agriculture is to enhance specifically the useful and desirable characteristics of crop plants and to eliminate the undesirable ones. It aims to improve crop quality and productivity while at the same time reducing both mechanical and chemical input on the farms.

The knowledge of biology is applied in industries. For instance,

biocatalyst is used to speed up a given reaction or a set of reactions. Biocatalyst has the potential of replacing or complementing chemical catalyst. It is also important in crime detection and this is called forensic science which is science in service of law. Research in biology has led to the production of genetically engineering human insulin for the treatment of patients suffering from diabetes mellitus. Research in biology has also led to the large scale production of human growth hormones, which has helped thousands of children who might otherwise have developed dwarfism. In genetics, biology has shed more light on a number' of issues boardering on human heredity. The findings now form the basis for genetic counselling. For instance, biology discourages marriage between people with inherited defects such as sickle cell anaemia (Chukwuneke, 2010). The Biological Science Curriculum Studies (BCSC, 1993) specified some of the roles and influences expected of the teachers in the face of the developments in biological knowledge. Such roles include that the biology teacher should;

• Help the young people cope with the vast amount of information currently available and put them in some organised form;

• Demonstrate how to use biological knowledge for improvement of their living

conditions;

• Know how to seek new knowledge, appraise it and distinguish that which is useful to the development of the individual and the society;

• Understand that at the heart of education lies the child, the learner, therefore, it is his responsibility to help the child to develop into useful and productive member of his/her community.

Consequently, teacher training programmes must help the teacher trainee to develop his capabilities, encourage self-learning, impart prudential judgement in selecting materials and methods of teaching, reinforce innovative attitude and encourage creative participation in planning for effective learning of knowledge and skills and their subsequent application in everyday life.

Genetics Concept Taught in Nigerian Universities

Genetics is the study of genes, genetic diversity, and heredity in living organisms. Given the significant role that heredity plays in the evolution of species, this field of biology is vital. Gregor Mendel, a 19th-century Moravian Augustinian priest from Brno, was the first person to conduct a scientific study of genetics. Mendel studied the patterns of "trait inheritance," or the passing down of traits from parents to offspring across the generations. He pointed out

that different "units of inheritance" account for the inheritance of traits among organisms (pea plants). This expression, which is still in use today, provides a nebulous definition for the term "gene." Even though the molecular mechanics of genes still form the fundamental principles of gene inheritance and the inheritance of traits in the twenty-first century, current genetics has expanded to examine the function and actions of genes. Within the context of the cell, the organism (such as dominance), and within the context of a population, gene structure and function, variation, and distribution are examined.

Numerous subfields of genetics have developed, including population genetics, epigenetics, and molecular genetics. Archaea, bacteria, and eukarya are among the realms of life that are investigated by the diverse group of organisms. Nature vs nurture is a common term used to describe how genetic processes interact with an organism's surroundings and experiences to affect development and behavior. A living cell or organism's internal or extracellular environment has the power to alter gene transcription. Two seedlings of genetically identical corn, one planted in a temperate area and the other in a desert one (lacking sufficient waterfall or rain), are a famous illustration. The two corn stalks may have a genetically set average height that is equal, but because of a lack of water and

nutrients in its surroundings, the corn stalk in the arid region only grows to half the height of the corn stalk in the temperate zone. At its most basic level, heredity in organisms happens when genes, which are distinct heritable units, are passed from parents to children. (2000) Gelbart Gregor Mendel, who researched the segregation of heritable features in pea plants, first noticed this property, demonstrating, for instance, that blooms on a single plant were either purple or White, but never a color in-between the other two.

Alleles are the distinct forms of the same gene that regulate the inherited characteristics (phenotypes).Each plant in the case of the pea, a diploid species, has two copies of each gene, one copy coming from each parent. (2000) Gelbart There are many species, including humans, that follow this inheritance pattern. Homozygous at a gene locus refers to a diploid organism with two copies of the same allele of a given gene, whereas heterozygous refers to an organism with two different alleles of a given gene. A particular organism's genotype is its collection of alleles, and its phenotype is the collection of qualities that can be seen in the organism. When an organism possesses one heterozygous copy of a gene it called When two organisms reproduce sexually, their offspring randomly inherit one of the two alleles from each parent; one of the two alleles is called

dominant as its qualities dominate the phenotype of the organism, and the other allele is called recessive as its qualities recede and are not observed. Some alleles do not have complete dominance and instead have incomplete dominance by expressing an intermediate phenotype, or codominance by expressing both alleles at once Lewontin(2000). One of the two alleles from each parent is randomly inherited by the child of a sexually reproducing pair of organisms. Mendel's first law, also known as the Law of Segregation, is the result of these discoveries of discrete inheritance and the segregation of alleles.

However, dominant, recessive, homozygous, or heterozygous genes can alter the likelihood of obtaining one gene over the other. Mendel discovered, for instance, that the probabilities of inheriting the dominant trait are 3:1 when homozygous recessive and dominant traits are crossed. Real geneticist examine and compute probabilities using a variety of methods, including the product rule, the sum rule, empirical probabilities, and more. Geneticists illustrate heredity using pictures and symbols. One or a few letters are used to symbolize a gene. usually a "+" symbol is used to mark the usual, non-mutant allele for a gene Cheney (2008). In fertilization and breeding experiments, the parents are referred to as the "P" generation, the offspring as the "F1" (first filial)

generation, and when the F1 offspring mate with each other, the offspring are referred to as the "F2" (second filial) generation. The Punnett square is a popular diagram that is used to predict the outcome of cross-breeding Müller-Wille, Staffan; Parolini, Giuditta

Multiple gene interactions

Organisms have thousands of genes, and in sexually reproducing organisms these genes generally assort independently of each other. This means that the inheritance of an allele for yellow or green pea color is unrelated to the inheritance of alleles for white or purple flowers. This phenomenon, known as "Mendel's second law" or the "law of independent assortment," means that the alleles of different genes get shuffled between parents to form offspring with many different combinations. Different genes often interact to influence the same trait. In the Blue-eyed Mary (Omphalodes verna), for example, there exists a gene with alleles that determine the color of flowers: blue or magenta. Another gene, however, controls whether the flowers have color at all or are white. When a plant has two copies of this white allele, its flowers are white—regardless of whether the first gene has blue or magenta alleles. This interaction between genes is called epistasis, with the second gene epistatic to the first

Griffiths AJ, Miller JH, Suzuki DT, Lewontin RC, Gelbart,(2000).

Many traits are not discrete features (e.g. purple or white flowers) but are instead continuous features (e.g. human height and skin color). These complex traits are products of many genes. Mayeux R (June 2005) The influence of these genes is mediated, to varying degrees, by the environment an organism has experienced. The degree to which an organism's genes contribute to a complex trait is called heritability. Measurement of the heritability of a trait is relative—in a more variable environment, the environment has a bigger influence on the total variation of the trait. For example, human height is a trait with complex causes. It has a heritability of 89% in the United States. In Nigeria, however, where people experience a more variable access to good nutrition and health care, height has a heritability of only 62%. Luke A, Guo X, Adeyemo (2001).

The molecular basis for genes is deoxyribonucleic acid (DNA). DNA is composed of deoxyribose (sugar molecule), a phosphate group, and a base (amine group). There are four types of bases: adenine (A), cytosine (C), guanine (G), and thymine (T). The phosphates make hydrogen bonds with the sugars to make long phosphate-sugar backbones. Bases specifically pair together (T&A, C&G) between two backbones and make like rungs on a ladder. The bases,

phosphates, and sugars together make a nucleotide that connects to make long chains of DNA. Genetic information exists in the sequence of these nucleotides, and genes exist as stretches of sequence along the DNA chain. Pearson H (May 2006) These chains coil into a double a-helix structure and wrap around proteins called Histones which provide the structural support. DNA wrapped around these histones are called chromosomes.Viruses sometimes use the similar molecule RNA instead of DNA as their genetic material Prescott, Harley, Klein DA (1996).

DNA normally exists as a double-stranded molecule, coiled into the shape of a double helix. Each nucleotide in DNA preferentially pairs with its partner nucleotide on the opposite strand: A pairs with T, and C pairs with G. Thus, in its two-stranded form, each strand effectively contains all necessary information, redundant with its partner strand. This structure of DNA is the physical basis for inheritance: DNA replication duplicates the genetic information by splitting the strands and using each strand as a template for synthesis of a new partner strand. Genes are arranged linearly along long chains of DNA base-pair sequences. In bacteria, each cell usually contains a single circular genophore, while eukaryotic organisms (such as plants and animals) have their DNA arranged in multiple

linear chromosomes. These DNA strands are often extremely long; the largest human chromosome, for example, is about 247 million base pairs in length. The DNA of a chromosome is associated with structural proteins that organize, compact, and control access to the DNA, forming a material called chromatin; in eukaryotes, chromatin is usually composed of nucleosomes, segments of DNA wound around cores of histone proteins. Alberts. (2002) The full set of hereditary material in an organism (usually the combined DNA sequences of all chromosomes) is called the genome.

DNA is most often found in the nucleus of cells, but Ruth Sager helped in the discovery of nonchromosomal genes found outside of the nucleus. In plants, these are often found in the chloroplasts and in other organisms, in the mitochondria. These nonchromosomal genes can still be passed on by either partner in sexual reproduction and they control a variety of hereditary characteristics that replicate and remain active throughout generations Encyclopaedia(2020).

While haploid organisms have only one copy of each chromosome, most animals and many plants are diploid, containing two of each chromosome and thus two copies of every gene. The two alleles for a gene are located on

identical loci of the two homologous chromosomes, each allele inherited from a different parent. Many species have so-called sex chromosomes that determine the sex of each organism. Griffiths AJ, Miller JH, Suzuki DT, Lewontin RC, Gelbart, (2000) In humans and many other animals, the Y chromosome contains the gene that triggers the development of the specifically male characteristics. In evolution, this chromosome has lost most of its content and also most of its genes, while the X chromosome is similar to the other chromosomes and contains many genes. This being said, Mary Frances Lyon discovered that there is X-chromosome inactivation during reproduction to avoid passing on twice as many genes to the offspring. Lyon's discovery led to the discovery of X-linked diseases Rastan, Sohaila (2015). When cells divide, their full genome is copied and each daughter cell inherits one copy. This process, called mitosis, is the simplest form of reproduction and is the basis for asexual reproduction. Asexual reproduction can also occur in multicellular organisms, producing offspring that inherit their genome from a single parent. Offspring that are genetically identical to their parents are called clones.

Eukaryotic organisms often use sexual reproduction to generate offspring that contain a mixture of genetic material inherited from two different parents. The

process of sexual reproduction alternates between forms that contain single copies of the genome (haploid) and double copies (diploid). Haploid cells fuse and combine genetic material to create a diploid cell with paired chromosomes. Diploid organisms form haploids by dividing, without replicating their DNA, to create daughter cells that randomly inherit one of each pair of chromosomes. Most animals and many plants are diploid for most of their lifespan, with the haploid form reduced to single cell gametes such as sperm or eggs.Although they do not use the haploid/diploid method of sexual reproduction, bacteria have many methods of acquiring new genetic information. Some bacteria can undergo conjugation, transferring a small circular piece of DNA to another bacterium. Bacteria can also take up raw DNA fragments found in the environment and integrate them into their genomes, a phenomenon known as transformation.These processes result in horizontal gene transfer, transmitting fragments of genetic information between organisms that would be otherwise unrelated. Natural bacterial transformation occurs in many bacterial species, and can be regarded as a sexual process for transferring DNA from one cell to another cell (usually of the same species).Transformation requires the action of numerous bacterial gene products, and its primary adaptive function appears to

be repair of DNA damages in the recipient cell Bernstein H, Bernstein C, Michod RE (2018).

The diploid nature of chromosomes allows for genes on different chromosomes to assort independently or be separated from their homologous pair during sexual reproduction wherein haploid gametes are formed. In this way new combinations of genes can occur in the offspring of a mating pair. Genes on the same chromosome would theoretically never recombine. However, they do, via the cellular process of chromosomal crossover. During crossover, chromosomes exchange stretches of DNA, effectively shuffling the gene alleles between the chromosomes. This process of chromosomal crossover generally occurs during meiosis, a series of cell divisions that creates haploid cells. Meiotic recombination, particularly in microbial eukaryotes, appears to serve the adaptive function of repair of DNA damages Bernstein H, Bernstein C, Michod RE (2018).

The first cytological demonstration of crossing over was performed by Harriet Creighton and Barbara McClintock in 1931. Their research and experiments on corn provided cytological evidence for the genetic theory that linked genes on paired chromosomes do in fact exchange places from one homolog to the other.

The probability of chromosomal crossover occurring between two given points on the chromosome is related to the distance between the points. For an arbitrarily long distance, the probability of crossover is high enough that the inheritance of the genes is effectively uncorrelated. Staub JE (1994) For genes that are closer together, however, the lower probability of crossover means that the genes demonstrate genetic linkage; alleles for the two genes tend to be inherited together. The amounts of linkage between a series of genes can be combined to form a linear linkage map that roughly describes the arrangement of the genes along the chromosome. Genes express their functional effect through the production of proteins, which are molecules responsible for most functions in the cell. Proteins are made up of one or more polypeptide chains, each composed of a sequence of amino acids. The DNA sequence of a gene is used to produce a specific amino acid sequence. This process begins with the production of an RNA molecule with a sequence matching the gene's DNA sequence, a process called transcription.

This messenger RNA molecule then serves to produce a corresponding amino acid sequence through a process called translation. Each group of three nucleotides in the sequence, called a codon, corresponds either to one of the

twenty possible amino acids in a protein or an instruction to end the amino acid sequence; this correspondence is called the genetic code. The flow of information is unidirectional: information is transferred from nucleotide sequences into the amino acid sequence of proteins, but it never transfers from protein back into the sequence of DNA a phenomenon Francis Crick called the central dogma of molecular biology Crick F (1970).

The specific sequence of amino acids results in a unique three-dimensional structure for that protein, and the three-dimensional structures of proteins are related to their functions. Some are simple structural molecules, like the fibers formed by the protein collagen. Proteins can bind to other proteins and simple molecules, sometimes acting as enzymes by facilitating chemical reactions within the bound molecules (without changing the structure of the protein itself). Protein structure is dynamic; the protein hemoglobin bends into slightly different forms as it facilitates the capture, transport, and release of oxygen molecules within mammalian blood.A single nucleotide difference within DNA can cause a change in the amino acid sequence of a protein. Because protein structures are the result of their amino acid sequences, some changes can dramatically change the properties of a protein by destabilizing the structure or

changing the surface of the protein in a way that changes its interaction with other proteins and molecules. For example, sickle-cell anemia is a human genetic disease that results from a single base difference within the coding region for the β-globin section of hemoglobin, causing a single amino acid change that changes hemoglobin's physical properties. Brigham(2002) Sickle-cell versions of hemoglobin stick to themselves, stacking to form fibers that distort the shape of red blood cells carrying the protein. These sickle-shaped cells no longer flow smoothly through blood vessels, having a tendency to clog or degrade, causing the medical problems associated with this disease.

Some DNA sequences are transcribed into RNA but are not translated into protein products such RNA molecules are called non-coding RNA. In some cases, these products fold into structures which are involved in critical cell functions (e.g. ribosomal RNA and transfer RNA). RNA can also have regulatory effects through hybridization interactions with other RNA molecules (such as microRNA).Although genes contain all the information an organism uses to function, the environment plays an important role in determining the ultimate phenotypes an organism displays. The phrase "nature and nurture" refers to this complementary relationship. The phenotype of an organism

depends on the interaction of genes and the environment. An interesting example is the coat coloration of the Siamese cat. In this case, the body temperature of the cat plays the role of the environment. The cat's genes code for dark hair, thus the hair-producing cells in the cat make cellular proteins resulting in dark hair. But these dark hair-producing proteins are sensitive to temperature (i.e. have a mutation causing temperature-sensitivity) and denature in higher-temperature environments, failing to produce dark-hair pigment in areas where the cat has a higher body temperature. In a low-temperature environment, however, the protein's structure is stable and produces dark-hair pigment normally. The protein remains functional in areas of skin that are colder—such as its legs, ears, tail, and face so the cat has dark hair at its extremities Imes DL, Geary LA, Grahn RA, Lyons LA (2006).

Environment plays a major role in effects of the human genetic disease phenylketonuria. The mutation that causes phenylketonuria disrupts the ability of the body to break down the amino acid phenylalanine, causing a toxic build-up of an intermediate molecule that, in turn, causes severe symptoms of progressive intellectual disability and seizures. However, if someone with the phenylketonuria mutation follows a strict diet that avoids this amino acid, they

remain normal and healthy. A common method for determining how genes and environment ("nature and nurture") contribute to a phenotype involves studying identical and fraternal twins, or other siblings of multiple births. Identical siblings are genetically the same since they come from the same zygote. Meanwhile, fraternal twins are as genetically different from one another as normal siblings. By comparing how often a certain disorder occurs in a pair of identical twins to how often it occurs in a pair of fraternal twins, scientists can determine whether that disorder is caused by genetic or postnatal environmental factors. One famous example involved the study of the Genain quadruplets, who were identical quadruplets all diagnosed with schizophrenia Rosenthal D (1964). The genome of a given organism contains thousands of genes, but not all these genes need to be active at any given moment. A gene is expressed when it is being transcribed into mRNA and there exist many cellular methods of controlling the expression of genes such that proteins are produced only when needed by the cell. Transcription factors are regulatory proteins that bind to DNA, either promoting or inhibiting the transcription of a gene. Within the genome of Escherichia coli bacteria, for example, there exists a series of genes necessary for the synthesis of the amino acid tryptophan. However, when

tryptophan is already available to the cell, these genes for tryptophan synthesis are no longer needed. The presence of tryptophan directly affects the activity of the genes—tryptophan molecules bind to the tryptophan repressor (a transcription factor), changing the repressor's structure such that the repressor binds to the genes. The tryptophan repressor blocks the transcription and expression of the genes, thereby creating negative feedback regulation of the tryptophan synthesis process Alberts (2002).

Differences in gene expression are especially clear within multicellular organisms, where cells all contain the same genome but have very different structures and behaviors due to the expression of different sets of genes. All the cells in a multicellular organism derive from a single cell, differentiating into variant cell types in response to external and intercellular signals and gradually establishing different patterns of gene expression to create different behaviors. As no single gene is responsible for the development of structures within multicellular organisms, these patterns arise from the complex interactions between many cells. Within eukaryotes, there exist structural features of chromatin that influence the transcription of genes, often in the form of modifications to DNA and chromatin that are stably inherited by daughter

cells.[83] These features are called "epigenetic" because they exist "on top" of the DNA sequence and retain inheritance from one cell generation to the next. Because of epigenetic features, different cell types grown within the same medium can retain very different properties. Although epigenetic features are generally dynamic over the course of development, some, like the phenomenon of paramutation, have multigenerational inheritance and exist as rare exceptions to the general rule of DNA as the basis for inheritance Chandler VL (2007).

Prospective Biology Teachers in the Understanding of Genetic Concept

prospective biology teachers can possess a strong understanding of genetic concepts. Gender does not inherently affect an individual's ability to comprehend genetics. The understanding of genetic concepts relies on knowledge, training, and experience. Prospective biology teachers are expected to have a thorough understanding of genetic principles, including DNA structure and replication, Mendelian genetics, inheritance patterns, genetic disorders, genetic variation, and applications of biotechnology. They should be able to effectively explain these concepts to students and facilitate their understanding through various teaching methods and resources.

Diversity in the teaching profession, including biology teachers, can provide a

range of perspectives and experiences that benefit students. It is important to create an inclusive and supportive learning environment where all prospective teachers have equal opportunities to excel and contribute to the understanding of genetic concepts among students. The effectiveness of a biology instructor in conveying genetic concepts is determined by their expertise, knowledge, teaching style, and ability to engage students. Here we explore the roles and contributions of prospective biology teachers in the understanding of genetic concepts:

Start with the Basics: Begin by learning the fundamentals of genetics, including DNA structure, gene expression, and inheritance patterns.

Use Resources: Take advantage of textbooks, online courses, and educational websites that offer interactive lessons and resources to help you grasp complex genetic concepts.

Engage with Professors and Peers: Don't hesitate to seek clarification from your professors or engage in group study sessions with peers to discuss and reinforce your understanding.

Practical Application: Look for opportunities to apply your knowledge

through lab work, research projects, or internships related to genetics.

Stay Updated: Genetics is a rapidly evolving field, so staying updated with the latest research and breakthroughs can deepen your understanding.

Challenges of Prospective Biology Teachers Understanding of Genetics

When learning genetics, Prospective biology teacher may encounter various challenges. Some common difficulties include:

Complexity of Concepts: Genetics involves intricate molecular and cellular processes, making it challenging for students to grasp the complexities of gene expression, DNA structure, and inheritance patterns.

Visualizing Molecular Interactions: Understanding genetic concepts often requires visualizing molecular interactions, which can be abstract and difficult for some students to conceptualize.

Mathematical Aspects: Genetic analysis often involves statistical and mathematical concepts, which can be challenging for students without a strong background in these areas.

Vast Terminology: Genetics has a rich vocabulary of specialized terms, which can be overwhelming for students as they navigate through the extensive jargon.

Rapid Advancements: The field of genetics is continuously evolving with new discoveries and technologies, so students may find it challenging to stay updated with the latest developments.

To overcome these challenges, Prospective biology teacher can benefit from engaging with professors and peers, utilizing visual aids and interactive resources, and seeking out practical applications through lab work or research projects. Persistence, patience, and a genuine curiosity about the subject will also be valuable assets in mastering genetics.

Ways of learning Genetic Concepts

Here are some ways in which Prospective Biology teachers can understand Genetic Concept:

1. Start with the Basics: Ensure you have a solid grasp of the foundational concepts and prerequisites for the topic. Review any related background knowledge or terminology to build a strong foundation.

2. Break it Down: Divide the difficult topic into smaller, more manageable chunks. Focus on understanding each subtopic before moving on to the next. This step-by-step approach helps prevent overwhelm and allows for better comprehension.

3. Use Visual Aids: Utilize visual aids such as diagrams, flowcharts, or concept maps to help visualize and organize the information. Visual representations can make complex information more accessible and aid in understanding connections between different concepts.

4. Seek Simple Explanations: Look for simplified explanations or analogies that relate the difficult topic to something more familiar. Finding everyday examples or comparing the topic to a common scenario can make it easier to understand and remember.

5. Engage in Active Learning: Actively engage with the material by taking notes, asking questions, and summarizing key concepts in your own words. Actively participating in the learning process reinforces understanding and retention.

6. Seek Additional Resources: Explore different resources such as textbooks, online tutorials, videos, or educational websites to gain alternative explanations and perspectives. Experiment with different sources to find what resonates best with your learning style.

7. Connect with Peers or Instructors: Engage in discussions with classmates or seek support from your instructor or tutor. Collaborating with others can

provide different insights and perspectives on the topic, further enhancing your understanding.

8. Practice Application: Apply the knowledge to real-life examples or scenarios. This practical application helps solidify understanding and reinforces the relevance of the difficult topic.

Remember, learning genetics takes time and effort. Be patient with yourself, stay persistent, and celebrate small victories along the way.

Summary of Reviewed Literature

The researcher reviewed the literature on the following topics: challenges encountered when learning genetics, improved methods of teaching genetics, nature of science, biology concept, genetic concept taught in Nigeria universities, comparative analysis of prospective biology teachers in the understanding of genetic concept, empirical review, and summary. The thorough literature review was completed in order to establish the study's structure.

Based on the above literature study, it can be seen that the understanding of genetic concepts relies on knowledge, training, and experience. Prospective biology teachers are expected to have a thorough understanding of genetic principles, including DNA structure and replication, Mendelian genetics,

inheritance patterns, genetic disorders, genetic variation, and applications of biotechnology. They should be able to effectively explain these concepts to students and facilitate their understanding through various teaching methods and resources. Diversity in the teaching profession, including both male and female biology teachers, can provide a range of perspectives and experiences that benefit students. It is important to create an inclusive and supportive learning environment where all teachers, irrespective of their gender, possess equal opportunity to succeed and support students' comprehension of genetic principles. knowledge, style of instruction, and capacity to hold students' attention when explaining genetic topics. It's critical to establish a welcoming and inclusive learning atmosphere where all students may flourish in biology and genetics.

The purpose of this study is to fill in this knowledge gap because no empirical research on the subject of Prospective biology teacher' comprehension of genetic concepts has been done in the university of Benin, Edo State, Nigeria.

CHAPTER THREE

METHODOLOGY

The methodology adopted for this study is presented under the following subheading.

- ❖ Design of the Study
- ❖ Population of the Study
- ❖ Sample and Sampling Technique
- ❖ Research Instrument
- ❖ Validity of the Instrument
- ❖ Reliability of the Instrument
- ❖ Methods of Data Collection
- ❖ Method of Data Analysis.

Design of the Study

This study adopted survey research design. This is due to the fact that this study seek to analysis of prospective Biology teachers in the understanding of Genetic Concept in University of Benin, Edo State.

Population of the study

The population of the study comprised all the undergraduate Biology Students in the Faculty of Education, University of Benin.

Sample and Sampling Techniques

The sample size for the study comprised of one hundred (100) undergraduate Biology Students in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin. The Simple random sampling technique was used to select students each from 100-300 levels. Thus, a total number of one hundred (100) undergraduate Biology students were sampled for this study.

Research Instrument

The research instrument "Analysis of in-service Biology teachers, understanding and perception of difficult concepts in genetics Questionnaire" which consist of content knowledge of genetics concept with answer and corresponding reason for each of the questions.

Validity of the Instrument

The Instrument was subject to content and face validity by the Research Supervisor and another Lecturer from the department of Curriculum and Instructional Technology (CIT) from Faculty of Education, University of Benin. Their inputs was used to rework on the Instrument and the project supervisor made the necessary corrections, modification and later considered the Instrument valid before they were administered.

Reliability of the Instrument

The reliability of the instrument was determined after trial testing on respondents from Other Departments not participating in the study. The data gathered were analyzed using Cronbach Alpha. The Reliability coefficient value was found to be 0.81. This value indicated that the instrument is reliable for collecting data for the study.

Method of Data Collection

The researcher administer the test in person and collect them back accordingly. students will be given enough time to go through all the items on the test and complete them also. The researcher was available to proffer clarification on any difficult item on the test sheet.

Method of Data Analysis

To ascertain the degree to which each statement in the questionnaire item was accepted or rejected, the data were analyzed using Simple percentage.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

In this chapter, the data collected from the response to the research question are presented and a discussion about the result obtained follows.

Research Questions 1

What extent are in-service Biology teachers able to answer questions on Genetics Concepts?

The percentage of in-service teachers who have correct understanding and misunderstanding of Genetics Concepts is seen below.

Table 1: Percentage of Students having Correct Understanding and Misunderstanding of Genetics Concepts.

ITEMS	% With Correct Understanding	% With Misunderstanding
1.	24.0	76.0
2.	46.0	54.0
3.	8.0	92.0

4.	38.0	62.0
5.	57.0	43.0
6.	30.0	70.0
7.	58.0	42.0
8.	60.0	40.0
9.	47.0	53.0
10.	39.0	61.0
11.	61.0	39.0
12.	67.0	33.0
13.	13.0	87.0
14.	34.0	66.0
15.	56.0	44.0
16.	71.0	29.0
17.	34.0	66.0
18.	56.0	44.0
19.	21.0	79.0
20.	12.0	88.0

Research question examines what extent are in-service Biology teachers able to answer questions on Genetics Concepts. According to the analysis, 24% understand Item 1 (76% misunderstanding). Item 2 has 46% correct understanding (54% misunderstanding), and Item 3 shows only 8% understanding it correctly (92% misunderstanding). For Item 4, 38% have the correct understanding (62% misunderstanding), and 57% understand Item 5 correctly (43% misunderstanding). Item 6 shows 30% correct understanding (70% misunderstanding), and 58% of students understand Item 7 correctly (42% misunderstanding). For Item 8, 60% have the correct understanding (40% misunderstanding), and for Item 9, 47% understand correctly (53% misunderstanding). Item 10 shows that 39% of students understand it (61% misunderstanding), while 61% correctly understand Item 11 (39% misunderstanding). 67% of students understand Item 12 correctly (33% misunderstanding), while only 13% understand Item 13 correctly (87% misunderstanding). Only 34% understand Item 14 (66% misunderstanding), and while 56% understand Item 15 correctly (44% misunderstanding). Item 16

has 71% correct understanding (29% misunderstanding), while 34% understand Item 17 correctly (66% misunderstanding). For Item 18, 56% have the correct understanding (44% misunderstanding), Item 19 shows 21% correct understanding (79% misunderstanding), and only 12% understand Item 20 correctly (88% misunderstanding).

Research Question 2. How do in-service Biology teachers perceives difficult Concept in Genetics

Research question two examines how do in-service Biology teachers perceives difficult Concept in Genetics. From the analysis the following items 3, 8, 10, 12, 13, 14, 15, 18 and 20 were perceived by in-service Biology teachers as difficult Concept in Genetics. In-service biology teachers perceive difficult concepts in genetics in various ways such as teachers find concepts like molecular genetics. Gene regulation, and genetic engineering challenging due to their intricate nature. Abstract concepts like genetic code, gene expression, and molecular interactions are difficult for teachers to teach and for students to understand. Genetics concepts often require visual representations to facilitate understanding, but teachers struggle to find or create effective visual aids.

Teachers have limited access to resources, including textbooks, online materials, and laboratory equipment, making it difficult to teach genetics effectively. Teachers find it challenging to connect genetics concepts to everyday life, making it harder for students to see the relevance and importance of the subject.

Discussion of Findings

Research question one reveals the varying degrees of understanding and misunderstanding among in-service Biology teachers regarding genetics concept. Across different items, the analysis indicates fluctuations in the percentages of correct understanding and misunderstanding. Notably, while some items witness relatively higher levels of correct understanding, others show a prevalent misunderstanding among in-service teachers. These findings suggests that in-service biology teachers' ability to answer questions on genetics concepts varies depending on factors such as their Subject matter knowledge, Teaching experience, Curriculum and teaching materials etc. The results of the findings agrees with Oyovwi (2015) who said to improve teachers' knowledge and confidence in teaching genetics, professional development opportunities, and supportive resources are essential.

Research question two investigates the aspects of the genetics concept that in-service teachers perceives as difficult. The analysis reveals significant areas of misunderstanding among teachers, such as Gene regulation and expression, Molecular genetics (DNA replication, transcription, translation), Genetic inheritance patterns (Mendelian and non-Mendelian), Gene mutation and genetic variation, Recombinant DNA technology and genetic engineering, Epigenetics and gene expression, Genomics and bioinformatics, Evolutionary genetics and phylogenetics, Genetic linkage and mapping and Gene-environment interactions and epistasis. These concepts are challenging due to their complexity, abstractness, and rapid evolution in the field of genetics. Teachers may struggle to teach these concepts effectively, and students may find them difficult to understand and apply.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

This study's primary goal is to investigate the analysis of in-service Biology teachers, understanding and perception of difficult concepts in genetics. Undergraduate Student of Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin made up the study's population. It was conducted using a simple random sampling. My supervisor and other lecturers at University of Benin validated the instructment. The researcher delivered the questionnaires to in-service Biology undergraduate Student from Departments of Curriculum and Instructional Technology, Faculty of Education, University of Benin and gathered the responses. Simple percentage were used to analyze the data.

The analysis's findings indicated that in-service biology teachers' ability to answer questions on genetics concepts varies depending on factors such as their Subject matter knowledge, Teaching experience and Curriculum and teaching

materials. In-service biology teachers perceive difficult concepts in genetics in various ways such as teachers find concepts like molecular genetics. Gene regulation, and genetic engineering challenging due to their intricate nature. Abstract concepts like genetic code, gene expression, and molecular interactions are difficult for teachers to teach and for students to understand.

Conclusion

The study's results led to the conclusion that In-service biology teachers' understanding and perception of difficult concepts in genetics can vary depending on the following such as teachers with a strong foundation in genetics and molecular biology tend to be more confident and effective in teaching these concepts. More experienced teachers may have developed strategies to address common student misconceptions and difficulties of genetics concept. Teachers who have attended workshops, training, or courses on genetics and genomics tend to be more aware of the challenging concepts and how to teach them effectively. Teachers who have access to comprehensive and up-to-date resources, such as textbooks, online materials, and laboratory equipment, may feel more comfortable teaching genetics. Teachers who

regularly assess student understanding and adjust their instruction accordingly tend to be more aware of the difficult concepts and how to address them.

Some common difficult concepts in genetics that in-service biology teachers may struggle with include Molecular genetics and molecular biology, Gene regulation and expression, Genetic inheritance patterns (Mendelian and non-Mendelian), Genetic variation and mutation, Recombinant DNA technology and genetic engineering, Epigenetics and gene expression, Genomics and bioinformatics, Evolutionary genetics and phylogenetics. By understanding these challenges, educators and administrators can provide targeted support and resources to help biology teachers enhance their teaching of genetics concepts and improve student learning outcomes.

Recommendations

The following recommendations were made based on the study's findings:

1. The government should hire skilled and experienced Biology instructors with adequate knowledge of genetics concept for senior secondary schools in order to effectively teach and learn genetics concept.

2. The government should organize workshops, training, or courses on genetics and genomics tend for in-service Biology teachers to be more aware of the challenging concepts and how to teach them effectively

3. School administrator should provide in-service Biology teachers with up-to-date resources, such as textbooks, instructional materials, and laboratory equipment, so that in-service Biology teachers may feel more comfortable teaching genetics.

4. In-service biology teachers should have a strong foundation in genetics and molecular biology tend to be more confident and effective in teaching genetics concepts.

5. Genetics is a rapidly advancing field, in-service Biology teachers should be up to date with new discoveries, technologies in teaching genetics concept effectively.

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APPENDIX

UNIVERSITY OF BENIN, EDO STATE

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY

ANALYSIS OF IN-SERVICE BIOLOGY TEACHERS, UNDERSTANDING OF THE CONCEPTS OF GENETICS.

QUESTIONNAIRE

Dear Respondent,

I would like to thank you most sincerely in advance for filling out a copy of this questionnaire. The questionnaire is intended to elicit the analysis of in-service Biology teachers, understanding and perception of difficult concepts in genetics (A case study of Egor Local Government Area of Edo State). The survey is only an academic exercise, purely for research purposes. So, feel free to express yourself in responding to the questionnaire. Confidentiality of your responses is guaranteed. Thank you in anticipation.

CONTENT KNOWLEDGE OF GENETIC CONCEPTS

Instruction- Please tick the correct answer and corresponding reason for each of the questions below:

1. What is the basic unit of inheritance in genetics?

A) DNA

B) Gene

C) Chromosome

D) Nucleus

Reason

a. A gene is a section of DNA that codes for a specific trait.

b. DNA is the larger molecule that genes are made from, but genes are the specific sections of DNA that are inherited.

c. Chromosomes are structures made of DNA, but they contain many genes, so they aren't the basic unit of inheritance.

d. Nucleus is a structure in cells that contains DNA, but it's not directly involved in inheritance.

2. Which of the following is an example of a dominant trait?

a. Huntington's disease

b. Cystic fibrosis

c. Sickle cell anemia

d. Hemophilia

Reason

a. Huntington's disease: Huntington's disease is a dominant trait because it is caused by a dominant allele. If a person inherits just one copy of the defective gene from either parent, they will develop the disease. This is because the defective gene dominates over the normal gene.

b. Cystic fibrosis: Cystic fibrosis is not a dominant trait. It is caused by a recessive gene. For a person to have the disease, they must inherit a defective gene from both parents.

c. Sickle cell anemia: Sickle cell anemia is also not a dominant trait. It is a recessive genetic disorder. People who inherit one sickle cell gene and one normal gene have the sickle cell trait, but not the disease. Only if a person inherits two defective genes do they develop sickle cell anemia.

d. Hemophilia: Hemophilia is a recessive trait linked to the X chromosome. A male who inherits one defective gene will have hemophilia, because they only have one X chromosome

3. Which of the options represent the correct sequence of events as observed during mitosis?

a. Chromosotnes align al the equator — chromosomes becomes visible —•

cytokinesis-chromatids separate

b. Chromosomes become visible — chromosomes align at the equator— chromosomes

separates —cytokinesis

c. Chromosomes become visible — chromosomes separate —chromosomes align at the

equator- Cytokinesis.

d. Chromosomes become visible — cytokinesis- chromatids separate- chromosomes align at the equator.

Reason:

a. It occurs in the somatic cells and 2 daughter cells arc formed

b. It occurs in the sex cells and 4 daughter cells arc formed

c. It occurs in the somatic cell and 4 daughter cells arc formed

d. It occurs in the sex cell and 2 daughter cells are formed

4. What is the term used to describe the genetic makeup of an organism, including both dominant and recessive genes?

A) Phenotype

B) Genotype

C) Karyotype

D) Chromotype

Reason

a. Genotype: Genotype refers to the genetic makeup of an organism, including both dominant and recessive genes. It describes the specific set of genes an individual carries, which can include different versions (alleles) of each gene. The genotype determines the potential characteristics an organism can display.

b. Phenotype: Phenotype refers to the observable characteristics of an organism that result from the interaction of its genotype with the environment. While genotype refers to the genetic makeup, phenotype is what we can see or measure, like physical appearance or behavior.

c. Karyotype: A karyotype is a visual representation of the chromosomes in a cell. It shows the number, size, and shape of chromosomes in an organized profile. It can reveal genetic disorders, but it does not describe the specific genes on each chromosome.

d. Chromotype: Chromotype is not a standard term used in genetics. It might sometimes be used to refer to the chromosome composition of a cell, but it's not a widely recognized term for this concept

5. Which of the following structure is only formed during meiosis?

a. Ribosome

b. Centrosome

c. Chiasmata

d. Cytoplasm

Reason:

a. It provides nutrient to the gene

b. It provides nutrient to the chromosomes

c. It breaks the chromatids

d. It holds the chromatid together

6. Which of the following options shows the true sequence of the phases during cell

division?

a. Prophase—♦ Metaphase-— Anaphase— Telophase— interphase

b. Prophase— Interphase — Telophase— Anaphase— Metaphase

c. Interphase — Prophase— Telophase— Metaphase— Anaphase

d. Interphase— Prophase —Metaphase—Anaphase —Telophase

Reason:

a. The cells begin to divide at the interphase

b. The cells undergoes cytokinesis during metaphase

c. The cell rests at the interphase

d. New spindles are formed at the telophase

7. Cytokinesis occurs during

a. Meiosis

b. Mitosis

c. Mitosis and Meiosis

d. none of the above

Reason

a. It ensures that each daughter cell get the necessary organelles in mitosis only

b. It ensures that there is distribution of complete set of genes into each daughter cell in both mitosis and meiosis

c. It ensures that daughter cells inherit new genetic combinations in mciosis only

d. It ensures that worn out organelles are included in daughter cells in both mitosis and meiosis.

8. Which of the following statements about chromosomes is correct?

a. All chromosomes of a species are the same in shape

b. The number present in a specie is constant

c. They arc neatly arranged in the cytoplasm

d. They bear ribosomes on their outer membranes

Reason:

a. It consists of two chromatids joined at centromere

b. It consists of two chromatids joined at the spindle

c. It consists of two chromatins joined at the centrioles

d. It consists of threadlike structures joined together

9. ln a family of eight (8), all the children are girls, which of the following reason correctly explains this?

a. the woman cannot produce male children

b. the man has low sperm count

c. the “y" component of the man's sex chromosome was always involved

d. the "X” component of the man’s sex chromosomes was always involved

Reason:

a. The gene that is located on the x-chromosomes is said to be Expressed in females only

b. Quasi

c. Sex-linked

d. Expressed in males only

10. An animal has 40 chromosomes in its gamete, how many chromosomes would you expect to find in this animal's brain cells?

a. 1

b. 20

c. 40

d 80

Reason

a. 1: This is incorrect because it implies that there is only one chromosome in the brain cell, which is not possible for an organism with 40 chromosomes in its gametes.

b. 20: This answer is incorrect as well. While it is true that gametes have half the number of chromosomes as regular body cells, option B fails to consider the full set present in the brain cells. Option B would be correct if the question asked about the number of chromosomes in the gamete, not the brain cells.

c. 40: While this answer is not correct, it might be tempting to select since 40 is

the given number of chromosomes in the gamete. However, this option neglects to account for the fact that gametes have half the number of chromosomes found in normal body cells.

d. 80: This is the correct answer. As explained in the previous response, the normal body cells of an organism (including brain cells) have twice the number of chromosomes as the organism's gametes. So, for an organism with 40 chromosomes in its gametes, you would expect 80 chromosomes in its brain cells.

11. Which of the following statements about allele to correct?

a. An allele is an alternative f<»rm of a gene that is located at a specific position on a specific chromosome

b. An allele is an alternative form of a gene that is located at different positrons on different chromosomes

c An allele is an alternative form of a gene that i« located at cytoplasm of the cell

d. An allele is an alternative form of a gene that is located on the cell wall.

Reason

a. Organisms typically have one allele for a trait.

b. Organisms typically have two allele for a trait.

c. Organisms always have multiple alleles for a trait.

d. None of the above

12. A man's blood group is AB. what is the probability of the man giving birth to a child with Blood group O?

a. 0%

b. 25%

c. 50%

d. 100%

Reason:

a. Except the mother has blood group 0

b. Universal recipient cannot give birth to universal donor

c. Universal donor cannot give birth to blood group 0

d. The child has blood group ABO

13. If two people who are both carriers for a genetically inherited fatal receive disease

decide to become parents, what will be the odds that their children will also be carriers?

a. 1 out of 4

b. 2 out of 4

c. 3 out of 4

d. 4 out of 4

Reason

a. The disease is very dangerous

b. Only one of the children will suffer severely from the disease

c. Two of the children will suffer severely from the disease

d. None of the children will suffer from the disease

14. The probability of having an inherited disease or a genetically determined physical trait can be predicted using

a. Chi square

b. Punnet square

c. Probability meter

d. Genetic guard

Reason:

a. It is a diagrammatic representation of likely genetic outcome of offsprings

b. It is a calibrated instrument used to measure probability

c. It is non-calibrated instrument used to measure level of probability

d. None of the above

15. If two parents are heterozygous for a genetically inherited dominant trait, what is the

probability that they will have a child together who has this trait in his or her phenotype?

a. 0.25

b. 0.5

c. 0.75

d. 1

Reason:

a. It cannot be expressed in the child's phenotype

b. It cannot be expressed in the child's genotype

c. It can only be expressed in the child's phenotype

d. It can be expressed both in the phenotype and genotype of the child.

16. Characteristics that exhibit continuous variation are generally controlled by.

a. A single gene

b. Recessive gene

c. Epistatic interactions

d Multiple genes

Reason:

a. They are mutants.

b. They exhibit a wide range of phenotypic characters

c. They exhibit two forms of phenotypic characters

d They exhibit a single type of phenotypic character

17. When a man who is Rh positive marries a woman who is Rh negative, there will be incidence of

a Still birth

b. Sicklers

c. Albinos

d. Living children

Reason:

a. The melanin pigment is reduced

b. It causes agglutination

c. The immune system of the offspring will be boosted

d. Fertilisation is increased

18. If two parents are sickle cell carriers, then their genotypes would be

a. HbAHbAand $Hb^{s}Hb^{s}$

b. Hb'Hbsand $Hb^{s}Hb^{s}$

c. HbAHbsand $Hb^{A}Hb^{s}$

d. HbAHbAand $Hb^{A}Hb^{A}$

Reason:

a. They are both sicklers

b. They are not sicklers

c. One of the them is a sickler

d. No of their of the springs will be sicker

19. In the Fl generation of Mendel's experiment obtained by crossing Pea plant of long stem with those of short stems, what was the observation?

a. Some were short while others were long

b. All were long

c. Half of them were long while half were short

d. Three quarters were long while one quarter were short

Reason

a. The long sterns did not combine with short stems

b. The short stem was dominant

c The long stem was dominant

d. All long and short stems had equal dominance

20. Which of the following conditions in humans does not involve the transmission of a pair of gene in the Mendelian fashion?

a. Albinism

b. Attached ear-lobe

c. Conjunctivitis

d. Brachydactyly

Reason:

a It does not adhere to the principle of monohybrid inheritance

b. It adheres to the principle of monohybrid inheritance

c It adheres to the principle of dihybrid inheritance

d. It adheres to the law of segregation