UNIVERSITY OF EDUCATION, WINNEBA

# USING COMPUTER-ASSISTED INSTRUCTION TO IMPROVE THE PERFORMANCE OF SCIENCE 2 STUDENTS IN PROTEIN SYNTHESIS AT SWEDRU SENIOR HIGH SCHOOL.

LETICIA KORANTEMA BUDU

APRIL, 2015

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**LETICIA KORANTEMA BUDU**

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**A Thesis in the Department of SCIENCE EDUCATION, Faculty of SCIENCE EDUCATION, submitted to the School of Graduate Studies in the University of Education, Winneba, in partial fulfillment of the requirements for award of MASTER OF PHILOSOPHY IN SCIENCE EDUCATION DEGREEE.**

**APRIL, 2015**

## DECLARATION

**Student's Declaration**

I, **LETICIA KORANTEMA BUDU**, declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

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Leticia Korantema Budu                    Date

**Supervisors' Declaration**

We hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines set for thesis laid down by the University of Education, Winneba.

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Prof. Yaw Ameyaw                    Date

(Principal Supervisor)

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Dr. Joseph Nana Annan                    Date

(Co-Supervisor)

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## DEDICATION

Dedicated to God, my husband, Mr. Anthony Adjetey Adjei, my children, Sharileus Godson Nii Adjei Adjetey, Sharleen Kezia Naa Adjeley Adjetey and Sharileen Sarah Naa Adjorkor Adjetey.

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## ABSTRACT

The study investigated the use of Computer-Assisted Instructions (CAI) to improve the performance of students in the teaching and learning of protein synthesis. The study was carried out at Swedru Senior High School. The accessible population was all form two biology students of the school. The sample for the study consisted of 90 students comprising 31 girls and 59 boys who were all SHS 2 science students. The study used qualitative and quantitative data gathering instruments. All the statistics used in this

research were done using the Statistical Package for Social Science (SPSS) for windows up to version 18.0 software. The study showed that students had negative approaches to the learning of protein synthesis, low self-efficacy with regards to protein synthesis; students had misconceptions of concepts in learning protein synthesis and agreed that there were too many concepts in protein synthesis and Students‘ attributed their interest in protein synthesis to effective teacher practice but not from friends. Negative learning approaches, misconceptions and low self-efficacy to learning of protein synthesis had no effect on students‘ performance though the mean scores of their performance were low. Students‘ attribution of interest and the use of CAI showed an effect in their performance with the mean scores being comparatively higher. It is recommended that young learners should be encouraged and guided to develop positive attitudes towards science and innovative learner-centered instructional strategies and use of computer-assisted instructional packages should be used by biology teachers to promote meaningful learning of difficult biology concepts.

# CHAPTER ONE

# INTRODUCTION

**Overview**

The chapter is structured under the following sub-headings:

Background to the study, Statement of the problem, Purpose of the study, Objectives of the study, Research questions, Significance of the study, Delimitation, Limitations and Definition of terms and abbreviations.

**Background to the study**

It is common knowledge that science is the basis for the development of any society. Developed countries, like the United States of America, Japan, Great Britain, France and Germany, could not have reached their current stage of development without science. In recent times, education administrators, teachers, parents and the general Ghanaian populace are becoming increasingly worried about the poor academic performance of students in science, especially at the Senior High School (SHS) level to which biology is of no exception.

Students' difficulties in learning biology have been studied by various researchers across the world (Seymour & Longdon, 1991; Lazarowitz & Penso, 1992; Bahar, Johnstone & Hansell, 1999). Many concepts or topics in biology, including water transport in plants, protein synthesis, respiration and photosynthesis, gaseous exchange, energy, cells, mitosis and meiosis, organs, physiological processes, hormonal regulation, oxygen transport, genetics, Mendelian genetics, genetic engineering, and the central nervous system can be perceived as difficult to learn by secondary school students. Tekkaya, Özkan and Sungur (2001) also found that hormones, genes and chromosomes, mitosis and meiosis, the nervous system, and Mendelian genetics were considered difficult concepts by secondary school students. Experiencing difficulties in so many topics in biology negatively affects students‘ motivation and achievement (Özcan, 2003).

Cavalcante, Newton and Newton (1997) have stated that one of the most important aims of science education is to increase conceptual understanding of children and conceptual understanding cannot be transferred from teacher to student and, thus, students should construct this understanding themselves. According to Ozden (2003), conceptual understanding is to learn the essence. He claims that instead of learning a lot of subjects superficially and isolated from each other, learning basic concepts, principles, rules and generalities will be more effective activity for providing conceptual understanding. This is very essential in the Ghanaian biology class practices where the contrary is done.

Much blame is put on teachers method of teaching science, others are of the view that lack of facilities and resources like library, laboratory equipment, textbooks, etc. as being possible causes of the fallen standards in science education in the country. As much as I agree to some extent with the reasons adduced above, I am also of the opinion that there are other factors that influence students‘ performance in biology which has eluded a large portion of the community since learning takes place within a context and not in isolation. There are numerous contextual factors that affect students‘ learning. For example, type of school, school resources, instructional approaches, teacher characteristics, student attitudes, and home support for learning contribute heavily to student learning and achievement (DuFour, 1999; Goe, 2008).

Teachers of biology at the Senior High School level in Ghana are charged with the task of making the exciting developments in this field accessible and interesting to students. One major curriculum component of biology is the understanding of how proteins work; in particular, how protein structure determines function (CRDD, 2008). It has been observed that students often have a difficult time visualizing and grasping three-dimensional structures in a two-dimensional environment. Even simple three-dimensional structures, such as DNA, can be difficult to represent with the two-dimensional non-interactive constraints of traditional educational tools (Shubert, Ceraj & Riley, 2008). This often leads to insurmountable difficulties in understanding protein function and in explaining how their function relates to their shape and in effect affects their performance. To overcome these difficulties, teachers and students can use technology to help teach this major concept in the teaching and learning of biology.

Technology contributes to global development and diversity in classrooms and helps develop upon the fundamental building blocks needed for students to achieve more complex ideas. In Ghana, and internationally, claims are being made about the potential for information and communication technologies (ICTs) to transform teaching and learning. Like many other countries, Ghana, as stated earlier, is concerned about senior high school students‘ achievement in science subjects as it relates to the demand and supply of professionals working in scientific areas regarded as essential for national development. Effective integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyze and synthesize the information, and present it professionally.

Little attention is paid to the student‘s use of technology in biology which could influence his/her performance in the subject. I am of the belief that finding answers to the question of students use of integrated software in the subject will in a long way open avenues for addressing the low level of achievement in biology, which seems to have taken a negatively deep and alarming trend.

**Statement of the Problem**

Though there has been an appreciable improvement in information technology and communication and governmental policies geared towards enhancing science and technology in the country, students‘ performance in the Senior High School Certificate Examinations (SSSCE) and the West African Senior School Certificate Examinations (WASSCE) administered by the West African Examination Council (WAEC) in the area of the sciences and biology, for that matter, continues to deteriorate year after year (Anamuah-Mensah, 2007; Anthony-Krueger, 2007). It is a fact that students continue to perform poorly in science despite having experienced and highly qualified teachers and reasonably well-equipped science laboratories in senior high schools. This situation as subtle as it appears does not favour Ghana‘s move towards developing a scientific and technological human resource base which is the bedrock of any development oriented country seeking world class economic status.

Many a time, the teacher is blamed for the poor performance, and even when a child is blamed, it is attributed to the child‘s cognitive or intellectual abilities. No consideration is given to the fact that the child understanding of concepts and to larger extent technology integration and his/her attitude in the science subjects has an effect on his/her performance (Hake, 1998; Okoro & Etukudo, 2001; Tabassum, 2004). Most of researches carried out have been geared towards looking at factors such as location of students, socio-economic, educational background of parents and gender related issues among others as possible attributes affecting students‘ performance in biology (Akinyemi & Orukota, 1995; Yidana, 2004). It is worth noting that a big gap exists in our appreciation of the possible relationship between certain technological, conceptual, human attributes and the individual student‘s performance in science in Ghana. This study therefore, sought to investigate the effect of integrating a software in the teaching and learning of protein synthesis on the performance of students and its impact on their performance in the subject.

**Purpose of the Study**

The study investigates the use of Computer-Assisted Instruction (CAI) to improve the performance of SHS 2 Science students in the teaching and learning of protein synthesis at Swedru Senior High School.

**Objectives of the Study**

The overall objective of this study is to investigate the effect of integrating a CAI in the teaching and learning of protein synthesis on the performance of students.

The specific objectives of the study were to:

1. find out whether any relationship existed between students' learning skills and their achievement in protein synthesis using CAI as an interventional tool.
2. determine the differences between students' self-belief in learning protein synthesis and their performance in the subject through the use of CAI.
3. ascertain the impact of students' misconceptions in protein synthesis on their performance on the topic through the application of CAI.
4. identify the students' interest in the learning of protein synthesis and its effect on their performance when an interventional tool like CAI is applied.
5. determine the effect of CAI integration in the teaching and learning of protein synthesis on the performance of students.

**Research Questions**

To achieve the above objectives, the study was guided by the following research questions:

1. What is the relationship between students' learning skills and their achievement in protein synthesis?
2. What is the significant difference between students' self-belief in learning protein synthesis and their performance in the subject?
3. What is the effect of students' misconceptions in protein synthesis on their performance?

4. What interest do students have in the learning of protein synthesis and how does it affect their performance in the subject?

5. What is the effect of CAI use in the teaching and learning of protein synthesis on the performance of students?

**Significance of the study**

The findings of this study should provide important and useful information which seems to have been overlooked by some stakeholders in education in Ghana. The Government of Ghana, like any other developing country, recognizes science and technology as a panacea for national development because of the link between science, technology and economic growth (Ogunniyi, 1998). The study is therefore likely to provide stakeholders and policy makers in education in Ghana enough information to make informed judgments during the formulation of policies with regard to the learning and teaching of biology. Through the findings of this study they can identify the contextual variables that may be modified to bring about improvement in curricula and writing of biology textbooks in order to enhance interest in learning and teaching of biology thereby improving performance.

**Delimitation**

The study was limited to Swedru Senior High School in the Agona East District of the Central Region of Ghana. In the selected school, only SHS 2 biology students were considered. The study did not cover every part of the Central Region, and the results of this study cannot be generalized.

**Limitation of the Study**

According to Best and Kahn (1989), limitations are conditions beyond the control of the researcher that will place restriction on the conclusion(s) of study and its/their application to other situation(s).

Limiting the study to only the Agona East District of the Central Region might not have revealed the general picture of the use of the technology in the teaching and learning practices and its impact on performance. Therefore, this puts a limit on the generalisation of the findings.

It‘s expected that, co-curricular activities based on the school time-table and unannounced ones could have affected the schedules of the research especially during the intervention stage.

Also, students would have hesitated in responding to the questionnaire and other software activities candidly due to fear that they might be exposing their weakness, as well as, probably their incapability in the use of the computer.

**Organisation of the Chapters**

This report was organized into six chapters. The first chapter provides the introduction and the background to the study as well as the problem statement, objectives of the study, research questions and significance of the study, delimitation and limitation of the study. The second chapter entails the review of relevant literature whiles the third chapter described the methodology which embodied the study area description, the research design, the study population, sampling, instrumentation, source and type of data collection. The data collection procedure and technique used for analysing the data was focused. The fourth chapter presents the interventions. The fifth chapter provided the results and discussion of the findings of the study while the last chapter covers the summary, conclusions and recommendations of the study and suggestions for further studies.

**Definition of Terms and Abbreviations**

A number of terms and abbreviations were used in this report. The following were some of their operational definitions:

**Attribution of interest:** Students work hard when they believe that their efforts in learning will lead to achievement of their objectives. Attribution of interest, therefore, is what students ascribe their interest in protein synthesis to.

**CAI:** Computer-Assisted Instruction (CAI) is used to indicate the application of the computer in the teaching and learning process. CAI is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place (Fourie, 1999).

**Constructivism:** A philosophical framework or theory of learning which argues human construct meaning from current knowledge structures proposed by Piaget (1978; 2000).

**Elaboration**: A learning technique, proposed by Ausubel (1978), that forges a link between what a learner is trying to learn and what he or she already knows so as to make the new material more personally relevant and meaningful. It is an exceptional memory strategy in so far as it requires integration of the new content in the learner‘s prior knowledge (English & Reigeluth, 1996).

**Epistemological beliefs**: Individual‘s understandings about the nature of knowledge and the nature of science learning.

**GES:** Ghana Education Service

**Learning skills:** In the course of their schooling, students develop learning skills and strategies that they use in executing learning tasks. Learning skills act as academic enablers. They are tools for enabling students to acquire knowledge and enhance their mental competence.

**J.H.S:** It is one of the basic levels of education. It was formally known as Junior Secondary School. From here students can enter into any Senior High School.

**Metacognition:** Awareness of nature, purpose and progress being made in a learning task.

**PTA** – In Ghana, Parent-Teacher Association (PTA) is a formal organization composed of parents, teachers and staff that is intended to facilitate parental participation in public or private basic and senior high schools. At the local level, the goal of all parent-teacher groups is to support their schools, encourage parent involvement and support teachers.

**Retention:** The ability to remember concepts or information learned some time later.

**Resilience:** The capacity for or outcome of successful adaptation despite challenging or threatening circumstances. Children who are resilient somehow overcome impairment in normal development, self-esteem deficits, identity issues, depression, delinquency and academic problems.

**School climate:** The values, cultures, safety practices and organizational structures that cause schools functioning and reacting. Respect for individual students and teachers, a safe and orderly environment, constructive interactions among administrators, parents, teachers and students all contribute to a positive school climate.

**Self-efficacy:** Academic self-efficacy is ―the individual‘s convictions that they can successfully carry out given academic tasks at designated levels". Academic self-efficacy like personal self-efficacy is derived from past experience.

**Self-regulation:** Exercise of influence over one's own motivation, thought processes, emotional states and patterns of behaviour. Self-regulated learning, however, requires not only knowledge of learning skills but also ability to match learning tasks to learning skills that work for the individual student.

**Senior High School (SHS):** It is one of the second cycle levels of education in Ghana. It was formally known as Senior Secondary School. From here students can enter into any tertiary institution or world of work.

**SSSCE**- Senior Secondary School Certificate Examination is WAEC organized final examination which was taken by only students in Ghana at the end of Secondary Education in Ghana. It has since been replaced by the West Africa Secondary School Certificate Examination which is taken by all WEAC member countries.

**Teacher quality**: Principal factor in educational provision. This affects quality of education in a significant way. Attributes of concern include, personal characteristics including, academic, qualification, pedagogical training, content knowledge, ability, years of service/teaching experience.

**TIMSS:** The **Trends in International Mathematics and Science Study (TIMSS)** provides information to improve teaching and learning in mathematics and science. TIMSS assesses achievement in mathematics and science at the fourth and eighth grades and collects a rich array of background information to address concerns about school resources and the quality of curriculum and instruction. Conducted every four years on a regular cycle, TIMSS provides countries with an unprecedented opportunity to measure progress in educational achievement in mathematics and science.

**Transfer**: The ability to use material learned to solve new problems, to answer questions that have not been encountered before or to learn new subject matter.

**WAEC**: The West African Examinations Council, a non-profit-making organization, with its head-quarters in Accra, Ghana, was established in 1952 after the Governments of Ghana (then Gold Coast), Nigeria, Sierra Leone and The Gambia enacted the West African Examinations Council Ordinances in 1951. Liberia became the fifth member of the Council in 1974. The main objectives of the Council are: To conduct examinations in the public interest and to award certificates, provided that the certificates did not represent lower standards of attainment than equivalent certificates of examining authorities in the United Kingdom. In Ghana, WAEC is responsible for several examinations.

# CHAPTER TWO

# LITERATURE REVIEW

## Overview

This chapter presents a review of related literature to this study. It highlights the following headings: Theoretical Framework of the study, Relationship of Behaviouristic Theory of learning to CAI, Effectiveness of CAI as a teaching and learning strategy, Computer-Assisted Instruction and Achievement, Performance of Students in Biology in Ghana, Students‘ Attitude towards Biology, Misconceptions to Understanding Biology, Cooperative Learning in Biology, Teacher Quality and Effectiveness, and Biology Learning.

## Theoretical framework of the study

The theoretical framework that underpinned the study was hinged on the broad tradition of constructivism traced to the work of Ausubel (1978), Vygotsky (1986) and Piaget (2000) of cognitive development and that of Skinner‘s operant conditioning theory. The constructivism tradition currently dominates research in science education. It might not be appreciated immediately that constructivism could underpin a survey that involves the analysis of questions pertaining to attitudes, interests, misconceptions, experiences and beliefs. This could be a legitimate assertion. Although constructivism is not in a literal sense a framework, the theoretical stance may be said to be constructivist.

Constructivism may be defined as an epistemological view which sees the learner as an active participant in the teaching/learning process. The learner comes into the learning situation with prior knowledge on the subject matter. It hinges on this prior knowledge that the learner interprets the new situation presented Tabassum (2004). This means that the construction of new knowledge in science is strongly influenced by prior knowledge. It is also a process where motivation and interest in the subject matter may improve or serve as an obstacle for such construction to take place. The new knowledge gained may be replaced, modified and added to already existing one. The construction of new knowledge takes place at an existing cultural context, such as geographical location, religion, social and economic status, ethnicity and language. It is, therefore, within the constructivist framework to say that one should pay attention to attitudes, misconceptions, experiences and interests in a teaching situation.

The study framework, therefore, could be seen to be structured on the principle that individuals build or construct their own meaning of new information on the basis of their existing knowledge and that what a person brings to the learning environment matters. Some researchers (Pintrich, Marx & Boyle, 1993; Von Glasersfeld, 1999) have noted that, the constructivists‘ position that students should have access to multiple viewpoints and representations for information is partially satisfied by well-constructed simulations.

It is worth knowing that, each learner brings experiences that affect his or her view of the world and his or her ability to accept other views grounded in science (Vygotsky, 1986). In this way, science education can be contextualized and linked to the life world experiences of learners. The new experiences are used by the learner to *construct* new meaning. This knowledge construction is shaped through social interactions with members of the community (Vygotsky, 1986). Thus, making learning meaningful for the learner, one has to take into consideration the social and cultural environments of the child. With recognition of the need for the child‘s environment in the classroom, school learning, achievement and attitudinal formation will largely be informed by the interaction between the conceptual domains of the home or community and school.

There are different definitions of learning and these different definitions depend on the school of thought one belongs; but, generally, learning can be defined as an enduring change in a person that is not heralded by genetic inheritance (Bigge & Shermis, 2004). Enduring changes in persons occur within the process of maturation, learning or through both. However, teachers can do little about students‘ pattern of maturation. Their greatest influence is on students‘ learning and to a larger extent both teaching-learning methods implored.

A major theory of learning in educational psychology is behaviourism. Many researchers including Skinner and Pavlov subscribe to this theory of learning. The basis and underlying principle of behaviourism, as Tabassum (2004) asserts, was that a stimulus (S) that elicited a response (R) and immediately followed by positive reinforcement would result in increasing the probability that the same or similar response would occur upon further presentation. Applying the theory of behaviourism in teaching and learning therefore consists of either promoting the proper response in students or increasing the probability of their proper responses (Bigge & Shermis, 2004).

Application of the behaviouristic theory in instructional strategy involves contiguity, reinforcement and repetition (Tabassum, 2004). This indicates that for a person to learn by applying the behaviourial tradition, the material to be learnt should be related to what that person already knows. Also, there should be feedback when a response is given. Proponents of behaviourism believe that a response is strengthened if it is followed by pleasure and weakened if followed by pain. Relatedly, as Bigge and Shermis (2004) posits, the more a stimulus-induced response is repeated, the longer the response will be retained.

Modern examples of teaching machines, automated and computer-assisted instructional devices owe their theoretical roots to the behaviourist tradition in psychology (Edwards, 1970). Although many researchers subscribe to the behaviourist tradition, the more recent developments in computer-assisted instructional devices have been most significantly affected by the writings of B.F. Skinner (Edwards, 1970). Skinner held the view that it was necessary to develop teaching machines capable of teaching skills to students. This led to the _teaching machine revolution' and the programmed instruction era (Emmons, 2008). From the general principles of behaviourism, Operant Conditioning theory of learning was propounded (Skinner, 1998). The operant conditioning is the learning process whereby a response is made more probable or more frequent (Bigge & Shermis, 2004). An operant is a set of acts or actions that constitute an organism's set of activity. Bigge and Shermis (2004) believe it is so called because behaviour operates upon the environment and generates consequences. Thus, in the process of operant conditioning, operant responses are modified or changed. Skinner‘s ideas came about as a result of his observations of the performance of animals in a device that he invented. In the device, an animal received a pellet of food (positive reinforcement) each time the animal performed a required activity rightly. Even though Skinner worked on low-level behaviours of animals, he applied the concepts to complex behaviour of humans because he found operant conditioning highly effective in training animals and therefore was confident that it promised equal success when used with children and youth (Bigge & Shermis 2004).

In operant conditioning, teachers are considered architects and builders of students‘ behaviour (Bigge & Shermis, 2004). Learning objectives are divided into a large number of very small tasks and reinforced one after the other into minute stimulus-response bonds (Thomas, 2001). In this approach, the teacher presents the problem to the student and when the correct answer is provided by the student, it is reinforced with a statement or a signal of approval by the teacher with an indication that the operants has been strengthened so as to increase the reliability of their occurrence in future. It is important and very necessary that teachers use properly timed and spaced schedules of reinforcement. Moreover, in operant conditioning the student assumes an active and participative role in the learning situation (Skinner, 1998). This indicates that the student takes care of his or her learning and, therefore, it lies with him/her to produce the right response once the right stimulus is provided.

**Relationship of Behaviouristic Theory of learning to CAI**

Skinner‘s reinforcement theory is central to computerized learning; especially drill and practice and tutorial learning (Bigge & Shermis, 2004; Tabassum, 2004). In these computer-facilitated learning, students‘ behaviours are reinforced by being permitted to proceed to the next frame when they get the right answer (Bigge & Shermis, 2004).

Since Skinner believes that positive reinforcement should consistently follow each of the desired responses until the selected level of mastery is attained and that feedback should be immediate, drill and practice mode of CAI stick to this guideline. In drill and practice, the student receives immediate response to his activity. The student is allowed to progress or return to original task depending on his performance. Tabassum (2004) opined that Skinner illustrated how to develop programmed learning sequence which is being used directly to design tutorial modules. Some of the illustrations of Skinner indicated by Tabassum (2004) are as follows:

1. obtain a clear, detailed objective specification of what it means to know the given subject matter;

2. write a series of information, question and answer frame that expose students to the material in graded steps of increasing difficulty;

3. request the student to be active. Tjaden and Martin (1995) note that a major advantage of CAI is that, by necessity, it requires the student to be an active participant in the learning process. It is not possible for the student to be a passive observer because there must be an input to evoke a response when using the computer;

4. provide immediate feedback. Thus, Skinner agrees with the continuity principle, but emphasizes the importance of the immediacy of the reinforcement to follow the response (Tabassum, 2004);

5. permit students to proceed at their own pace.

The tutorial mode of CAI follows these illustrations. There should be clear objectives, materials should be presented in graded steps and the student is active during the learning process. Moreover, there should be immediate feedback to students and the students should be able and allowed to proceed at their own pace as far as tutorials are concerned.

Basically, it can be deduced that the use of CAI, especially in drill and practice and tutorials modes, is supported mostly by the behaviourist view of learning. This is due to the principle of practice and reinforcement. Therefore, it is important that, the developers of drill and practice and tutorials mostly incorporate this theory of learning in their programme.

**Effectiveness of CAI as a teaching and learning strategy**

Thomas (2001) has indicated that when a new technology appears on the market, various arguments are made to indicate how that technology will enhance learning. In the light of this, Tabassum (2004) indicates that advocates of CAI have high expectations for the computer as an instrument for identifying and meeting individual needs. Thus, since proponents of CAI argue that their mode of instruction improves student learning, many researches have been conducted to ascertain the truthfulness of this claim.

The outcomes of these researches indicate that CAI is not uniformly effective in that some studies show no significant differences in achievement between CAI and non-CAI students (Ornstein & Levine, 1993), especially those studies that compared CAI alone against conventional instruction (Cotton, 1991). However, it has been found out that student achievement increases when CAI is used in addition to or as a supplement to the conventional instruction (Hake, 1998; Okoro & Etukudo, 2001; Tabassum, 2004; Manochehri & Young; 2006; Sun, Lin & Yu, 2008).

**Computer-Assisted Instruction and Achievement**

The effect of CAI on achievement cannot be over-emphasized. As noted by Ornstein and Levine (1993), the effectiveness of CAI with regard to achievement is not uniform. This trend comes about as a result of how the CAI is applied (Lowe, 2001); whether on its own or as a supplement to conventional instruction. These studies indicate that CAI is capable of improving student achievement. Other studies also confirm these findings. More and Ralph (1992) completed a study on whether computer-based learning for a first-year biology class was superior or inferior to other modes. The student participants (184) were made up of 123 first-year, 41 sophomores, 7 juniors, 10 seniors, and 3 graduate students. One-half of the class was placed in a traditional hands-on laboratory for two hours per week and the other half was placed in a Macintosh computer laboratory to view courseware for the same period. The data showed that the group utilizing courseware for the laboratory component of the course did gain significantly in the change between pre-test and post-test performance although the courseware group had a lower mean score on the pre-test.

Tjaden and Martin (1995) studied the learning effects of computer-aided instruction on college students. They concluded that students need direction from and interaction with an instructor for introduction to topics and question and answer periods. The results of their study showed that 71% of the student participants preferred computer-aided instruction to a lecture. However, the two highest achievers and the two lowest achievers preferred the instructor for lecture and tutorial. These findings support earlier research by Hardiman and Williams (1990), Spencer, Steele and Quinn (1999) saying that both very bright and very poor academic students benefit from an instructor while the average student does just as well with alternative teaching methods (cited in Tjaden & Martin, 1995). This study seems to suggest that CAI is able to improve student achievement and performance.

In other researches aimed at buttressing the impact of CAI on performance across other disciplines, Brophy (as cited in Jenks & Springer, 2002) indicated that CAI is effective in science lessons. Kulik and Bangert-Drowns (1983) have found that CAI has the potential for improving student achievement scores in pre-college classes. Roberts and Madhere, 1990 (as cited in Jenks and Springer, 2002) stated that their findings indicated marginal successes in academic gains in reading and mathematics. In social studies settings, Stern and Repa (as cited in Jenks & Springer, 2002) showed that CAI was successfully used to teach social skills to teens enrolled in a behaviour modification programme. This implies that the benefit of CAI is not limited to only one subject area.

However, it should be noted that the discussion is never one-sided as Hajdukiewica (1991) studied the use of computer software to assist students who needed remedial mathematics. The study was part of Project Synergy: Software Report for Under-Represented Students, conducted at Miami-Dade Community College. Students in the computer-assisted experimental group showed significant gain scores between pre and post departmental tests. However, the study was designed loosely and several variables would have to be taken into consideration before forming any judgments. Delafuente, Araujo and Legg (1998) indicate that ‗exam scores for pharmacy calculations taught in a traditional lecture format are similar to exam scores for those students learning the same material by CAI'. Thus, there was no significant difference in final exam score between students taught by CAI and those by the traditional instruction.

Glickman (as cited by Jenks and Springer, 2002) also noted that though there was better concept understanding among students taught by CAI, there was no significant difference between such students and those taught by the traditional approach in terms of achievement after he had conducted a non-equivalent control group design study. Imhanlahimi and Imhanlahimi (2008) also found that the traditional method of instruction proved to be superior when compared to computer-assisted instruction. They further indicated that students that were taught through co-operative computer-assisted learning strategies outperformed their colleagues who were taught through individual computer-learning strategy. As Imhanlahimi and Imhanlahimi (2008) put it, the performance of the co-operative computer-assisted group was probably due to the opportunity they had to interact with themselves and ask questions in areas where they had learning difficulties. This review has shown that when CAI is used in isolation, that is, used to replace the teacher, the results are not uniform. While some studies seem to favour CAI, others also produce dissenting conclusions. Emmons (2008) assessing the situation came to the conclusion that research has failed to support any clear advantages of programmed instruction over traditional methods, pointing to mixed or inconsistent results and cases where successful completion of the programme did not impact on achievement. In view of this, Kulik and Bangert-Drown (1983) indicate that when CAI is used as a complete replacement for conventional teaching, its effectiveness may be seriously questioned.

They, therefore, warn that total reliance on the computer as a teacher seems to be one thing that school systems should avoid.

Taking position on these two extreme conclusions based on the impact of CAI on performance, analyzing 59 research reports, Cotton (1991) came to the conclusion that the single best-supported finding in the research literature is that the use of CAI as a supplement to traditional, teacher-directed instruction produces achievement effects superior to those obtained with traditional instruction used in isolation. This conclusion has been supported by many authors (Ornstein & Levine, 1993; Bontempi & Warden-Hazlewood, 2003; Tabassum, 2004).

Teaching using the traditional approach with CAI has been further shown to be the way to go. Akour (2008) found out that traditional approach plus computer-assisted instruction group performed better than their colleagues in the traditional approach only group after conducting a quasi-experimental study among college students in Jordan. Basturk (2005) also found out that students performed better in introductory statistics when they were taught through lecture plus CAI as compared to lecture only.

These seem to indicate that the best mode of CAI is when it is used to supplement the traditional teaching. This does not in any way mean that using only CAI is not feasible, since there is evidence that CAI only can improve performance (Goode, 1988; Ryan, 1991; Harrison, 1993). Moreover, this does not in any way suggest also that the traditional approach to teaching is ineffective, since in some studies there were no significant differences between CAI and traditional approach.

The question continues to be raised among educators about the importance of using technology as a teaching tool. Frey (1990) and Clark (2000) stressed the importance of computer literacy for college graduates entering the workforce and promoted computer experiences in every discipline and in every classroom. Ryan (1991) said that colleges need to make use of technology to prepare the future workforce in remedial reading and writing. It is therefore important that research is conducted to explore how CAI can effectively be used to improve the teaching and learning of protein synthesis.

**Performance of Students in Biology in Ghana**

Biology guides and inculcates in learners skills, knowledge and attitudes necessary for professions like medicine, pharmacy, dentistry and agriculture (Fraser, 2001). It is because of these essential functions of biology that Bibby (as cited in Shaibu & Olarewaju, 2007) called for biology education for every child in this contemporary world dominated by science. Great concern over low pass rate in the sciences (physics, chemistry and biology) in national examinations conducted by the West Africa Examination Council (WAEC) has been expressed. Ironically, statistics from Ghana Education Service (as cited in Anamuah-Mensah, 2007) indicate that about 20% of students in senior secondary schools participate in science stream class. To affirm this development, the Council‘s results on achievements of elective science students in the general science programme have consistently shown that percentage of elective science students who obtained credit passes in the science subjects are low (WAEC, 2002; 2003; 2004; 2005). Despite the uninspiring achievement of SHS elective science students in the sciences, it has been observed that percentage of credit passes for example, in biology from 1999 to 2005 have been below 50% (Anamuah-Mensah, 2007). For example, in 2002 out of 8,922 candidates who sat for the Biology paper, only 3,476 (39%) passed with grades A-D. In 2003 out of 9,581 candidates presented, only 3,772 (39.4%) obtained grades A-D. Also, in 2004 out of the 10,546 candidates, 5,051 (47.9%) passed with A-D, and in 2005 out of 14,176 candidates only 5,803 (40.7%) obtained grades A-D (Anamuah-Mensah, 2007; Anthony-Krueger, 2007).

Numerous reasons have been identified in the literature to be the underlying causes of the underachievement of SSS elective science students in biology. Some of these are that students see the subject as difficult, which, according Lakpini (2007), is influenced by their religious, social and cultural backgrounds. Soyinbo, Eke and Ato (as cited in Shaibu and Olarewaju, 2007) indicate that misconceptions students hold about some of the biology topics, such as genetics and evolution, also affect their understanding of the subject. Mucherah (2008) observes that some SHS elective science students also perceive biology as a subject that involves so much reading which makes it difficult for them. Poor teaching methods employed by some SHS biology teachers in the teaching of the subject also influence students' achievements in the subject (Mucherah, 2008). Furthermore, inadequate laboratory-based biology practical work to link theory with practice has also been reported in the literature to affect students' learning outcomes in the subject (Anthony-Krueger, 2007). Large class sizes and SHS students' biology classroom environments have all been reported to have a strong association with SHS students‘ achievement in biology (Myint & Goh, 2001; Chui-Seng, 2004; Mucherah, 2008).

In Kenya, for example, a study conducted has revealed that achievements in national school examinations were influenced by the kind of school one attended, and the availability of resources in the school (Mucherah, 2008). This is not very different in Ghana, where achievements of SHS elective science students in biology appear to be determined by the kind of school one attends. This is because results released by the West Africa Examinations Council in biology have consistently indicated that schools well equipped in terms of science laboratories, textbooks, and qualified science teachers tend to generally, produce better results while poorly equipped schools perform poorly in the subject (Addae-Mensah, 2003). It is, therefore important, to determine the students‘ learning styles, general attitude towards biology and interest in the subject and how the aforementioned variables affect their performance through the use of CAI.

**Students' Attitude towards Biology**

Attitudes toward science represent ~~a~~ person‘s positive or negative response to the enterprise of science. Put in another way, they refer specifically to whether a person likes or dislikes science. Educational studies have produced mixed results but tend to show that attitudes affect students‘ persistence and performance (Schommer, 1994). Modest positive correlations between science attitude and science achievement have been reported in many studies (Keeves & Morganstern, 1992; Dhindsa & Chung, 2003; Osborne, Simpson, & Collins, 2003). These studies have focused greatly on science in general

(Dawson, 2000) with little attention paid to particular disciplines like biology, physics or chemistry (Salta & Tzougraki, 2004). According to Freedman (1997), scientific attitude has a predominant cognitive orientation whereas attitude toward science is predominantly affective. This could present a tainted picture of students‘ attitude towards a particular science subject (Spall, 2004). The focus of this study is not toward scientific attitudes but on the attitude (learning skills, self-efficacy and interest) towards biology (and specifically protein synthesis) which is one of the sciences anyway. Only a few attitudes towards biology inventories have focused specifically on students‘ attitudes or perceptions toward the subject (Dalgety, Coll, & Jones, 2003; Kitchen, Reeve, Bell, Sudweeks & Bradshaw, 2007).

In data collected from 655 senior high school students in Slovakia, Prokop, Tuncer and Chuda (2007) have reported that gender influence students‘ attitudes toward biology. Their report indicates that more males perceive biology as a difficult school subject than females. The above findings is extremely consistent with that of Baram-Tsabari and Yarden (2005) who reported that male secondary school students in Tanzania see biology as a more difficult school subject than female students. Prokop, Tuncer and Chuda, (2007) also found that senior secondary school students‘ attitudes toward biology was influenced by the teacher and the learning environment.

In Ghana, Yidana (2004) has reported that male senior secondary school students see biology as a difficult school subject as compared with females who see biology as not difficult. He also reported that male secondary school students‘ attitude towards biology was influenced by their social backgrounds and the pedagogical strategies employed by their biology teachers in the classroom.

Generally, it appears from the literature that, studies that have investigated students‘ attitudes towards biology have concentrated on gender differences with little information on whole class students‘ attitudes towards the subject and ways of improving it through CAI. This study therefore pays attention to this gap in the literature.

**Misconceptions to Understanding Biology**

Students come to school with varying experience with ideas about and explanation of the natural world. The scope of these ideas is as diverse as the students' backgrounds and they are often different from those of scientists (Lewis, Leach & Wood-Robinson, 2000). Some words in biology are used in an alternative way in daily life; for this reason, some misconceptions may arise from the use of words that mean one thing in everyday life and another in a scientific context such as food, respiration, and population. Misconceptions may originate from certain experiences that are commonly shared by many students (Erdmann, 2001). Some of them rooted in everyday experiences. Concepts like source of plant food, respiration in plants, genetics and classification belong to this category. For instance, in our society there is a common belief that every fin marine animal is a fish. For example, whales are regarded as fishes and not mammals. As Bell (1985) has suggest in one of his studies, the words 'energy' and 'food' are often used in everyday sense of being 'energetic' and needing 'to stay alive' and 'be healthy'

Misconceptions also arise when students combine newly learned concepts (for example, plants make their own food) with their previously held, more primitive concept (plants get their food from soil). Such situation creates conceptual conflict in the students' mind.

Fisher (1985) has observed that a significant number of students have the mistaken notion that amino acids are produced by translation. He went on to further assert that, as students study protein synthesis, they learn that each codon specifies an amino acid and that amino acids are involved in translation. They also learn that various enzymes, such as aminoacyl-tRNA synthetase, play roles in protein synthesis. Some students have difficulty understanding which of the molecules involved in translation of the products of protein synthesis are also produced. These students may think that amino acids—but not enzymes involved in protein synthesis—are produced by translation.

Several studies have investigated students' understanding of biological concepts in different countries: genetics (Lewis, Leach, & Wood-Robinson, 2000; Pash1ey, 1994), cell (Dreyfus, & Jungwirth, 1988), photosynthesis (Bell, 1985; Haslam, & Treagust, 1987; Waheed, & Lucas, 1992), the circulatory system (Yip,1998), ecology (Griffiths & Grant, 1985; Munson, 1994), vertebrate and invertebrate (Braund, 1998) respiration (Sanders,1993), classification (Trowbridge & Mintzes, 1988), and energy (Boyes & Stanisstreet, 1991). These studies showed that the majority of students leave secondary school with a distorted view of biological objects and events. Many of these topics about which students hold misconceptions are basic to biology knowledge and much interrelated.

It has been also shown that teachers could have played a role in the formation of misconceptions held by their students (Sanders, 1993; Yip, 1998). These studies indicated that misconceptions passed from teachers through wrong or inaccurate teaching.

Furthermore, Sanders (1993) suggested that assessment strategies used by biology teachers could be a factor influencing the development of misconceptions in their students. Sanders (1993) opines that teachers should not only assess to get mark for the pupils but also need to listen to what their students tell them, as it can provide information about students' understanding or lack thereof. This means that students' require constant feedback about their correct and incorrect ideas. Recently, Mintzes, Wandersee and Novak (2001) suggested several new assessment strategies that encourage meaningful learning and conceptual understanding in the biological science. Among the suggested remedies are concept maps, V diagrams, clinical interviews, portfolios and conceptual diagnostic tests.

Another factor that contributes occurrence of misconceptions by students is textbooks, which include many errors and incorrect information (Storey, 1991, 1992). Many concepts in biology are interrelated and they are key to understanding other concepts. Therefore, not only lack of integration among topics but also inappropriate presentation of topics in textbooks influence students' further understanding. For example, without the understanding of cell biology, the concepts of protein synthesis and genetics are meaningless to students. Also, applying the lack of understanding to photosynthesis, the concepts of food chain and food web are meaningless to students among others.

It can be said that students hold misconceptions that are developed before and during their school years, and these misconceptions may be compounded by daily life experience, use of everyday language in a scientific context, compartmentalization of concepts, teaching strategies, and textbooks. All these factors seem to not only result in rote learning and the compartmentalization of ideas, but also defeat the aim of the biology syllabus to promote meaningful learning. To review the possible source of misconceptions in the teaching and learning of protein synthesis, the question can be asked on how the study will take into consideration the conceptual development. This can be promoted by classroom instruction that avoids excessive factual details, establishes meaningful connection between new and existing concepts, and takes into consideration students' prior knowledge through the use of CAI.

**Cooperative Learning in Biology**

Cooperative learning is not a new concept. It has endured as an important way of learning in some cultures for generations (Swisher, 1990; Haynes & Gebreyesus, 1992; Jagers, 1992). During the past years evidence has accumulated on the effectiveness of cooperative learning in classrooms from preschool to college and beyond, in a wide variety of disciplines. Cooperative learning methods have been applied in the physical sciences (Smith, Hinckley, &Volk, 1991), mathematics (Duren & Cherrington, 1992), and biology (Lazarowitz, Hertz, Baird, and Bowlden, 1988), as well as in the social sciences (Lambiotte, Dansereau, Rocklin, Fletcher, Hythecker, Larson, & O'Donnell, 1987) and humanities (Barratt, 1992).

The value of cooperative learning as an educational tool lies in both its effective and cognitive impacts. For many students, the feelings of self-confidence and self-esteem they gain from learning cooperatively with their fellow students may be as important to their education as the specific knowledge they attain.

Among the many studies that measure the effects of cooperative leaning in biology, there is wide variation in quality, with some succumbing to the pitfalls of research involving human subjects, including small sample size, lack of random distribution and assignment to test conditions of students and teachers, and built-in bias in training teachers and teaching the material. However, several good studies have shown that cooperative learning methods are effective for learning certain types of biological concepts. Lazarowitz, Hertz, Baird, and Bowlden (1988) have found that high school students in a cooperative classroom spend more time focusing on their assignment and achieved at a higher level in a cellular biology unit that demanded inquiry and high-level thinking than did students in a traditional competitive classroom. At the same time, students in the competitive classroom did better in a plant morphology and anatomy unit that required more observation and information gathering (Lazarowitz *et al*.)

In studies of middle-school biology students in Nigeria, in which the teachers were randomly assigned, carefully trained, and observed during the course of their teaching, results show that students who preferred cooperative learning benefited most from it (Okebukola, 1986b, 1992); that cooperative learning is a powerful way to help students develop favorable attitudes toward lab work (Okebukola, 1986a); and that although students in a competitive environment were best at learning practical laboratory skills, those in a cooperative learning environment scored higher on cognitive achievement tests in science (Okebukola & Ogunniyi, 1984).

There is close affinity and links between cooperative learning and technology in that, cooperative learning and technology (such as computer simulations) are natural partners (Millis & Cottell, 1998). This is because, as Yusuf and Afolabi (2010) asserts, the use of technology involves human dimensions of caring, community and commitment. In effect, using technology in ways that promote sequenced learning within groups can lead to more in-depth processing of course content and, hence, more retention of information (Newberry, 1999). It is evident that technology can be used to enhance and encourage cooperative learning in our schools through small groups using a single computer, network-based instructional programmes or collaborative projects on the internet (Barron & Orwig, 1997).

The work of these and other researchers points to the benefit of using cooperative learning in many classroom settings in biology. In addition to promoting academic achievement, cooperative learning has considerable value in affecting students' attitudes toward the subject matter and themselves. This cannot be overlooked as search for new ways to make biology more accessible to all students who perceive the science classroom to be an alien and unwelcoming place.

**Teacher Quality and Effectiveness, and Biology Learning**

There is no gain saying about the fact that biology occupies a very sensitive position in medical science and related disciplines. This informs several efforts geared toward studying biology at a secondary level of education. Ferguson (1992) concluded from his research in Ghana that ―Good teachers have distinguishable impacts on students examination score". Sanders (1993) and Wenglisky (2002) found that the simple largest factor affecting academic growth of population of students is differences in effectiveness of individual classroom teachers. Wenglisky (2002) propounded that the higher a teacher is qualified, the higher his or her level education in the teaching profession.

Teacher attitude has been cited by several studies as an important determinant in attitude formation (Anderson, 2006). These attitudes include the use of instructional materials and teaching methods. The use of instructional materials in the teaching process is less stressful for both teacher and students (learners). A study by Akinyemi and Orukota (1995) revealed that the performance of Nigeria students in Ordinary Level Biology was generally poor. This was attributed to many factors of teaching, of which teaching aids were considered as an important factor. Jegede, Okota and Eniayelu (1992) has reported that factors responsible for students' poor performance in science, technology and mathematics are poor laboratory facilities, inappropriate teaching methods and inadequate numbers of learning facilities in schools as against consistent increase in the number of students. Omosewo (1980) and Bassey (2005) considered human factors as the teacher's professional commitment, creativity, mechanical skills, initiative and resourcefulness.

Teachers' personality have also been identified as the most reason for students' like and dislike for a subject, since students attitude towards science-related aspects is significantly influenced by how they perceive their science teacher. To determine teacher quality, Goe (2008) identified four indicators. These include teacher qualifications, teacher characteristics, teacher practices and teacher effectiveness. Goe (2008) discerned that subject-matter knowledge and teacher experience matters in determination of teacher quality. There is a correlation existing between the achievement of senior high school students and their teachers subject-area expertise than exist between the success of younger students and their subject teacher‘s subject knowledge. Several studies indicate that teacher completion of an undergraduate or graduate major in for example, mathematics correlates with higher students‘ achievement in high school (Aaronson, Barrow & Sanders, 2003; Frome, Lasater & Cooney, 2005). Wenglisky (2002), identify similar trend in science. Regardless of the fact that researches have shown that there are no meaningful differences between more and less experienced teachers (Gallagher, 2004; Carr, 2006). Experience holds sway in everyday life. Teaching is of no exception and, to a larger extent, can influence a lot in academic endeavours. Relatively, experience can go hand in hand with the climate that exists in a school. An experienced teacher in a well-resourced school will have students performing academically better than the same teacher with less resourced school.

Goe (2008) observes that some teachers may contribute to overall student achievement gains by virtue of the collegiality, leadership ability or impact on school culture. Such practice covertly or overtly do appear to benefit schools and may play an important, if not unseen, role in students‘ success.

A variety of factors may contribute in enhancing the quality of the teacher, which, in effect as espoused earlier, can affect students‘ attitude and performance in science. Those factors include, the school climate within which the teacher operates, workload on the teacher, motivational packages, provision of effective leadership from Head of school- which research has shown that schools where Heads are effective instructional leaders have improved achievement- (DuFour, 1999), and professional development.

# CHAPTER THREE

# METHODOLOGY

## Overview

This Chapter describes the methodology used to carry out the study. The chapter describes the following: Research Design for the Study, Research Population, Sample and Sampling Technique, Research Instruments, Validity of the Instruments, The reliability of Instrument, Data Collection Procedure and Data Analyses Procedure.

## Research Design

Gay (1992) notes that research design indicates the basic structure of a study, the nature of the hypothesis and the variables involved in the study. The design thus indicates whether there is an intervention and what the intervention is, the nature of comparisons to be made, the method to be used, the timing and frequency of data collection, the setting in which the data collection is to take place and the nature of communication with subjects. In a nutshell, research design spells out the basic strategies that a researcher adopts to develop information that is accurate and interpretable.

This study is an action research which aims at improving students' performance in the teaching and learning of protein synthesis. Action research was chosen because it is a natural part of teaching. During this process, teachers are continually observing students, collecting data and changing practices to improve student learning and the classroom and school environment. Action research provides a framework that guides the energies of teachers toward a better understanding of why, when, and how students become better learners (Miller, 2007). This study was carried out in three major phases. The first phase consisted of pre-intervention activities, the second phase was the implementation of intervention and the third phase was the post-intervention activities. Figure 1 shows the systematic approach of which the study was carried out. The study began with a week‘s revision of some concepts learnt in the previous term. This was followed by analysis of students‘ workbooks in the classroom. Lesson plans were then developed and used in teaching students the concepts of protein synthesis for six weeks and, at the end of each week, students were made to take an essay-type test. Students‘ performance in class was monitored.

**Pre-intervention**

This phase consisted of two activities which were done to ascertain the level of students‘ performance and understanding of concepts in protein synthesis. The first activity was the revision of some of the concepts learnt in the previous term. These concepts included base pairs, nucleotides, types of RNA, DNA replication, transcription, special codes, codons, anti-codons, translation, base-pairing rule, DNA and RNA polymerases. The lesson took place in the first week of the study with most of the learning activities being oral interactions of the researcher with the students. They were made to explain the concepts of protein synthesis and state the rules associated with the concept. They were also made to write the detailed base-pairing using the rules. Students were asked to describe the structure of the DNA and RNA and how they were discovered. At the end of the second week, the second activity was carried out. The researcher examined teacher‘s note book and students‘ workbooks. The teacher‘s note book was examined to verify if the teacher had taught the students with or without preparing scheme of work and lesson plans and also if lessons were guided by instructional objectives. Students‘ workbooks were examined to check if students were given enough projects on the topics treated, if they did enough tests, assignments and class exercises in the previous term. Data on these two pre-intervention activities are presented in Chapter Four.

**Intervention**

Weekly lesson plans were developed with respect to the senior high school curriculum for second term. According to the biology syllabus for senior high schools in Ghana, students were supposed to learn protein synthesis in the second term of the second year, currently, but, previously, same term of third year of the 4-year SHS syllabus. Therefore, teaching and learning activities using the CAI about cell biology and specifically protein synthesis were developed systematically specifying the instructional objectives to be achieved each week. The lesson plans incorporated the test items to be administered for the week. Samples of weekly lesson plans prepared can be found in Appendix D. The lesson began with Description of Watson-Crick Model of DNA.

The lesson dealt with the introduction of DNA as a genetic base. This was to identify the various molecules making up the DNA molecules. The students were taken through the structure of basic units of nucleic acids-nucleotides, description of DNA and RNA and the differences between DNA and RNA. During the lesson various media and 3-D animation of guides on the base-pairing rule was shown to students. Students were made to practice using the practice questions that the CAI had.

Replication of DNA was taught in second week. The main aim of this lesson was to guide students to identify the usefulness of DNA replication as in other processes like interphase stage in cell division. This was also meant to enhance the students understanding of the term semi-conservative replication. Using the CAI provided an audio-visual perspective of the concept. At the end of the week, a class test was conducted to test the ability of students to explain basic concepts taught in previous weeks.

Transcription was taught in the sixth week. Transcription is mechanism by which the base sequence of DNA representing a gene is converted into the complementary base sequence of mRNA. This lesson therefore, dealt with the formation of m-RNA which carries instruction from only a very short section of the DNA molecule. The mechanism of unwinding and unzipping of the double helix to expose single strands with the breakage of relatively weak hydrogen bonds between the complementary bases of the two strands is emphasized. The use of CAI guided the students to describe the various processes involved in the formation of RNA.

The constructed essay-tests were administered to the students at the end of each week and the multiple-choice types were carried out at mid-weeks. The duration of each test was thirty minutes. The tests were marked and distributed to students before the next lesson. Descriptive feedbacks were provided on each wrong response provided by the students. This was done to enable students identify specific strengths and areas needing improvement. General discussions on the feedback of the tests were done after the distribution of the marked scripts to students. Students‘ weaknesses and misrepresentation of concepts showing less knowledge and understanding of concepts treated in the classroom were addressed.

**Post-intervention**

This phase of the study involved monitoring the effects of the intervention strategies on the students‘ learning and evaluation of the intervention strategies. This was done by monitoring students‘ work outputs at the end of each week. Students‘ outputs were monitored by the researcher based on their responses to the questions in the weekly tests as well as during lessons. Test items which were used in the weekly tests were constructed based on the activities and concepts which were treated within the week and the previous weeks. The test items consisted of essay and multiple-choice type questions. Essay type test was chosen because they are different from other constructed response items; they require more systematic and in-depth thinking. Essay type tests measures complicated learning outcomes and also emphasizes on the integration and application of thinking and problem solving skills (Reiner, Bothell, & Sudweeks, 2003). Multiple choice test items were used because of their applicability in measuring higher-level objectives, such as those based in comprehension, application and analysis (Osterlind, 2005).

To determine the performance of students, three Protein Synthesis Achievement Tests (PSAT) and class exercises were conducted during the period after teaching the topic with CAI. The PSAT was marked and 1mark awarded for a correct answer and 0 for a wrong answer in all cases.

Their responses were marked based on the following criteria: whether they were related to the questions asked and whether they were with explanations and reflected understanding of concepts learnt. The findings from the observations were used to modify and adjust the interventional strategies to achieve the desired learning outcomes (Fig.1). Results from this activity served as a basis for evaluating the performance of students and the intervention strategies used.

**Phase I**

Pre-intervention

1. Revision of some concepts on protein synthesis learnt in previous term with students

2, Examining teacher‘s note book and students‘ workbooks and ascertain areas of remedies.

**Phase II**

Intervention

1. Development of lesson plans

2. Development of CAI for teaching protein synthesis

3. Teaching with MS PowerPoint and CAI

4. Conducting weekly tests

i) Asking of probing questions

ii) Marking and provision of appropriate feedback

iii) Quick feedback on tests

iv) Sessions to discuss feedback with students

**Phase III**

Post-Intervention

1. Monitoring of students‘ outputs after using CAI

2. Critical evaluation of intervention strategies

**Figure 1: The Design of the Study**

**Study Area**

The study area was purposively chosen to reflect the problem being faced by biology students in the school. Swedru Senior High School, in terms of governance, is under the Agona East District, but, traditionally, recognised as part of Agona West Municipal; its location represents urban, semi-urban and rural settlements (Fig. 2). Agona West Municipal has urban settlements though it also has a few rural communities. However, as an urban community, it has several social amenities such as the community library, fast connection internet cafes and a science resource centre. All these give its inhabitants a comparative learning advantage. Agona East, is a newly created and very deprived District. Agona East, however, has had some reasonable interventions to motivate students to learn. For instance, several Non-governmental Organisations (NGOs) working in the district have instituted scholarship packages for needy students who are willing to be educated, and for those who perform well. Two of such Non-government Organisations are Plan International and Compassion. Besides, the Agona East District has a community library and situated at the capital town, Agona Nsaba, where the children have access to reading books. However, the Agona East District can boast of a high number of role models in the area such as some former members of parliament, members of the intelligentsia and former District Chief Executives. It is worth noting that this district still enjoys support from the Agona West Municipal Assembly in terms of books for the schools and general logistics to support teaching and learning.

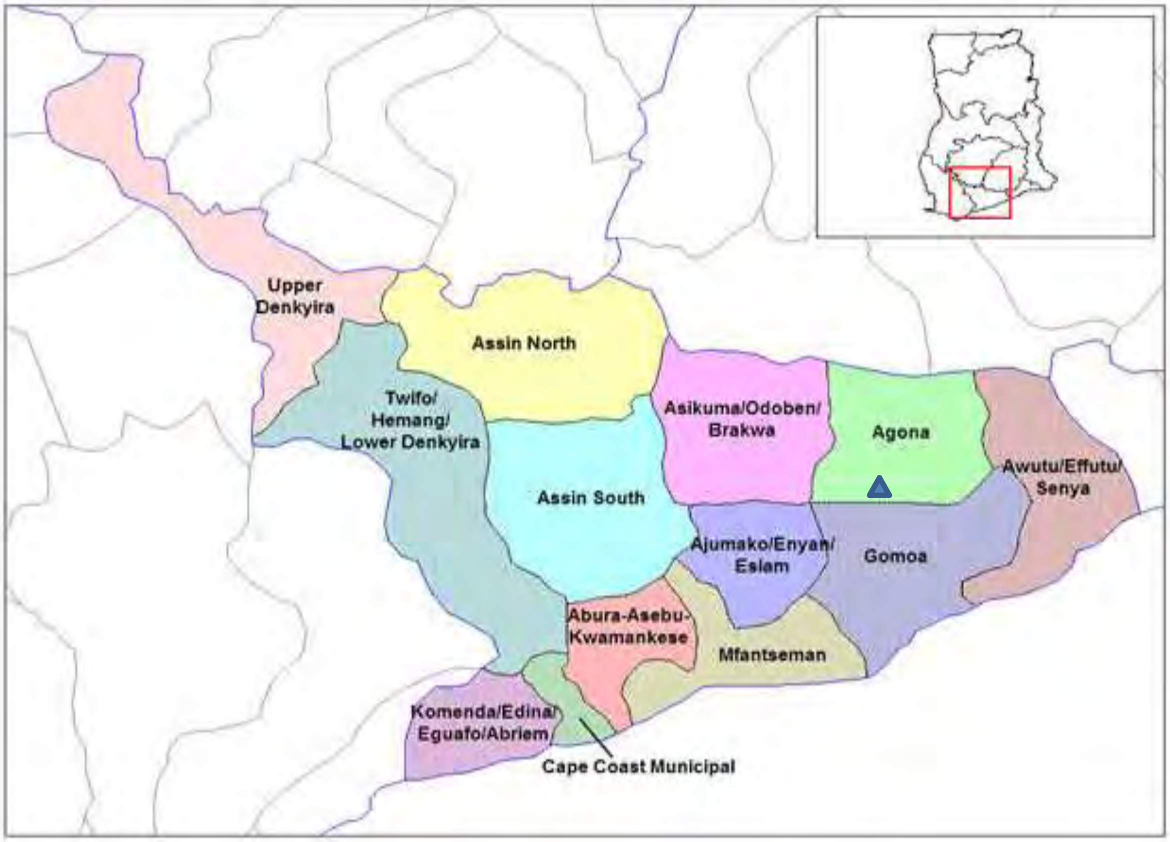


**Fig. 2: Map of Central Region of Ghana showing the location of the study area.**

**Key: Location of the Study**

Swedru Senior High School

**Population**

Castillo (2009) opines that, a research population is a large well-defined collection of individuals or objects having similar characteristics. Castillo further distinguished between two types of population: the target population and the accessible population. The target population which is also known as the theoretical population refers to the group of individuals to which researchers are interested in generalizing the conclusions. Whilst the accessible population, which is also known as the study population, is the population in research to which the researchers can apply their conclusions.

The target population for this study was all students at Swedru Senior High School in the Agona West Municipality, Agona Swedru in the Central Region of the Republic of Ghana. The sample is a representation of the whole population of Swedru Senior High School students in the study area.

However, the accessible population was all form two biology students in Swedru Senior High School. This school was chosen due to availability of science teaching materials in the school and its status as a science resource centre. Beside these, it was also selected due to its proximity to the researcher and the willingness of the Science Department and the school to accept the study.

**Sample and Sampling Technique**

A sample is a finite part of a statistical population whose attributes are studied to gain information about the larger population (Webster, 1985). According to Castillo (2009), sampling techniques are the strategies applied by researchers during the sampling process. The sample for the study was a class of second year biology students of Swedru Senior High School. Second year biology students were chosen through purposive sampling technique. The students were chosen because they had done at least a full year‘s course in biology; they were not new in the school and were not under pressure to write any external examination. They had also been introduced to some basic scientific concepts in year one, and at least some basic concepts in biology in the first term. These classes were also purposely chosen because of fair representation of both boys and girls in the class. The total sample size was ninety students. The class comprised of 31 girls and 59 boys.

**Data Collecting Instruments**

A questionnaire was used to collect the data for the study. It is appropriate to use a questionnaire for the collection of data when a large scale research involving a literate population is concerned.

It is probably the most common method used in educational research and is also more familiar to respondents (Muijs, 2004). However, the disadvantages are that they often have low response rates, time-consuming follow-up and data entry. In addition, questionnaire cannot probe deeply into respondents‘ opinions and feelings (Muijs, 2004).

As observed by Van Dalen (2009), a researcher may cast questions in a closed, open, or any combination of these forms. A close ended questionnaire was used. This is because, according to Wilson and Mclean (1994), closed questions in general are quick to complete and straight forward to code (e.g. for computer analysis) and do not discriminate unduly on the basis of how articulate the respondents are. Forty items were constructed with at least ten items on each issue under investigation. All the items were presented with indicated number of options for the item. This was deliberately done to enable respondents choose appropriate options. The questionnaire was designed to bring out from students what actually informed their attitudes towards the teaching and learning of protein synthesis before and after using the CAI.

In addition, the study used qualitative and quantitative data gathering instruments. These were students‘ learning progress tracking sheet and teaching and learning record sheet.

**Students’ Learning Progress Monitoring Sheet**

The purpose of this form was to collect information on students‘ performance in the pre-intervention exercise and the weekly classroom tests using the CAI. The data collected were used to assess the performance of students from the beginning of the study till the end of the implementation of the intervention. This form consisted of criteria on which students‘ responses to questions in the pre-intervention exercise and weekly tests were examined. Students‘ responses to questions were assessed as to whether they related to the questions asked, included explanations, described the situation demanded by the questions and reflected understanding of the concepts learnt. (Appendix H).

**Teaching and Learning Record Sheet**

This form was designed purposely to record data from subject teacher‘s note book, use of CAI as well as students‘ work books in the previous term. The data which was recorded included scheme of work, lesson plan, instructional objectives, teaching and learning activities, printouts of exercises from self-help tests from CAI and the evaluation exercises. A number of class tests done; home works carried out and project work done for the previous term were all included. (Appendix I)

## Validity of Instruments

As Ary, Jacobs and Razavieh (2002) maintain issues of reliability and validity are important in both qualitative and quantitative research. According to Cohen, Manion and Morrison (2001), reliability refers to the consistency of test scores. A reliable test yields the same or close to the same score for a person each time it is administered. In addition, alternate forms of the test should produce similar results. Validity on the other hand is the extent to which a test predicts what it is designed to predict.

The instrument was submitted to the supervisor for his comments and these were used. He offered some suggestions/modification which improved the face validity of the instrument. The face validity of students' learning progress tracking sheet and teaching and learning record sheet were assessed by two senior lecturers in the University of Education, Winneba who have rich experience in research assessment and evaluation.

## Reliability of Instruments

For high reliability, the instruments were pilot tested. Pilot study is the most effective strategy to minimize problems in the actual conduct of the study (Muijs, 2004).

A reliability test was conducted by subjecting the instruments to the Cronbach's Alpha test of reliability. This is because Cronbach Alpha is a much more general form of internal consistency than the other forms of test of reliability. An instrument with a coefficient of reliability of 0.7 and above is however, considered to offer reasonable reliability for research purposes in education (Gall, Borg & Gall, 1996; Muijs, 2004). The reliability coefficients ranged from 0.838 - 0.842 for the questionnaire and 0.77 for Protein synthesis Achievement Test. The alpha coefficients were computed independently using a statistical software (SPSS) for the four components of constructs of attitude namely: learning strategies employed by students in protein synthesis, self-efficacy level of students, misconceptions and students‘ attribution of interest in protein synthesis scales. Each of the constructs yielded values of r= 0.674, 0.707, 0.704 and 0.687 respectively.

**Data Collection Procedure**

As Weller and Romney (2008) posits, data collection is the process in which data of a study is gathered. Data for this study was collected in three stages. The first stage was the collection of teaching and assessments information from the teacher‘s note book and students‘ workbooks. The teacher‘s note book was examined to ascertain the contents of his lessons preparation whilst students‘ workbooks were examined to find out kinds and frequency of tasks performed in the previous term. Data from these activities were collected with the use of teaching and learning documents record form. The second stage involved data on the pre-intervention exercise. Before the implementation of the intervention, concepts learnt by students in the previous term were revised and, at the end of the revision, students were made to answer four essay-type questions in their work books. This pre-intervention exercise was marked and data was collected with the use of students‘ learning progress monitoring form.

The final stage involved data on students' outputs in the mid-weekly and weekly tests. After the pre-intervention exercise, students were introduced to the intervention weekly lessons and tests using the CAI. Students were made to understand that the weekly tests were to help them learn and improve their understanding of the concepts they were about to do in the term. Students were taught for six weeks and at the end of each mid-week and week, multiple choice (using the CAI) and essay-types test were administered to them. The tests were marked and data collected on students' responses to each test item were recorded with the use of students' learning progress monitoring sheet.

**Data Analysis**

Data analysis is the process of converting raw data collected into usable information (Statistics Canada, 1998). This study employed both qualitative and quantitative methods of data analysis. Data from pre-intervention exercise and students' outputs in the weekly tests were analyzed qualitatively or quantitatively. Students' responses to questions in pre-intervention exercise and in the weekly tests were analyzed to assess whether they reflected understanding of the concepts learnt. Therefore, answers with correct explanations and examples showing application of principles learnt were grouped as _applicable to concepts' (A). Responses that were related to questions but with incorrect explanations, together with wrong answers were classified as _non-applicable (NA). Students were expected to include explanations in the answers they provide in the tests. Therefore, responses that included explanation were classified as _with explanation' (WE) and those without explanation were classified as _no explanation' (NE). The results from these analyses were expressed in percentages and tabulated with samples of students‘ responses to the test questions. Data from students‘ workbooks and teacher‘s notebook were further analysed. Given the multi-method nature of the study, various methods of data analysis were used. To answer the research questions, a descriptive analysis using simple percentages was used. Mainly, mean values of the performance of students in the assessment and pool of responses on attitudes were determined. Each attribute item is compared with the performance of students and analysed. Bivariate correlation was also computed to determine the significance of the variations that occurred. In order to explain the effect size, the coefficient of determinant $r^2$ was computed.

All the statistics used in this research were obtained using the Statistical Package for Social Science (SPSS) for windows up to version 18.0 software.

# CHAPTER FOUR

# RESULTS

## Overview

This chapter presents the results of the study on the performance of SHS2 science students of Swedru Senior High School in the teaching and learning of protein synthesis before and after using CAI. In an effort to achieve this aim, responses from students based on four attitude scales (learning strategies/skills, self-belief in protein synthesis, misconceptions in protein synthesis and attribution of interest in learning protein synthesis) were analysed.

The mean scores of performance in the Protein Synthesis Achievement Tests (PSAT) were correlated with mean scores of students‘ learning skill, self-beliefs and students attribution of interest in protein synthesis to determine if there was any effect of students‘ attitude on their achievement in the topic. The mean attitude score of each student‘s responses to each of the attitude scale were also determined. The mean score of performance of each student‘s achievement in the Protein Synthesis Achievement Tests (PSAT) were also determined. The results obtained were used to draw up eight weeks of lessons using CAI to teach the students after which the mean scores of the test they took were analysed.

## Relationship between students’ learning skills and their achievement in protein synthesis.

One of the objectives of the study was to find out the relationship between students‘ learning skills and their achievement in protein synthesis. To address this objective, the research question: What is the relationship between students‘ learning skills and their achievement in protein synthesis?‘was posed. To answer this question, students were asked to answer questions on the learning strategies they employed in the learning of protein synthesis. The students had the option of answering from a five-point Likert scale from Strongly Disagree to Strongly Agree (Appendix A). Statements associated with the factor identified had subscales, as ―the understanding of topics" (derived from items 3, 7, 8, 12 13 and 14), ―learning practices" (derived from items 1, 2, 4, 5, 9, 10, 14, 15, and 16), ―preparation for test" (derived from items 6 and 11) and ―linking of ideas learnt" (derived from items 17, 18, 19, and 20). Four variables, ―understanding," ―practices," ―preparation" and ―linking" were defined on the basis of the results of the factor analysis. Cronbach‘s alpha was determined for each of them and the values obtained are presented in Table 4.1. The relative low value of Cronbach‘s alpha for the subscales is considered to be satisfactory as it is due to the fact that reliability coefficients explain a minor rate of variance.

To determine the learning strategies used by students in protein synthesis, a descriptive statistics of students‘ responses showed a mean score ranging from 2.10±0.05–2.43±0.04 across the four subscales that were analysed. Results presented in Table 4.2 show that students disagreed that they understood topics taught in integrated science. On their practices, students disagreed that they had good learning practices (mean score =2.30±0.04)

Students strongly disagreed that they learnt hard in protein synthesis because they wanted to do well in protein synthesis test. This was indicative of the low mean score (2.43±0.04) for students that disagreed to this assertion. Many students disagreed that they linked ideas by thinking of their own ideas covered, linked new ideas with already existing ones by drawing diagrams and jotting down ideas (mean score=2.10±0.05).

**Table 4.1: Reliability Coefficients of Subscales**

| Subscales | Reliability coefficients |
|---|---|
| Understanding | 0.253 |
| Practices | 0.425 |
| Preparation | 0.380 |
| Linking | 0.560 |

A pool of students' responses on their learning strategies used in protein synthesis showed a negative response (mean score =2.35±0.03); that is, students' studied had a negative approach to the learning protein synthesis.

**Table 4.2: Scores of Students' Responses on their Learning Strategies**

| Subscale | Mean Score±1SE |
|---|---|
| Understanding | 2.48±0.03 |
| Practices | 2.30±0.04 |
| Preparation | 2.00±0.02 |
| Connection | 2.18±0.02 |

To determine the performance of students, three Protein Synthesis Achievement Tests (PSAT) and class exercises were conducted during the period after teaching the topic without CAI. The PSAT was marked and 1mark awarded for a correct answer and 0 for a wrong answer in all cases.

In order to determine the performance of students‘ in the achievement tests and class exercises, the means score across the sample was determined. The mean scores of the performance in the exercises across the sampled areas showed significant variations between the three trials (Table 4.3). This shows that the mean scores improved with sequence tests.

**Table 4.3: Mean scores of students in PSAT across the three trials**

| Trials | n | Mean Score ±1SE |
|---|---|---|
| 1 | 90 | 31.86 ±0.88 |
| 2 | 90 | 37.17 ± 0.82 |
| 3 | 90 | 40.86 ±0.76 |

In order to determine and obtain a relationship between students‘ learning skill and achievement in protein synthesis, twenty items were formulated and each respondent‘s learning skills was determined by determining their mean score. A mean value less than 2.5 was taken as poor (negative attitudes) learning skill while a score 2.5 was an indication of good (positive attitudes) learning skill. A bivariate correlation analysis between students�goes learning skills and their performance in the Protein Synthesis Achievement Tests and class exercises was as well conducted.

Twenty five students (27.8% of respondents) showed positive attitudes in learning. Sixty-five students (72.2% of respondents) had negative attitudes towards learning of protein synthesis. A bivariate analysis between students‘ learning skills and their performance in the protein synthesis tasks showed that there was no significant relationship between learning skill and performance (r=-0.046). It, therefore, suggests that learning skill, as it stands, may not affect the performance of students in protein synthesis.

**Students' self-belief in learning of protein synthesis and their performance in the subject.**

The question: ‗Is there a significant difference between students‘ self-belief on science learning and students‘ performance in protein synthesis?" was posed. Eleven items were formulated and each respondent‘s self-belief was determined by determining their mean score. A mean score of 2.5 or less was taken as a low self-efficacy while a score above 2.5 was an indication of high self-efficacy.

Twenty six students (29.2% of respondents) showed high self-efficacy (mean score 2.65-3.64). Sixty four students (70.8% of respondents) had low self-efficacy as indicated in Table 4.4. A pool of students‘ responses on their self-efficacy level with regards to protein synthesis showed a low self-efficacy (mean score =2.46±0.03).

**Table 4.4: Proportion of Students with High and Low self-efficacy**

| Self-efficacy | % Frequency | Mean±1SE |
|---|---|---|
| High | 22.5 (81) | 2.65±0.01 |
| | | 3.64±0.01 |
| Low | 77.5 (279) | 1.98±0.01 |
| | | 2.33±0.01 |

**Absolute figures in parenthesis*

To determine the relationship between self-efficacy of students and their performances in the Protein Synthesis Achievement Tests, a bivariate analysis of the two variables conducted showed that there was a significant relationship between performance and self-efficacy because r=-0.306 (Table 4.5). The notion of the impact of students' self-efficacy may have a negative effect on the performance of students in protein synthesis.

**Table 4.5: Bivariate analysis of significant differences between students' self-belief in learning protein synthesis and their performance.**

| Variable | Mean | S.D | Pearson Coefficient (r) | | |
|---|---|---|---|---|---|
| | | | Performance | Attribution | Sig |
| Performance | 36.33 | 7.64 | 1.000 | -0.306* | S |
| Self-belief | 27.02 | 3.02 | -0.306* | 1.000 | S |

S = Significant at $P_{0.05}$; N=90

**Effect of students' misconceptions in protein synthesis on their performance.**

In order to conduct the investigation, the question: ‗What is the effect of students‘ misconceptions in protein synthesis on their performance?" was posed. Ten items were formulated and each respondent‘s misconception statements associated with the factor identified had subscales, as ―Cell Division" (derived from items 2 and 3), ―DNA" (derived from items 1, 5, and 6), ―Role of Protein" (derived from items 4, 7 and 10) and ―Mutation" (derived from items 8 and 9). Four variables, ―Cell Division," ―DNA," ―Role of Protein" and ―Mutation" were defined on the basis of the results of the factor analysis.

To determine the students‘ misconceptions in protein synthesis, a descriptive statistics of students‘ responses showed a mean score ranging from 2.60±0.08 to 4.31±0.08 across the four subscales that were analysed. Results presented in Table 4.6 show that students generally agreed with the statements which is an indication of the fact that they had misconceptions in protein synthesis. A pool of students‘ responses on their misconceptions in protein synthesis showed a positive response (mean score =3.25±0.03) that is, students‘ studied had challenges to the understanding of concepts in protein synthesis.

**Table 4.6: Scores of Students' Responses on their Misconceptions**

| Subscale | Mean Score±1SE |
|---|---|
| Cell division | 3.88±0.08 |
| DNA | 2.60±0.08 |
| Role of Protein | 2.79±0.06 |
| Mutation | 4.31±0.08 |

To determine the effect of students' misconception on their performances in the Protein Synthesis Achievement Tests and exercises, a bivariate analysis of the two variables conducted showed that there was no significant relationship between performance and misconceptions at r=-0.164. The notion of the effect of students' misconception may not have an effect on the performance of students in protein synthesis.

**Students' attribution of interest in learning of protein synthesis and how it affects their performance in the subject.**

In order to determine students' attribution of interest in learning protein synthesis the question asked was: ‗To what do students' attribute their interest in the learning of protein synthesis and how does it affect their performance?"

The questionnaire items sought to determine what students felt about the support teachers (teacher practice) and friends gave (peer factor); and nature of concepts (concepts).

Comparing responses of students, it was revealed that students attribute their interest in learning protein synthesis to effective teacher practices and relationship; 78.1% of respondents agreed that their teachers helped to understand the lessons they taught. Many (74.4%) agreed that they were given special treatment by their teacher; this was confirmed in item 7 of the questionnaire with 90% of the students disagreeing with the statement that their teachers were hostile to them and 66.7% did not feel at ease asking their teacher for help with their school work, 78.9% were of the view that their teacher encourages them to learn protein synthesis.

To ascertain whether friends help and encourage other to learn protein synthesis, 70.0% disagreed to this assertion. Meaning, friends did not help and encourage each other in the learning of protein synthesis. On sharing of materials with friends there were varying responses; 32.3% agreed and 67.7 disagreed. Meaning that, friends did not share materials willingly with each other. This may be due to the fact that some students did not return, misplaced and did not take good of care items borrowed, among other probable reasons. Students' agreed that, there were too many concepts in protein synthesis that made them lose interest in learning the topic (84.4%) with a few disagreeing (15.6%).

To determine how this factor affected students' performance, a bivariate correlation was done to determine the relationship between the two variables. There was negative relationship, but this was not significant (Table 4.7). That is, there was no significant relationship between students' attribution of interest in learning protein synthesis and their performance in the subject (r= -0.007).

**Table 4.7: Bivariate analysis of relationship between students' attribution of interests in learning protein synthesis and their performance.**

| Variable | Mean | S.D | Pearson Coefficient (r) | | |
|---|---|---|---|---|---|
| | | | Performance | Attribution | Sig |
| Performance | 36.63 | 7.64 | 1.000 | -0.007 | S |
| Attribution of Interest | 33.28 | 4.32 | -0.007 | 1.000 | S |

S = Significant at $P_{0.05}$; N=90

**Teachers Notebook and Students' Workbooks**

Based on the analysis of the pre-intervention results, to diagnose the lapses in the teaching and learning of protein synthesis in the class, the teacher‘s notebook and students workbooks were analyzed. The teacher‘s notes were checked to determine the teacher‘s scheme of work for the previous term, whether the students were taught with lesson plans and whether evaluation exercises on each lesson were given. Students‘ workbooks were checked to determine the number of tests, exercises, assignments and projects the students did in the previous term. It showed that, from teacher‘s notebook, the students were not taught with lesson plans. Terminal scheme of work was prepared specifying the topics taught for the term. Learning or instructional objectives to be achieved within each week or the term were not stated in the scheme. Teaching and learning activities and evaluation exercises to be performed by students at the end of each week or the term were not stated. Data from students‘ workbooks showed that students were not given enough class exercise and project work in the previous term. They did only two assignments and one mid-term test. To address this, an intervention activity was carried out which involved the effective use of CAI in the teaching and learning process.

**Intervention**

To help students learn and understand protein synthesis, students were taught for eight weeks using effectively CAI. At the end of each week students were made to answer questions on the concepts learnt within the week and the previous weeks. Questions asked were constructed with increasing cognitive demand to challenge students to reason and apply the principles learnt in answering them. The test results were given to students before the first lesson of the next week. This helped students to get enough time to do remediation on the concepts they could not provide valid responses to. To assist students to know the mistakes they made and how to overcome such mistakes in subsequent tests, descriptive feedback in the form of written comments was provided against any incorrect responses which did not reflect understanding of concepts learnt. Feedbacks on the tests were discussed with students for them to know what were expected as responses to the questions asked. This strategy assisted students to use the best and correct approach in finding solutions to the questions asked in the subsequent tests. These strategies adopted improved the performances of students in the weekly tests. Data collected on students' output in the weekly tests after weekly lessons were analyzed as follows:

**Week Two:** *DNA Replication*

Most of the responses students provided were with explanation. For Question 1, 20% of the responses students provided were without explanation, 67.0% of the responses reflected understanding whilst 33% of the responses did not reflect understanding of the concept. For Question 2, 90% of the responses included explanation with 10% of the responses without explanation; about 69.7% of the responses showed understanding whilst 30.3% of the responses did not show understanding of the concept. In Question 3, all 90% of responses provided by students were with explanation; 80% of the responses reflected understanding whilst 20% of the responses did not show understanding of the concept. In Question 4, about 80% of the responses included explanation with 20% of the responses without explanation; 57.6% of the responses showed understanding whilst 42.4% of the responses did not show understanding of the concept (Table 4.8).

**Table 4.8: Analyses of Students' Responses in Class Test 1**

| | Response (%) | | | |
|---|---|---|---|---|
| Question | WE | NE | U | NU |
| 1 | 20.0 | 80.0 | 67.0 | 33.0 |
| 2 | 90.0 | 10.0 | 69.7 | 30.3 |
| 3 | 90.0 | 10.0 | 80.0 | 20.0 |
| 4 | 80.0 | 20.0 | 57.6 | 42.4 |

WE = With Explanation; NE = No Explanation; U= Understanding; NU= No Understanding

**Week Three:** *DNA as the Genetic Code for Protein Synthesis*

In the lesson, the numbers of different amino acids which occur in known protein were discussed through CAI games and models. The aim was to guide students to identify DNA with its different nitrogen bases and deduce the sequence in which twenty (20) different amino acids should be part to form a particular protein. Hence, the possible combinations of the triplet nitrogen base code responsible for a particular amino acid. This was done with models and CAI modules to provide animation for the process.

**Week Four:** *Communication of the DNA with the Cytoplasm*

Students in this lesson discussed and observed the communication of the DNA with the cytoplasm. This was aimed at guiding students to describe the instruction for the protein synthesis of the protein embodied in the triplet code which are conveyed from the DNA in the nucleus to the site of protein synthesis which is the ribosome. The animation of the process was carried out on a large screen with students taking practice lessons on individual personal computers with software kit that came with the CAI. The second class test was conducted to determine how students were performing with regard to the concept taught.

Analyses of students‘ responses in the second class test showed that most of the responses students provided included explanation that reflected understanding of the concepts learnt (Table 4.9). In Question 1, all the responses students provided included explanation, 90.9% of the responses showed understanding whilst 9.1% of the responses did not show understanding of the concepts. In Question 2, all the responses students provided included explanation, about 85 % of the responses reflected understanding whilst 15% of the responses did not reflect understanding of the concept. In Question 3, 98% of the responses students provided included explanation; about 94.8% of the responses came with understanding whilst 5.2% of the responses did not show understanding of the concepts. Question 4 showed 90.2% of the responses included explanation with 9.8% of the responses without explanation; 67% of the responses showed understanding whilst 33% of the responses did not reflect understanding of the concept.

**Table 4.9: Analyses of Students' Responses in Class Test 2**

| | Response (%) | | | |
|---|---|---|---|---|
| Question | WE | NE | U | NU |
| 1 | 98.0 | 2.0 | 90.9 | 9.1 |
| 2 | 100.0 | 0.0 | 85.0 | 15.0 |
| 3 | 98.0 | 2.0 | 94.8 | 5.2 |
| 4 | 90.2 | 9.8 | 67.0 | 33.0 |

WE = With Explanation; NE = No Explanation; U= Understanding; NU= No Understanding

**Week Five:** *Types of RNA*

Using the CAI, students compared the structure of DNA to RNA. The aim of the lesson was to guide students to identify the differences in RNA, distinguish the types of RNA and the functions. The students identified a clear distinction between the DNA and RNA using the CAI; the types of RNA (mRNA, rRNA and tRNA). Students were taken through the genetic code with its series of definitions (codons and terminators or nonsense codons). A table of genetic codes was generated leading to the teaching of transcription in week six.

**Week Seven:** *Assembly of the Proteins*

With the use of CAI and models, students are introduced to how m-RNA leaves the nucleus and attaches itself to the surface of the ribosomes. The aim was to guide students understand the incorporation of amino acids into a protein such that each amino acid combines with another type of RNA called transfer (t-RNA). The site for this assembly was also emphasized. It was evidently clear that students enjoyed the lesson and had better understanding of the processes.

**Week Eight:** *Translation*

Students were taken through CAI activities to obtain a definite sequence of amino acid in the protein, as the amino acid must be ordered. The students were guided through the various stages of translation. This was done by the activation of amino acid into the t-RNA, transfer of the activated amino acids to the t-RNA, assembly of the polypeptide chain, synthesis of the peptide bond and chain terminating the release of protein. A third class test was conducted to ascertain the extent to which the students appreciated and understood the concepts taught.

Most of the responses students provided included explanation and reflected understanding of the concepts learnt. In Question 1, 98% of the responses included explanation with 2% of the responses without explanation; about 86% of the responses showed understanding whilst 14% of the responses did not show understanding of the concept. In Question 2, about 96% of the responses included explanation with 4% of the responses without explanation; about 87% of the responses showed understanding whilst 13% of the responses did not show understanding of the concepts learned. In Question 3, all the responses students provided included explanation, 79% of the responses reflected understanding whilst 21% of the responses did not reflect understanding of the concept (Table 4.10).

**Table 4.10: Analyses of Students' Responses in Class Test 3**

| | Response Categories (%) | | | |
|---|---|---|---|---|
| Question | WE | NE | U | NU |
| 1 | 98.0 | 2.0 | 86.0 | 14.0 |
| 2 | 96.0 | 4.0 | 87.0 | 13.0 |
| 3 | 100.0 | 0.0 | 79.0 | 21.0 |

Note. WE = with explanation; NE = no explanation; U= understanding; NU= no understanding

**Post-Intervention**

The constructed essay-tests and multiple choice types were administered to the students at the end of the eighth week. This led to the answering of the last research question, ―What is the effect of CAI in the teaching and learning of protein synthesis on the performance of students?

**Effect of CAI on the Teaching and Learning of Protein Synthesis on the Performance of Students**

In order to determine the performance of students‘ in the achievement tests and class exercises, the mean scores across the sample were determined. The mean scores of the performance in the exercises across the sampled areas showed significant variations between the three trials (Table 4.11).

**Table 4.11: Mean scores of students in PSAT across the three trials after using CAI**

| Trials | n | Mean Score ±1SE |
|---|---|---|
| 1 | 90 | 68.42 ±0.92 |
| 2 | 90 | 71.11 ± 0.74 |
| 3 | 90 | 73.86 ±0.68 |

Comparing the mean scores of the pre-intervention trials and post-intervention trials showed significant changes between the scores (Table 4.12). This may be adduced to the fact that, the use of CAI significantly improved the performance of the students in protein synthesis. That is, students scored significantly higher in the post-intervention tests.

**Table 4.12: Difference in Mean Scores of PSAT across Pre and Post-intervention Trials**

| | Trials | | |
|---|---|---|---|
| Event | 1 | 2 | 3 |
| Pre-intervention | 31.86 | 37.17 | 40.86 |
| Post-intervention | 68.42 | 71.11 | 73.86 |
| Change in scores | 36.56 | 33.94 | 33.00 |

n=90

To ascertain the impact of the use of CAI on their attitude and their performance, a 23-item questionnaire on students‘ opinions on the use of CAI was administered immediately after the post-intervention PSAT. The questionnaire was based on a five-point Likert scale (5=Strongly Agree, 4=Agree, 3=Neutral, 2-Disagree, 1=Strongly

Disagree). Three sub-scales were culled from the questions posed. They were: Interest (how motivating, exciting, appealing and attention-grabbing the lesson was); Explanatory (understanding/comprehension of the concepts of the lessons); and Presentation (using technology in showing and explaining content of the topic to the learners). The reliability co-efficient observed for the scales were Interest ($\alpha$=0.71), Explanatory ($\alpha$=0.72) and Presentation ($\alpha$=0.73).

The results showed that (Table 4.13), the students were satisfied with various aspects of the lesson. Generally, the overall means of aspects of the lesson from the response were very high; Interest (Mean = 4.42, SD = 0.37), Explanatory (Mean = 4.43, SD = 0.36) and Presentation (Mean = 4.35, SD = 0.36). The students showed that, using the CAI, the lessons were interesting, practical and the presentations were attention-grabbing promoting class participation. The results is further indicative of the fact that the lessons were learner-centered and probably promoting higher-order thinking skills which resulted in their impressive performance.

**Table 4.13: Students' Score on 3 Sub-scales of Post-intervention Questionnaire**

| Sub-scale | Mean | SD |
|---|---|---|
| Interest | 4.42 | 0.37 |
| Explanatory | 4.43 | 0.36 |
| Presentation | 4.35 | 0.36 |

# CHAPTER FIVE

# DISCUSSION

## Overview

This chapter presents the discussion on the findings of the study. It highlights the implications of these findings to educators, instructional and curriculum designers.

## Summary of the Major Findings

The major findings of the study are listed below:

1. It was found that a pool of students‘ responses on their learning strategies used in protein synthesis showed a negative response (mean score =2.35±0.03), that is, students‘ studied had a negative approach to the learning protein synthesis. The mean scores of the performance in the exercises across the sampled areas showed significant variations (mean scores = 31.86, 37.17 and 40.86) between the three trials. A bivariate correlation analysis between students‘ learning skills and their performance in the protein synthesis tasks showed that there was no significant relationship between learning skill and performance (r=-0.046). It therefore suggests that, learning skill as it stands, may not affect the performance of students in protein synthesis.

2. A pool of students‘ responses on their self-efficacy level with regards to protein synthesis showed a low self-efficacy (mean score =2.46±0.03). A bivariate analysis of the two variables showed that there was a significant relationship

between performance and self-efficacy (r=-0.306). The notion of the impact of students' self-efficacy may have an effect on the performance of students in protein synthesis.

3. It was found out that students' responses on their misconceptions in protein synthesis showed a positive response (mean score =3.25±0.03); that is, students studied had a challenge to the understanding of concepts in protein synthesis. There was no significant relationship between performance and misconceptions (r=-0.164). The notion of the effect of students' misconception may not have an effect on the performance of students in protein synthesis.

4. It was found out that students attribute their interest in protein synthesis to effective teacher practices and not on peers' relationships. Students' agreed that there are too many concepts in protein synthesis that make them lose interest in learning the topic. There was negative relationship between students' attribution of interest in learning protein synthesis and their performance in the subject (r= -0.007) but this was not significant.

5. The pre-intervention and post intervention trials showed significant changes. Students scored significantly higher in the post-intervention tests. The use of CAI significantly improved the performance of the students in protein synthesis. The study further confirmed lessons were learner-centered and probably promoting

higher-order thinking skills which resulted in their impressive performance after using the CAI.

**Relationship between students' learning skills and their achievement in protein synthesis.**

Learning to learn is the ability to pursue and persist in learning, to organize one‘s own learning, including through effective management of time and information (Zimmerman, 1990). The results showed that students had negative attitude towards learning (mean score =2.35±0.03). This means that, their negative learning attitude which cut across understanding, practices, preparation and linking, had an effect on their results in the various trials (see Table 4.3).

The poor performance could be due to the fact that, students see biology in general as a difficult subject (Yidana, 2004). Hence, students indicated that they don‘t learn hard in protein synthesis, because doing well in protein synthesis test is not the focus. This was indicative of the low mean score for students that disagreed with this assertion (mean score =2.43±0.04). Many did not link ideas by thinking of their own ideas covered or link new ideas with already existing ones, drawing diagrams, jotting down ideas (mean score=2.10±0.05). This confirms Nisbet and Shucksmith (1988, p. 6) view that when learning skills are integrated and used by students ―with a purpose in view", they become learning strategies. The integrated series of learning skills used by students in a particular subject may not be appropriate for the tasks that the student would like to accomplish and, in effect, affect their performance as in this case. Individual studies such as Prince and Felder (2006) have found a robust positive effect of students doing well on skill development, understanding the interconnections among concepts, deep conceptual understanding, ability to apply appropriate metacognitive and reasoning strategies, teamwork skills as well as enhancement of problem-solving skills which improve students' performances.

This study showed that students' negative learning strategies in protein syntheis did not have any correlation with their performance in the PSAT (r=-0.046). It was evident that, with the change of teaching and learning strategies, the students' adopted a new strategy for learning protein synthesis.

**Differences between students' self-efficacy and its impact on learning protein synthesis and their performance in the topic**

Students put a high premium on protein synthesis, but their low self-efficacy had a negative effect on their performance. As Bandura (1997) posits, self-efficacy, which refers to people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances, influences several aspects relevant to the goal setting process. Some of these choices people make for themselves are the persistence shown when facing difficulties, the effort engaged in a task, and whether the thought patterns individuals adopt are self-hindering or self-aiding (Bandura, 1991). The results showed a low level of self-efficacy among students. The students knew what protein synthesis was all about but had difficulty in grasping the concepts. They found protein synthesis to be interesting but confusing. This means that students attach much importance to learning protein synthesis but do not have the belief in performing well in the subject.

There was a significant relationship between performance and self-efficacy at r =-0.306. The result is in agreement with findings that review and meta-analyses of self-efficacy studies of both children and adults suggest that self-efficacy contributes to academic performance (Pajares, 2002). Thus, students with poor self-efficacy have low aspirations which may result in disappointing academic performances becoming part of a self-fulfilling feedback cycle (Margolis & McCabe, 2006).

**The effect of students' misconceptions in protein synthesis on their performance**

Students often have misconceptions (which may have arisen prior to and/or because of formal instruction) that affect their academic progress. Biology academics and students have identified the content areas of cellular metabolic processes (including photosynthesis, respiration and enzymes), osmosis (diffusion and active transport), genetics (protein synthesis, cell division, DNA), homeostasis, evolution (Gabel, 1994; Taylor, 2006; 2008; Ross & Tronson, 2004; 2007 ; Köse, 2008) as biological concepts which are most difficult to learn and to teach.

From the results, students‘ misconceptions in protein synthesis showed a mean score ranging from 2.60±0.08–4.31±0.08 across the four sub-scales that were analysed. Results presented in Table 4.6 show that students generally agreed with the statements, which is an indication of the fact that they have misconceptions in protein synthesis. The results showed that there was no significant relationship between performance and misconceptions. These findings agree with Erdmann, (2001), that misconceptions may originate from certain experiences that are commonly shared by many students. These concepts are central to the mastery of a specific discipline, and many students find it difficult to learn and teachers find difficult to teach (Meyer and Land, 2003, 2005) which may go on to affect performance.

**Students' attribution of interest in protein synthesis and how it affects their performance in the subject**

Attributions of success or failure point the extent to which a learner takes personal responsibility for his or her learning by having interest in whatever they are learning. On the basis of causal attributions of their achievements in academic tasks, students make judgments‘ of responsibility. Hogg and Vaughan (2005) points out that, it is these judgments‘ that influence affective experience and future reactions to success or failure in learning.

To examine students‘ attribution of interest a descriptive analysis of the questionnaire was carried out. The questionnaire items sought to determine what students felt about the support teachers (teacher practice) and friends gave (peer factor); and nature of concepts (concepts).

Analysis of the data showed that all these factors had very strong influence on students‘ attitude towards the study of protein synthesis. However, students‘ perception of the teacher‘s support seemed to be a major factor in the development of students‘ interest towards protein synthesis. Students attributed their interest in protein synthesis to effective teacher practices. This is in agreement with Johnson (2008) and Pickens and Eick (2009), who argue that there is the need for teachers to maintain dialogue with all their students in order to better assess what motivates them and, therefore, to better understand what methods will be most effective in helping each one break free of the emotional ties that bind them to a certain behavior in achieving academic success. This study has also confirmed that the teacher is crucial in the development of attitudes and interests of students toward protein synthesis.

The study further revealed that peers do not help and encouraged each other to learn protein synthesis; hence, students attributed their lack of interest in protein synthesis to this assertion. Fantuzzo, Sekino and Cohen (2004), have reported that most children who have positive peer relationship (i.e., have friends and/or are liked by classmates) also do well academically and that children who are rejected by peers early on tend to encounter more academic difficulties in later years.

Students‘ agreed that there were too many concepts in protein synthesis that make them lose interest in learning the topic. The study agreed with Tekkaya, Özkan and Sungur (2001) that the possible sources of students‘ difficulties in learning some biology concepts among others, are the high school biology curriculum and the teaching-learning strategies employed by teachers.

There was negative relationship but this was not significant. That is, there was no significant relationship between students‘ attribution of interest in learning protein synthesis and their performance in the subject. This confirms the position of Wentzel and Caldwell (1997).

**Effect of CAI on the Teaching and Learning of Protein Synthesis on the Performance of Students**

The ability to choose an appropriate instructional approach for use in the teaching and learning process is one of the most important skills. The choice of instructional approaches in an instructional blend impacts on learners‘ performance (Wentzel, 2002). Koc (2005) asserts that, teachers need to use a variety of teaching activities in their classrooms, and that the variety should include technology as much as much as possible. Computer-Assisted Instruction (CAI) therefore, could possibly be a good choice since it is ICT-related. In order to conduct the investigation on the impact of CAI on students‘ performance in protein synthesis after the intervention, the question: ‗What is the effect of CAI use in the teaching and learning of protein synthesis on the performance of students?" was posed.

Comparing the mean scores across the pre-intervention trials and post intervention trials showed significant changes between the scores (Table 4.9). This study confirms Burrowes (2003) statement that teaching in a constructivist, active learning environment is more effective than traditional instruction in promoting academic achievement, increasing conceptual understanding, developing higher level thinking skills, and enhancing students interest in biology.

Tabassum (2004) has indicated that advocates of CAI have high expectations for the computer as an instrument for identifying and meeting individual needs. This was confirmed as in their final evaluations, students after the post-intervention activities commented that they enjoyed the class much more than their traditional classes. The most compelling support for superiority of the interactive approach came from the use of CAI by Knight and Wood (2005) to teach protein synthesis in which comparisons of normalized learning gains calculated from pre-test and post-test scores in the traditional and interactive classes. In this course, achievement increases when students get regular practice via prescribed (graded) active-learning exercises using the CAI (Freeman, O‗Connor, Parks, Cunningham, Hurley, Haak, Dirks & Wenderoth, 2007).

The study confirmed that using CAI, as part of peer-learning approach, was a powerful way to promote conceptual understanding. This finding supported the findings of Smith, Wood, Adams, Wieman, Knight, Guild, and Su (2009). When students come together to share ideas and help each other during the use of CAI, their understanding of concepts taught improves with subsequent improvement in their performance. The study has thus demonstrated that computer-assisted instruction approach had a favourable effect on SHS 2 students‘ achievement or performance in protein synthesis.

# CHAPTER SIX

## SUMMARY OF FINDINGS, CONCLUSIONS, RECOMMENDATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

### Overview

This Chapter covers the summary and the conclusions of the study. Recommendations based on the study findings have also been presented.

### Summary of Findings

The study was an action research carried out at Swedru Senior High School, Agona Swedru in the Central Region of Ghana. The purpose of this study was to use CAI to help improve SHS 2 students‘ performance in the teaching and learning of protein synthesis.

The findings have provided valuable information on students‘ attitude towards learning of protein synthesis; how students‘ believe in themselves to achieve results, what students attribute their interest in protein synthesis to, misconceptions students have in the learning of protein synthesis, the use of CAI in the teaching and learning of protein synthesis and how these factors affect their performance. Students had negative approach for the learning of protein synthesis. The study also found that students had low self-efficacy with regard to protein synthesis. It was found that, students had misconceptions in learning protein synthesis and agreed that there were too many concepts in protein synthesis. Students‘ attributed their interest in protein synthesis to effective teacher practice but not from friends.

The study also found that students' negative learning approach, misconception and low self-efficacy to learning of protein synthesis showed no effect on their performance though the mean scores of their performance were low. Students' attribution of interest and the use of CAI had an effect in their performance with the mean scores being comparatively higher in the post-intervention tests.

**Conclusions**

From the findings it can be concluded that students had negative attitude towards learning which had an effect on their performance. Thus, the poor performance could be due to the fact that students see biology in general as a difficult subject. More so, it could be inferred that with the change of teaching and learning strategies, the students' adopted a new strategy for learning protein synthesis resulting in a better performance.

The study has shown that students have a low level of self-efficacy to the learning of protein synthesis, which had an effect on their performance. It came to light that the students come across as knowing what protein synthesis was all about, but had difficulty in grasping the concepts. Thus, regardless of the fact that they found protein synthesis to be interesting it seems confusing to them. It can be concluded from the findings that students' put a high premium on protein synthesis, but their low level of self-efficacy had an effect on their performance.

More so, the study has shown that students generally agreed to have misconceptions in protein synthesis. In addition, the study also found that there was no significant relationship between their misconceptions and performance. From the study, it can be concluded that misconceptions may originate from certain experiences that are commonly shared by many students when it comes to concepts in protein synthesis.

Valuable information on students' perception of the teacher's support as a major factor in the development of their interest towards protein synthesis was established. From the findings it can be concluded that students attributed their interest in protein synthesis to effective teacher practices. This study has also further revealed that, peers do not help and encouraged each other to learn protein synthesis with students' attributing their lack of interest in protein synthesis to this assertion. In addition, the study found out that there are too many concepts in protein synthesis that make students lose interest in learning the topic.

The study confirmed that using CAI as part of peer-learning approach was powerful way to promote conceptual understanding. More so, it could be inferred from the study that when students come together to share ideas, and help each other during the use of CAI, their understanding of concepts taught improves with subsequent improvement in their performance. From the above, one can say that when students were exposed to the computer-assisted instructional approach during the teaching and learning of protein synthesis they performed significantly better than, when the traditional instructional approach was used. This study therefore suggests that CAI is able to improve student performance in the concept protein synthesis. In conclusion, teachers must be encouraged to adopt innovative techniques in the use of CAI in the teaching-learning process.

**Recommendations**

Based on the findings of this study, the following recommendations are made:

1. Innovative and more effective learner-centered instructional strategies, such as computer-assisted instructional packages, should be used by biology teachers to promote meaningful learning of difficult biology concepts like protein synthesis. Appropriate computer-assisted packages should, therefore, be developed and adopted for use in the Ghanaian school systems.
2. Curriculum planners and developers should be motivated by the findings of the study to introduce innovative instructional strategies, such as, computer-assisted instructional approaches, in the elective biology programme to encourage biology teachers incorporate computer-assisted programmes in their classroom instructions to enhance students‘ performance in biology.
3. The Ministry of Education, GES, CRDD and other stakeholders associated with science education should also push for structural modifications in science education to promote the use of computer-assisted instructional packages (for example the concept cartoons) to the success of the students and sensory features in the constructivist science teaching in the teaching and learning of biology at the SHS level.
4. Stakeholders in science education should organise regular instructional fora, workshops and in-service training sessions for biology teachers on the effective use of

computer-assisted instructional packages to enhance the effective application of the computer-assisted instructional packages especially in the constructivists' approach to instructional design.

**Suggestions for Further Research**

The findings and conclusions of this study are used to support the following recommendations for further studies:

1. It is suggested that the study be replicated using computer-assisted instructional packages on other equally difficult biology concepts, such as, photosynthesis, genetics, Mendelian genetics, chromosome theory of heredity, cellular respiration, and hormonal control of human reproduction, water transport in plants, mitosis, meiosis, among others. This would also provide a basis for greater generalisation of the conclusions drawn from the findings of the study.
2. It is suggested that, in the teaching and learning of protein synthesis, the study be replicated using larger samples to provide a basis for more generalisation of the conclusions drawn from the findings of the study about the effectiveness of computer assisted instructional packages.
3. Furthermore, other studies can be conducted using this idea for the tertiary institutions but the limitations in the design for this study must be taken care of or even extended to different regions to determine the situation within and between cross regional settings of the Ghanaian society.
4. Researchers should also consider investigating methods that can be used to address learning choices of learners whose learning styles are incompatible with the regular

classroom conditions and use of computer-assisted instructional packages. This will enable curriculum developers give relevance guidelines on what should be recommended for use by instructors.

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# APPENDIX A

## PRE-INTERVENTION QUESTIONNAIRE

**UNIVERSITY OF EDUCATION, WINNEBA.**

**SCHOOL OF RESEARCH AND GRADUATE STUDIES.**

**SCIENCE DEPARTMENT.**

**Using CAI to Improve the Performance of SHS 2 Science Students in the Teaching and Learning of Protein Synthesis at the Swedru Senior High School.**

I am finding out what you think or feel about various things concerning learning protein synthesis and how they affect your performance in the topic. The purpose of my study is to improve the teaching and learning of protein synthesis in secondary schools.

This study is purposely meant for academic research work.

Please, kindly answer the questions objectively. You are strongly assured of the confidentiality and anonymity of information you provide. Thank you for your anticipated co-operation.

Code…………..

Name of school……………………………………

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

## SECTION A

### Learning Strategies in Protein Synthesis

Please tick (√) the cell that indicates your degree of agreement with each statement with respect the learning skills/strategies employed in your learning of Integrated Science.

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. After studying protein synthesis I ask myself questions to make sure I know the material I have been studying. | | | | | |
| 2. When I am studying, I try to put together the information from class and from the biology book. | | | | | |
| 3. I do the work in the protein synthesis lessons because I want to understand the ideas. | | | | | |
| 4. I work on practice exercises and answer end of the chapter questions on protein synthesis even if I do not require to. | | | | | |
| 5. I do not learn hard because it is hard for me to decide what the main ideas are in when I am studying protein synthesis. | | | | | |
| 6. I do the work in protein synthesis because I want to do well in tests. | | | | | |
| 7. I understand the ideas taught in protein synthesis so I enjoy reading my notes. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 8. During a test, I often find that I cannot remember the facts I have learned this affect my learning. | | | | | |
| 9. Before I begin studying protein synthesis, I think about the things I need to do to learn. | | | | | |
| 10. When I study protein synthesis, I put important ideas in my own words. | | | | | |
| 11. I work hard in protein synthesis even if the topic is difficult to me. | | | | | |
| 12. When I study for a test in protein synthesis, I try to remember as many facts as I can. | | | | | |
| 13. I work hard in protein synthesis class because it is important to my understanding. | | | | | |
| 14. Even when a topic is dull and uninteresting, I keep working until I understand it. | | | | | |
| 15. When studying for a protein synthesis test, I practice saying the important facts over and over to myself. | | | | | |
| 16. I learn protein synthesis because I like to appear capable to my friends. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 17. When I am studying protein synthesis, I usually think of my own examples of ideas covered. | | | | | |
| 18. When studying protein synthesis, I often draw diagrams. | | | | | |
| 19. When studying protein synthesis, I jot down new concepts/ideas. | | | | | |
| 20. When studying protein synthesis, I try to connect the new ideas with related ideas that I already know. | | | | | |

## SECTION B

**Self-efficacy Level of Students' in Learning Protein Synthesis .**

Please tick (√) the cell that indicates your degree of agreement with each statement with respect to your level of self-belief in learning protein synthesis.

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. I know what protein synthesis is all about. | | | | | |
| 2. I find protein synthesis easy. | | | | | |
| 3. I find protein synthesis interesting. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 4. I like the challenge that problem solving in protein synthesis is involving. | | | | | |
| 5. I learned how to manage my time a little better to get my assignment in protein synthesis done. | | | | | |
| 6. Observing others do well in protein synthesis make me believe that I can do better than my current performance. | | | | | |
| 7. I am satisfied with my performance in protein synthesis. | | | | | |
| 8. I rank among the best in protein synthesis in my class. | | | | | |
| 9. I expect to do well in protein synthesis tests. Compared with others in the Biology class, I expect to do well. | | | | | |
| 10. It is those students who have ability to do well, that do well in protein synthesis tests. | | | | | |
| 11. I am satisfied with the marks that I get in protein synthesis. | | | | | |

**SECTION C**

**Students' Misconceptions in Protein Synthesis**

Please tick (√) the cell that indicates your degree of agreement with each statement with respect to your misconceptions in protein synthesis.

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. DNA is not present in all living things | | | | | |
| 2. I believe that only mammalian life cycles contain meiosis, mitosis and fertilization | | | | | |
| 3. I understand that Meiosis ends in zygote formation. | | | | | |
| 4. Some proteins play dual roles as participants in and products of translation. | | | | | |
| 5. Genetic trait is determined by the code in a DNA molecule. | | | | | |
| 6. Amino acids originate from the DNA. | | | | | |
| 7. Once synthesized on the ribosome, protein remains in their folded state. | | | | | |
| 8. All mutations have a drastic change effect on protein structure. | | | | | |
| 9. All mutations do have negative effect. | | | | | |
| 10. There is a difference between amino acids and proteins. | | | | | |

## SECTION D

### Attribution of interest in Protein Synthesis

Please tick (√) the cell that indicates your degree of agreement with each statement with respect to what makes you like or dislike protein synthesis.

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. I like protein synthesis because my teacher helps me understand the lessons. | | | | | |
| 2. I am not given special treatment in class by my Teacher so I don‘t like protein synthesis. | | | | | |
| 3. When I need help with my school work, I feel comfortable asking my teacher. This makes me like protein synthesis. | | | | | |
| 4. I don‘t like protein synthesis because my teacher doesn‘t care if I fail or pass my tests. | | | | | |
| 5. My teacher helps other students more than she helps me in class this makes me to dislike protein synthesis. | | | | | |
| 6. My teacher motivates and encourages me to learn protein synthesis a lot. This makes me to like the topic. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 7. My teacher is very hostile towards me hence my dislike for protein synthesis. | | | | | |
| 8. I feel good because my friends help me learn protein synthesis. | | | | | |
| 9. My friends discourage me from protein synthesis because they say it is difficult. | | | | | |
| . My friends share their protein synthesis materials with me so I find the topic interesting. | | | | | |
| 11. There are too much concepts in protein synthesis this makes me lose interest in the topic. | | | | | |

# APPENDIX B

**UNIVERSITY OF EDUCATION, WINNEBA.**

**SCHOOL OF RESEARCH AND GRADUATE STUDIES.**

**SCIENCE DEPARTMENT.**

**Using CAI to Improve the Performance of SHS 2 Science Students in the Teaching and Learning of Protein Synthesis at the Swedru Senior High School.**

**POST-INTERVENTION QUESTIONNAIRE**

Code……………

Name of school……………………………………

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

Please tick (√) the cell that indicates your degree of agreement with each statement.

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 1. My teacher taught the lesson well. | | | | | |
| 2. It was lesson interesting using the computer assisted instruction. | | | | | |
| 3. I now understand protein synthesis better | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 4. Concepts in protein synthesis are now easier to understand | | | | | |
| 5. The lessons taught were very clear. | | | | | |
| 6. I understand concepts of protein synthesis. | | | | | |
| 7. The content was well delivered by my teacher. | | | | | |
| 8. I understand the lesson better. | | | | | |
| 9. There was good organization of the lessons. | | | | | |
| 10. The lesson was well supported in delivery. | | | | | |
| 11. Examples provided by my teacher enhanced my understanding | | | | | |
| 12. I had new learning experience. | | | | | |
| 13. Team work enhanced my understanding. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 14. the lesson was exciting | | | | | |
| 15. Lesson done with worksheets was interesting. | | | | | |
| 16. The class was enjoyable than ever. | | | | | |
| 17. I had enough clarification of some difficult concepts. | | | | | |
| 18. I can now apply most of the concepts to everyday life. | | | | | |
| 19. My teacher‘s lesson delivery was exceptional. | | | | | |
| 20. I had clarity in assignments given by my teacher. | | | | | |
| 21. During group discussions I learn better. | | | | | |
| 22. I can identify patterns in protein synthesis and make generalizations. | | | | | |

| Statement | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| 23. The lessons were Motivating. | | | | | |
| 24. Group presentations were exciting and motivating. | | | | | |

# APPENDIX C

## PRE-INTERVENTION (PSAT) QUESTIONS

### UNIVERSITY OF EDUCATION, WINNEBA

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

Dear Student,

This test is aimed at assessing your knowledge and understanding on the topic ‗protein synthesis'. You are expected to attach the necessary importance to this practice test and pay particular attention to details. This is to enable me have a fair assessment of your achievement in the topic.

Thank you.

Code…………..

Name………………………………

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

**Duration: 40minutes**

**PRACTICE TEST QUESTIONS**
**MULTIPLE CHOICE QUESTIONS**
**DNA & PROTEIN SYNTHESIS**

1. One of the functions of DNA is to

A. secrete vacuoles. B. make copies of itself. C. join amino acids to each other. D. carry genetic information out of the nucleus.

2. Two sugars found in nucleic acids are

A. sucrose and ribose. B. glucose and fructose. C. deoxyribose and ribose. D. deoxyribose and glucose.

3. The number of adenine bases in a DNA molecule equals the number of thymine bases because **A**. DNA contains equal numbers of all four bases. **B**. thymine always follows adenine on each DNA strand. **C**. DNA is made of alternating adenine and thymine bases. **D**. adenine on one strand bonds to thymine on the other strand.

4. Which of the following would **not** occur during complementary base pairing?

**A**. A-T **B**. U-G **C**. C-G **D**. A-U

5. Which of the following describes a DNA molecule?

A. Double helix of glucose sugars and phosphates. B. Ladder-like structure composed of fats and sugars. C. Double chain of nucleotides joined by hydrogen bonds. D. A chain of alternating phosphates and nitrogenous bases.

6. Which of the following is an example of complementary base pairing?

A. Thymine – uracil. B. Guanine – adenine. C. Adenine – thymine. D. Cytosine – thymine.

7. Which of the following is the correct matching of base pairs in DNA?

A. Adenine–Guanine and Thymine–Uracil. B. Guanine–Cytosine and Adenine–Uracil. C. Adenine–Thymine and Guanine–Cytosine. D. Guanine–Thymine and Adenine–Cytosine.

8. DNA replication involves the breaking of bonds between

A. bases. B. sugars and bases. C. phosphates and bases. D. sugars and phosphates.

9. Which of the following statements best describes **DNA replicatio**n?

A. tRNA, by complementary base pairing with mRNA, produces proteins. B. RNA nucleotides, by complementary base pairing with DNA, produce DNA. C. DNA nucleotides, by complementary base pairing with DNA, produce DNA. D. RNA nucleotides, by complementary base pairing with DNA, produce tRNA.

10. The base found in RNA nucleotides but **not** in DNA nucleotides is

A. uracil (U). B. adenine (A). C. guanine (G). D. cytosine (C).

11. The product of transcription is

A. DNA. B. protein. C. mRNA. D. a ribosome.

12. A section of DNA has the following sequence of nitrogenous bases: **CGATTACAG.** Which of the following sequences would be produced as a result of transcription?

A. CGTUUTCTG B. GCTAATGTC C. CGAUUACAG D. GCUAAUGUC

13. mRNA is produced in the process called

A. respiration. B. translation. C. replication. D. transcription.

14. A function of transfer RNA (tRNA) is to

A. stay in the nucleus and be copied by DNA. B. carry amino acids to the growing polypeptide chain. C. copy DNA and carry the information to the ribosome. D. read the codons and provide the site for protein synthesis.

15. Which of the following **best** describes the function of mRNA?

A. It stays in the nucleus and is copied by DNA. B. It carries amino acids to the growing

polypeptide chain. C. It makes up the ribosomes and provides the site for protein synthesis. D. It is transcribed from the DNA and carries the information to the ribosome.

16. The molecule that is responsible for carrying amino acids to ribosomes is

A. DNA. B. tRNA. C. rRNA. D. mRNA.

17. A polypeptide found in the cytoplasm of a cell contains 12 amino acids. How many nucleotides would be required in the mRNA for this polypeptide to be translated?

A. 4 B. 12 C. 24 D. 36

18. If the nucleotide sequence of an anticodon was AUC, then the DNA triplet would be

A. ATC. B. TAG. C. AUC. D. UAG.

19. If the code for an amino acid is AGC on the DNA molecule, the anticodon on the tRNA would be

A. AGC B. TGC C. UCG D. UGC

20. During protein synthesis, peptide bonds are formed at the

A. nucleus. B. nucleolus. C. lysosomes. D. ribosomes.

21. Determine the sequence of amino acids produced by this DNA sequence: **GGAGTTTTC**

**A**. Proline, Valine, Lysine. **B**. Glycine, Valine, Leucine. **C**. Proline, Glutamine, Lysine. **D**. Glycine, Glutamic acid, Leucine.

22. **Use the following information to answer the question:**

1. Uracil bonds with adenine. 2. Complementary bonding between codon and anticodon. 3. DNA unzips. 4. mRNA joins with ribosome. The correct order of the above during protein synthesis is

**A**. 1, 2, 4, 3 **B**. 1, 3, 2, 4 **C**. 3, 1, 4, 2 **D**. 3, 2, 1, 4

23. The tRNA anticodon for the DNA sequence AGT would be

A. UCA. B. AGU. C. TCA. D. AGT.

24. A change in the sequence of bases in a strand of DNA that occurs as a result of exposure to X-rays is an example of

A. mutation. B. denaturation. C.transcription. D. protein synthesis.

25. For a substance to be classified as a mutagen, it must cause

A. a change in DNA. B. enzymes to denature. C. hydrolysis of proteins. D. mRNA to be produced.

26. Which of the following would be a result of the substitution of one base pair in DNA by a different base pair during replication?

A. A mutation would occur. B. tRNA would bond to DNA. C. Phosphate would join with adenine. D. Uracil would appear in the DNA strand.

27. Recombinant DNA is defined as DNA produced from

A. RNA and a protein. B. DNA and hemoglobin. C. viral DNA and glucose. D. DNA of two different organisms.

28. When a foreign gene is incorporated into an organism‘s nucleic acid, the resulting molecule is called A. ATP. B. recombinant DNA. C. transfer RNA (tRNA). D. messenger RNA (mRNA).

29. If the triplet code on a DNA molecule changes from ACT to AGC, the result is called

A. mutation. B. metastasis. C. translation. D. transcription.

30. **Use the following events to answer the question.**

1. mRNA is formed. 2. DNA segment opens (unzips). 3. mRNA attaches to ribosomes. 4. amino acids form peptide bonds. 5. tRNA carries amino acids to mRNA. 6. The correct order of events required for protein synthesis is

**A**. 1, 2, 3, 4, 5. **B**. 2, 1, 3, 4, 5. **C**. 2,1, 3, 5, 4. **D**. 2, 1, 4, 5, 3.

31. Which of the following terms describes the process shown below? **DNA** $\rightarrow$ **mRNA**

A. Unzipping. B. Translation. C. Replication. D. Transcription.

32. One of the functions of DNA is to

A. secrete vacuoles. B. make copies of itself. C. join amino acids to each other. D. carry genetic information out of the nucleus.

33. A role of mRNA in protein synthesis is to

A. form ribosomes. B. form the protein‘s tertiary structure. C. carry appropriate amino acids into place. D. carry genetic information out of the nucleus.

# APPENDIX D

## ANSWER KEY FOR PART A DNA & PROTEIN SYNTHESIS

.

.

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | B | 6. | C | 11. | C | 16. | B | 21. | C | 26. | A | 31. | D |
| 2. | C | 7. | C | 12. | D | 17. | D | 22. | C | 27. | D | 32. | B |
| 3. | D | 8. | A | 13. | D | 18. | A | 23. | B | 28. | B | 33. | D |
| 4. | B | 9. | C | 14. | B | 19. | A | 24. | A | 29. | A | | |
| 5. | C | 10. | A | 15. | D | 20. | D | 25. | A | 30. | C | | |

# APPENDIX E

## PRE-INTERVENTION (PSAT) QUESTIONS 2

**UNIVERSITY OF EDUCATION, WINNEBA**

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

Dear Student,

This test is aimed at assessing your knowledge and understanding on the topic ‗protein synthesis'. You are expected to attach the necessary importance to this practice test and pay particular attention to details. This is to enable me have a fair assessment of your achievement in the topic.

Thank you.

Code…………..

Name……………………………….

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

**Duration: 1hr 15minutes**

**PRACTICE TEST QUESTIONS**

**MULTIPLE CHOICE QUESTIONS**

**DNA, PROTEIN SYNTHESIS , RECOMBINANT DNA**

**SHORT ANSWER QUESTIONS**

1. Give the purpose of each of the following steps in the process of protein synthesis.

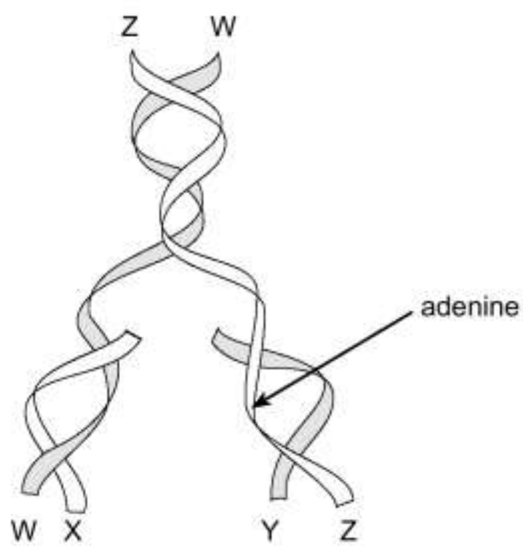
a) Ribosome moving along a mRNA: **(1 mark)**

b) Adenine bonding to thymine: **(1 mark)**

c) An amino acid bonding to a specific tRNA: **(1 mark)**

d) Forming of peptide bonds: **(1 mark)**

2.




If adenine is located on **strand Z** as shown, then on **strand X** at the same location must be

A. uracil.
B. adenine.
C. thymine.
D. cytosine.

3. Describe the structure of DNA. You may use labeled diagrams to answer this question. **(4 marks).**

4.

Using the table below, list **three** differences between RNA and DNA.

**(3 marks: 1 mark for each contrasting pair)**

| RNA | DNA |
|---|---|
| | |
| | |
| | |

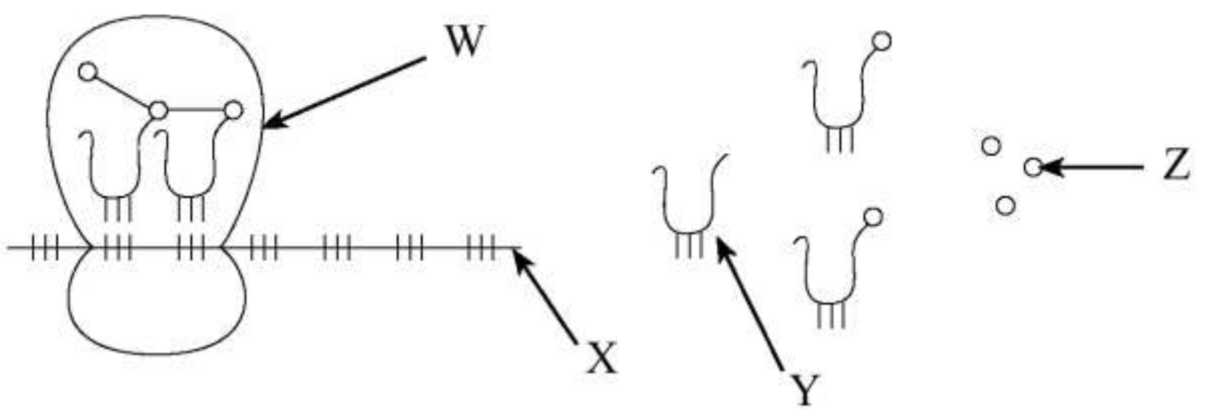
5. a. Describe the three steps of DNA replication. **(3 marks)**

b. Where in the cell does DNA replication occur? **(1 mark)**

c. What is the purpose of DNA replication? **(1 mark)**

d. Which base is found in DNA but **not** in RNA? **(1 mark)**

6.




The diagram above shows a part of the process of protein synthesis.

a. Identify the following labeled structures. **(4 marks)**

b. Name the part of protein synthesis represented by the diagram above. **(1mark)**

c. Where in the cell is **X** synthesized? **(1mark)**

7. a) Describe the three steps of DNA replication. **(3 marks)**

   b) Where in the cell does DNA replication occur? **(1 mark)**

   c) What is the purpose of DNA replication? **(1 mark)**

   d) Which base is found in DNA but **not** in RNA? **(1 mark)**

8. In a tabular form give the differences between DNA and RNA in terms of:

| | **DNA** | **RNA** |
|---|---|---|
| **Name of sugar** | | |
| **Nitrogen base present** | | |
| **Shape of the molecules** | | |
| **One function in the cell** | | |

a. name of sugar

b. nitrogen base present

c. shape of the molecules

d. one function in the cell **(4 marks: 1/2 mark for each box)**

# APPENDIX F

## POST-INTERVENTION (PSAT) QUESTIONS

**UNIVERSITY OF EDUCATION, WINNEBA**

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

Dear Student,

This test is aimed at assessing your knowledge and understanding on the topic ‗protein synthesis'. You are expected to attach the necessary importance to this practice test and pay particular attention to details. This is to enable me have a fair assessment of your achievement in the topic after the use of CAI.

Thank you.

Code……………

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

**QUIZ #1**

**Duration: 40minutes**

**RNA and Protein Synthesis Quiz**

True or False. If the answer is False, change the underlined word(s) to make the statement true.

______ ____________________ 1) The sugar found in RNA is called deoxyribose.

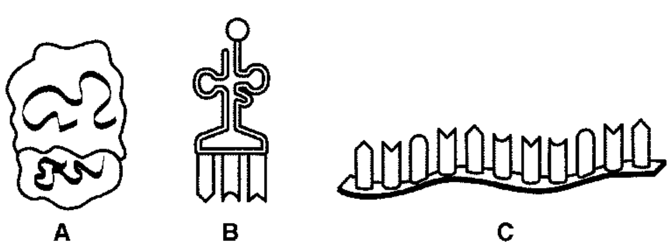
______ ____________________ 2) The DNA molecule is double stranded and the RNA molecule is single stranded.

______ ____________________ 3) The process of translation occurs at the ribosome.

______ ____________________ 4) The job of mRNA is to pick up amino acids and transport them to the ribosomes.

______ ____________________ 5) Transcription must occur before translation may occur.

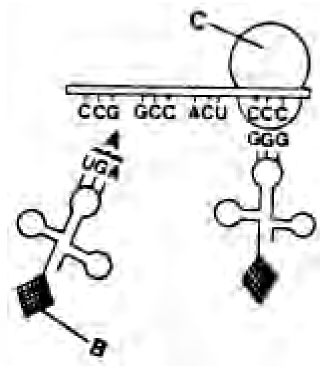
6) In the figure below, A, B, and C are three types of ____________________.



7) Part A is the ________________________.

8) Part B is the ________________________.

9) Part C is the ________________________.




**Identify the labeled structures on the following diagram of translation.**

10) The sense strand of a DNA molecule is: C C C A C G T C T

The mRNA sequence from this DNA molecule is : ____________________

Use the amino acid chart on the last page to identify the amino acids from the mRNA sequence in problem # 10.

11)First amino acid: ____________________

12)Second amino acid: ____________________

13)Third amino acid: ____________________

**Multiple Choice**

14) Which of the following is attached to the transfer RNA (tRNA)?

A. DNA B. ribosome C. amino acid D. nucleic acid

15) Which of the following is <u>not</u> part of protein synthesis?

A. replication B. translation C. transcription

16) The codon is located on the

A. mRNA. B. tRNA. C. rRNA. D. DNA.

17) In the RNA molecule, which nitrogen base is found in place of thymine?

A. guanine B. cytosine C. thymine D. uracil

18) During the process of transcription, which of the following is produced?

A. $H_2O$ B. ATP C. mRNA D. DNA

19) The actual site of protein synthesis is the

A. nucleus. B. mitochondrion. C. chloroplast. D. ribosome.

20) If the DNA template reads —ATA”, then which of the following would be the corresponding sequence on the mRNA?

A. UAU B. ATA C. TUT D. UCU

21) The genetic code is based upon the reading of how many bases at a time?

A. one B. two C. three D. four

22) Amino acids are held together by __?__ bonds.

A. hydrogen B. peptide C. ionic D. high energy

23) How many codons are needed to specify three amino acids?

A. 3 C. 9

B. 6 D. 12

24) One similarity between DNA and messenger RNA molecules is that they both contain

a. the same sugar
b. genetic codes based on sequences of bases
c. a nitrogenous base known as uracil
d. double-stranded polymers

25) Some events that take place during the synthesis of a specific protein are listed below.

a. Messenger RNA attaches to a ribosome.

b. DNA serves as a template for RNA production.
c. Transfer RNA bonds to a specific codon.
d. Amino acids are bonded together.
e. RNA moves from the nucleus to the cytoplasm.

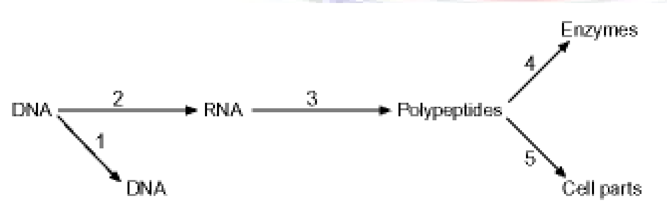
The correct order of these events is

a. B E A C D
b. D A E C B
c. B C E D A
d. C B A E D

26) What is the complementary messenger-RNA sequence for the DNA sequence shown below?


a. C-A-A-G-G-U
b. G-T-T-C-C-A
c. G-U-U-C-C-A
d. C-A-A-G-G-T

**Use the diagram below for Questions 27-29**




27) Which processes occur in the nucleus?

a. 1 and 2
b. 2 and 3
c. 3 and 4
d. 4 and 5

28) Process 2 is known as

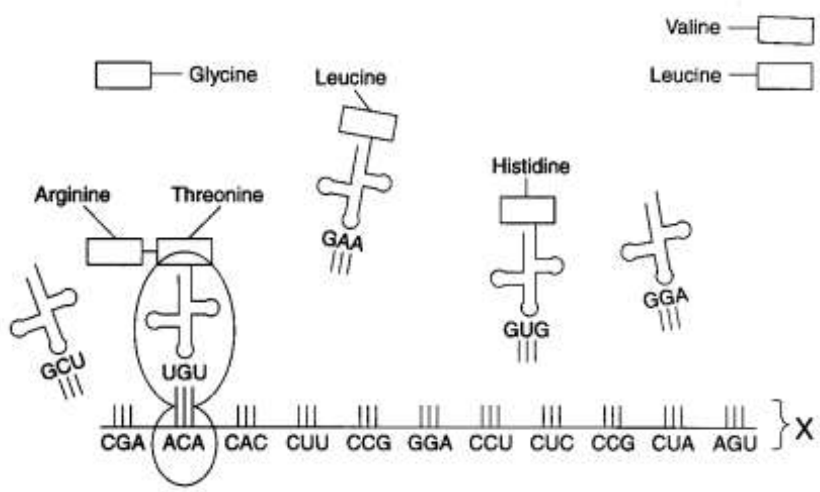
a. replication

b. mutation
c. transcription
d. translation

29) What is the product of process 3?

a. a strand of DNA
b. two complementary strands of DNA
c. a strand of RNA
d. a chain of amino acids

**Use the diagram below for Questions 30-32**




30) Structure X was made in the

a. nucleus
b. cytoplasm
c. lysosome
d. vacuole

31) The process represented in the diagram is most closely associated with the cell organelle known as the

a. nucleolus
b. ribosome
c. chloroplast
d. mitochondrion

32) Which amino acid would be transferred to the position of codon CAC?

a. leucine
b. glycine
c. valine
d. histdine

33) If a portion of a messenger RNA molecule contains the base sequence A-A-U, the corresponding transfer RNA base sequence is

a. A-A-U
b. G-G-T
c. T-T-C
d. U-U-A

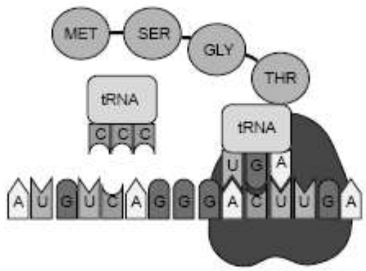
34) Which defines a codon?

a. a protein that beins transcription by breaking apart H bonds
b. a free-floating base that attaches to an open DNA strand
c. the genetic code word of three bases on mRNA that specify one amino acid
d. the strong bond between two complementary nitrogen bases

35) What is the role of tRNA during translation?

a. bond to open the DNA strand to carry the code for protein synthesis out of the nucleus
b. carry ribosomes to the site of protein synthesis
c. break aparty mRNA and send it back to the nucleus so that it can be reused
d. Carry amino acids to the mRNA for correct placement into the protein chain

36) This diagram shows which cellular process?




a. Replication
b. Transcription
c. Translation
d. Mutation

37) Which of the following changes would be expected if a CAUUUG sequences of bases mutated to CACUUG?

a. the amino acid sequence would be shorter than expected
b. the identity of one amino acid would change
c. the identity of more than one amino acid would change
d. the amino acid sequence would remain unchanged

Condon Chart

| | U | C | A | G | |
|---|---|---|---|---|---|
| U | Phenylalanine | Serine | Tyrosine | Cysteine | U |
| | Phenylalanine | Serine | Tyrosine | Cysteine | C |
| | Leucine | Serine | Stop | Stop | A |
| | Leucine | Serine | Stop | Tryptophan | G |
| C | Leucine | Proline | Histidine | Arginine | U |
| | Leucine | Proline | Histidine | Arginine | C |
| | Leucine | Proline | Glutamine | Arginine | A |
| | Leucine | Proline | Glutamine | Arginine | G |
| A | Isoleucine | Threonine | Asparagine | Serine | U |
| | Isoleucine | Threonine | Asparagine | Serine | C |
| | Isoleucine | Threonine | Lysine | Arginine | A |
| | Methionine | Threonine | Lysine | Arginine | G |
| G | Valine | Alanine | Aspartic Acid | Glycine | U |
| | Valine | Alanine | Aspartic Acid | Glycine | C |
| | Valine | Alanine | Glutamic Acid | Glycine | A |
| | Valine | Alanine | Glutamic Acid | Glycine | G |

## POST-INTERVENTION (PSAT) QUESTIONS 2

**UNIVERSITY OF EDUCATION, WINNEBA**

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

**QUIZ #2**

**Duration: 25minutes**

Code……………

Date………………

Sex: Male ☐

Female ☐

Form: SHS 2B1 ☐ SHS 2B2 ☐ SHS 2B3 ☐

1. What does DNA stand for? ..................................................................

2. What type of sugar is found in DNA? ...........................................................

3. What type of bond holds the bases in DNA together? …………………………………

4. a. What is the term for a double ringed base? ……………………………………………..

   b. Give 2 examples of this type of base. …………………………………………….

5. a. What is the term for a single ringed base? ………………………………………….

   b. Give 2 examples of this type of base. ……………………………………………

6. How many nucleotides are shown is the diagram above?

…………………………………….

7. What is the shape of a DNA molecule? ……………………………………………..

8. What are the ―rungs” of the DNA molecule? ………………………………………….

9. What is the ―backbone” of the DNA molecule? …………………………………….

10. What is the monomer of DNA? …………………………………………

11. What Guanine ONLY bond with? ……………………………………………

12. What does Thymine ONLY bond with? …………………………………..

13. What is the first step to DNA Replication? ………………………………..

14. What type of enzyme matches up free floating nucleotides to the parent strand?

…………

15. What is the term for the DNA strand that acts as a pattern to the newly synthesized DNA?

……………………………………………………………….

16. What is the end product of DNA replication?

………………………………………….

17. What nucleotide complements cytosine? …………………………………………….

18. What nucleotide complements adenine? …………………………………………….

19. Give the complementary DNA strand to the DNA below.

ATCGGCGTAGCGTAAGCTACGTAGCTTTAGC

……………………………………………………………..

20. Where does DNA replication occur in the cell? …………………………………….

21. During which phase of the cell cycle does DNA replicate itself?

……………………………

## POST-INTERVENTION (PSAT) QUESTIONS

**UNIVERSITY OF EDUCATION, WINNEBA**

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

**QUIZ #3**

**Duration: 20minutes**

Identify the following characteristics as DNA or RNA.

1. ………..contains deoxyribose

2. ………..contains A, T, C and G

3. ……….. single stranded molecule

4. ………..double helix

5. ……….. contains ribose

6. ………... contains A, U, C and G

7. ………… found ONLY in the nucleus

8. ……….. found in the nucleus and cytoplasm

9. ………..3 different types: m, t and r

10. ……….shape discovered by Watson & Crick

11. ………..AUGCCUAGUC

12. …………ATCGTTAGCT

13. What process makes mRNA? ……………..

14. What type of RNA makes up ribosomes? …………..

15. What type of RNA carries amino acids to the ribosome? …………..

16. What does the ―m” in mRNA stand for? …………………

17. Where in the cell is mRNA made? ……………….

18. Where does mRNA go after it leaves the nucleus? ……………….

19. What does the ―t” in tRNA stand for? ..............

20. What process occurs at the ribosome? ………………..

21. What would be the mRNA for the following DNA strand?

DNA: TACGGCATCGTAGCTA

mRNA: …………………………

# POST-INTERVENTION (PSAT) QUESTIONS

## UNIVERSITY OF EDUCATION, WINNEBA

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

**QUIZ #4**

**Duration: 15 minutes**

1. What is the term for the 3 bases ion the tRNA that matches with the 3 bases on the mRNA?

……………………………

2. What is the ANTICODON to the following codons?

A. AUG ……. B. UGC …….. C. GGC …….. D. CUA ………

3. What occurs during translation? …………..

4. What occurs during transcription? …………………..

5. How are transcription and translation different?

……………………………………………………………………………………………
……………………………………………………………………………………………
………………………………

6. What does the tRNA carry to the ribosome? ………………………………………..

7. What is the final product of protein synthesis? ………………………..

8. What molecule in protein synthesis is ONLY found in the nucleus? ……………..

9. What is the name of the enzyme that makes mRNA? ………………………….

10. What organelle is involved in translation? …………………………………..

**POST-INTERVENTION (PSAT) QUESTIONS**

**UNIVERSITY OF EDUCATION, WINNEBA**

**Department of Science Education**

**Protein Synthesis Achievement Test (PSAT)**

**QUIZ #4**

1. Which of the following mutations would likely be most dangerous to a cell?

a. Deletion of three nucleotides

*b. Addition of one nucleotide*

c. Substitution of one nucleotide for another

2. Which of the following molecules is (are) produced by transcription?

*a. Ribosomal RNA*

b. Ribosomal proteins

*c. Messenger RNA*

*d. Transfer RNA*

3. Which of the following molecules is (are) produced by translation? (Include molecules that are subject to further modification after initial synthesis.)

a. The amino acid glycine

*b. Ribosomal proteins*

c. Transfer RNA

*d. The digestive enzyme pepsin*

*e. RNA polymerase*

f. Ribozymes

Explain the significance of each of these characteristic features of transcription and translation:

1. A promoter region is found several dozen nucleotide pairs upstream from the starting point for transcription.

2. A 5‘ cap and a poly-A tail are added to a eukaryotic pre-mRNA molecule.

3. The average length of a transcription unit along a eukaryotic DNA molecule is about 8,000 nucleotides, whereas an average-sized protein is about 400 amino acids long.

4. A number of genes are subject to alternative RNA splicing.

5. Translation of mRNA involves the formation of polyribosomes.

# APPENDIX G

## MARKING SCHEMES

### MARKING SCHEME FOR QUIZ #2

**The Structure of DNA and DNA Replication**

1. Deoxyribo Nucleic Acid

2. Deoxyribose

3. hydrogen bond

4. a. purine

   b. A & G

5. a. Pyramidine

   b. T & C

6. 4

7. Double helix

8. Bases

9. Phosphates & sugars

10. Nucleotide

11. Cytosine

12. Adenine

13. DNA molecule unzips

14. DNA polymerase

15. Template

16. 2 identical strands of DNA

17. Guanine

18. Thymine

19. TAGCCGCATCGCATTCGATGCATCGAAATCG

20, NUCLEUS

21. S phase

## MARKING SCHEME FOR QUIZ #3

**RNA vs. DNA and Types of RNA**

1. DNA

2. DNA

3. RNA

4. DNA

5. RNA

6. RNA

7. DNA

8. RNA

9. RNA

10. DNA

11. RNA

12. DNA

13. transcription

14. rRNA

15. tRNA

16. Messenger

17. Nucleus

18. the ribosome

19. Transfer

20. Translation

21. mRNA: AUGCCGUAGCAUCGAU

**MARKING SCHEME FOR QUIZ #4**

1. Anticodon

2. A. UAC

   B. ACG

   C. CCG

   D. GAU

3. Protein is made

4. mRNA is made

5. Transcription makes mRNA and opccur in the nucleus, translation makes protein and occurs in the ribosome

6. Ribosome

7. Protein

8. DNA

9. RNA polymerase

10. Amino acid

## INTERVENTIONS FOR QUIZ #5

### Students' Misconception Exercise

1. A significant number of students have the mistaken notion that amino acids are produced by translation. As students study protein synthesis, they learn that each codon specifies an amino acid and that amino acids are involved in translation. They also learn that various enzymes, such as aminoacyl-tRNA synthetase, play roles in protein synthesis. Some students have difficulty understanding which of the molecules involved in translation the products of protein synthesis are also. These students may think that amino acids—but not enzymes involved in protein synthesis—are produced by translation.

2. It may be difficult for students to keep track of the plethora of RNA molecules and the roles they play. I emphasize the reasons for the versatility of this molecule, and clarify for students the significance of the multiple roles of RNA.

### Addressing and correcting the misconceptions that students have about protein synthesis

1. You might wish to address student confusion about the products of translation in your lectures on protein synthesis. Clarify for students those products of protein synthesis.

Recognize that students may not understand the source of amino acids that are used in translation, and address this topic directly.

2. Discuss the relatively recent discovery of ribozymes, pointing out to students that our understanding of the processes of life continues to change and grow, and that each new discovery can lead to new and exciting questions.

3. Emphasize to students that proteins are not the only catalysts in living cells. The discovery of ribozymes and the increasing recognition of the important role they play in translation have changed our understanding of protein synthesis and provided new insights into the origin of life on Earth. When you discuss ribozymes with your class, make the point that our understanding of the processes of life continues to change and grow, and that each new discovery can lead to new and exciting questions.

# APPENDIX H

## STUDENTS' LEARNING PROGRESS MONITORING SHEET.

**Week**:

**Date**:

**Task number**:

**Criteria**

1. Response relates to the question asked
2. Response includes explanation
3. Response reflects understanding of concepts learnt (Response describe the situation demanded by the question).

**Preamble**: Responses which include explanation are tallied and classified as ―With explanation" (WE). Responses which do not include explanation are classified as under ―No explanation". Responses which relate to the question asked and describe the situation demanded by the question are classified as Understanding" (U). Responses which relate to the question but do not describe the situation demanded by the questions are classified as ―No understanding" (NU).

1. Responses are with explanations

| | With explanation (WE) | | No Explanation (NE) | |
|---|---|---|---|---|
| Question | Tally | % Frequency | Tally | % Frequency |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

2. Responses reflect understanding of concepts learnt.

| | Understanding (U) | | No Understanding (NU) | |
|---|---|---|---|---|
| Question | Tally | % Frequency | Tally | % Frequency |
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

# APPENDIX I

## TEACHING AND LEARNING RECORD SHEET

1. Teacher prepares scheme of work

……………………………………………………………………………………………….

2. Lessons are delivered with the use of lesson plan

..
…………………………………………………………………………………………………
.

3. Lesson notes have;

A. instructional objectives

………………………………………………………………………………………………..

B. Teaching and learning activities

………………………………………………………………………………………………..

C. Evaluation exercises

…………………………………………………………………………………………………

4. Activities done by students in the classroom include;

A. Classroom tests

Total………………

B. Exercises

Total ……………

C. Home works

Total………………

D. Project works

………………

# APPENDIX J

## Reliability Coefficients

### Questionnaire

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 90 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 90 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .842 | .838 | 52 |

**Learning Strategies in Protein Synthesis**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 90 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 90 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .734 | .737 | 20 |

**Self-efficacy level of students**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 90 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 90 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .707 | .700 | 11 |

**Misconceptions in Protein Synthesis**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 90 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 90 | 100.0 |

a. Listwise deletion based on all variables in the procedure.

**Reliability Statistics**

| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .704 | .702 | 10 |

**Attribution of interest in Protein Synthesis**

**Case Processing Summary**

| | | N | % |
|---|---|---|---|
| Cases | Valid | 90 | 100.0 |
| | Excluded[a] | 0 | .0 |
| | Total | 90 | 100.0 |

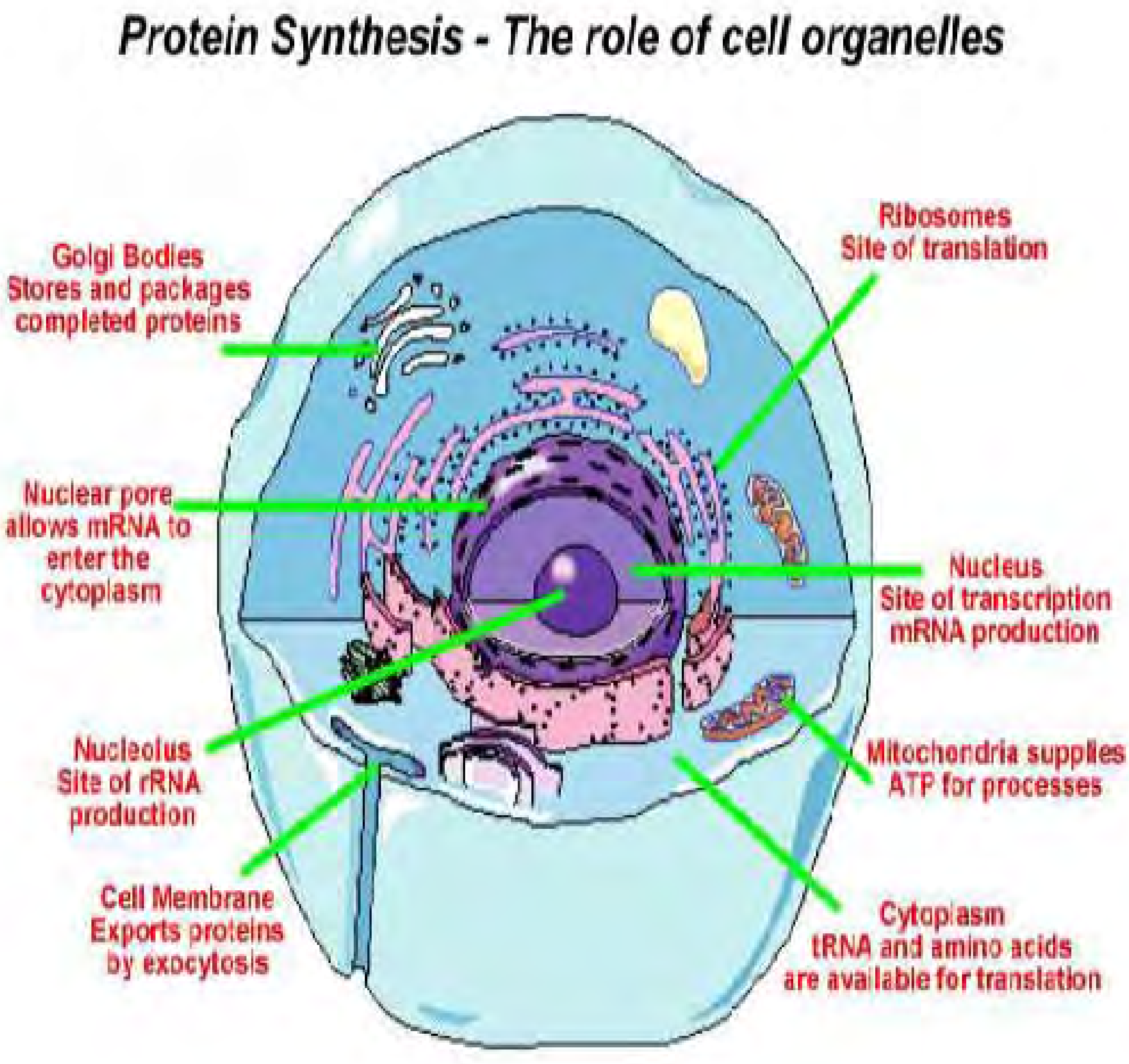
a. Listwise deletion based on all variables in the procedure.

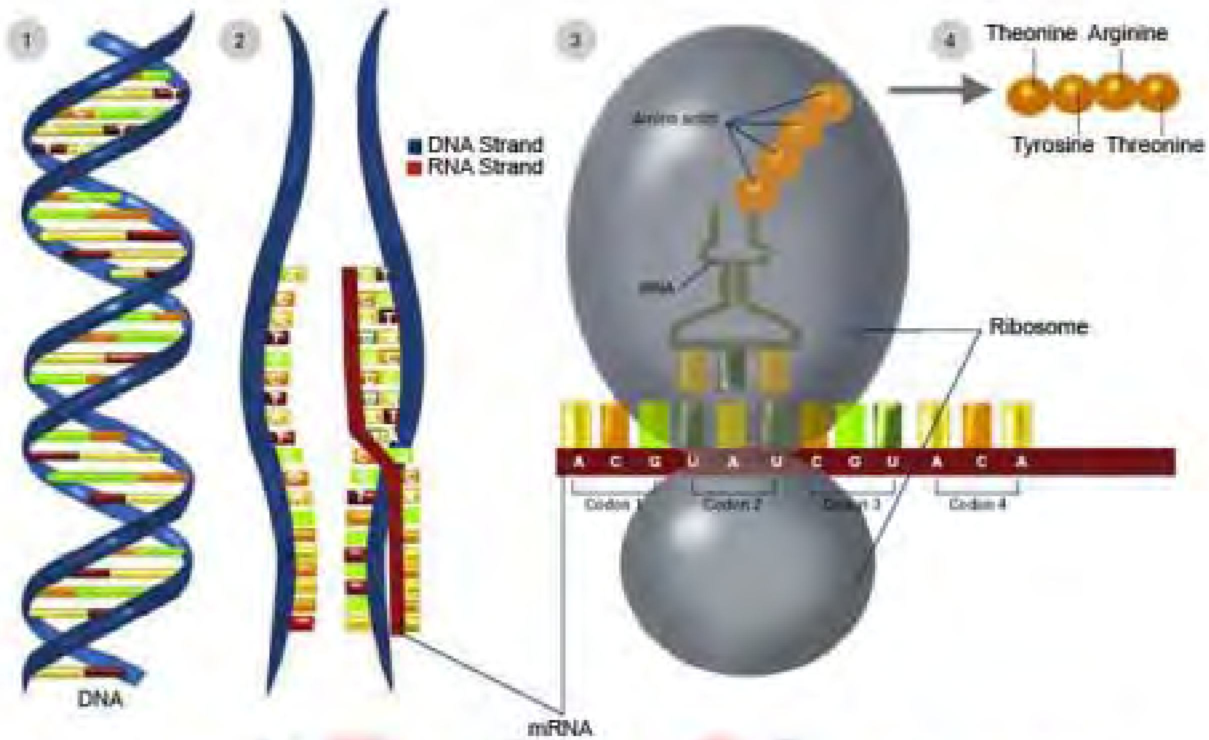
**Reliability Statistics**

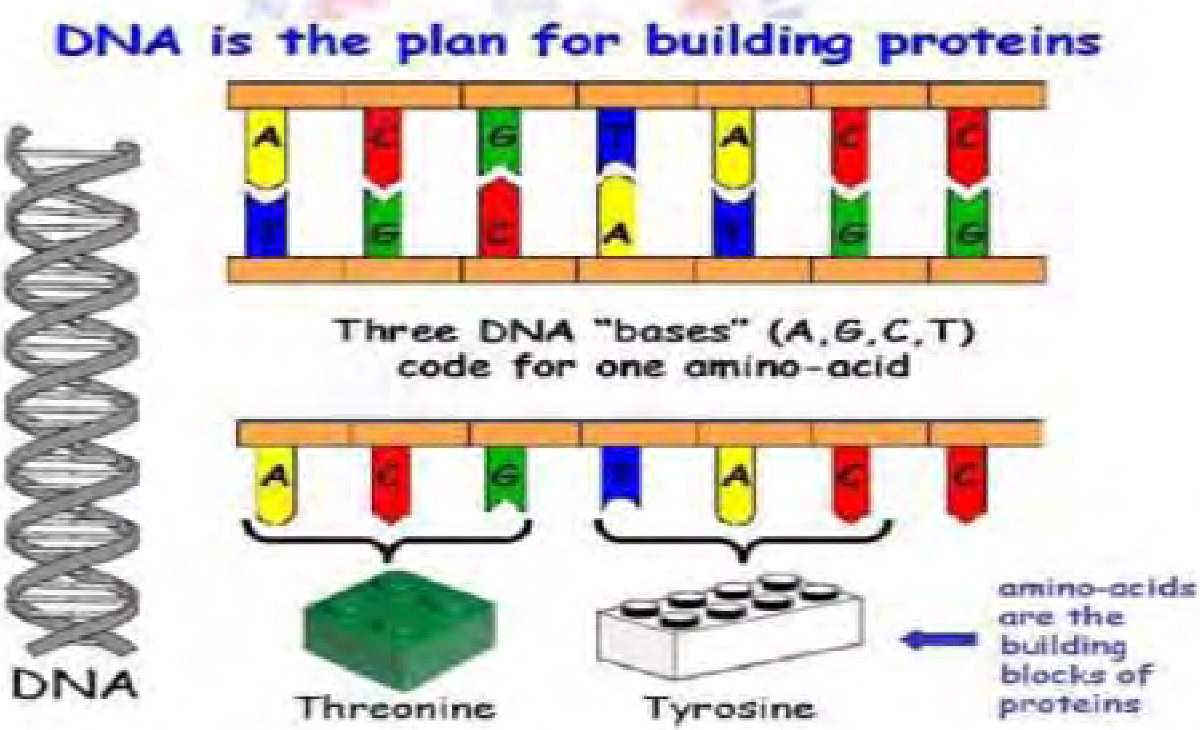
| Cronbach's Alpha | Cronbach's Alpha Based on Standardized Items | N of Items |
|---|---|---|
| .587 | .573 | 11 |

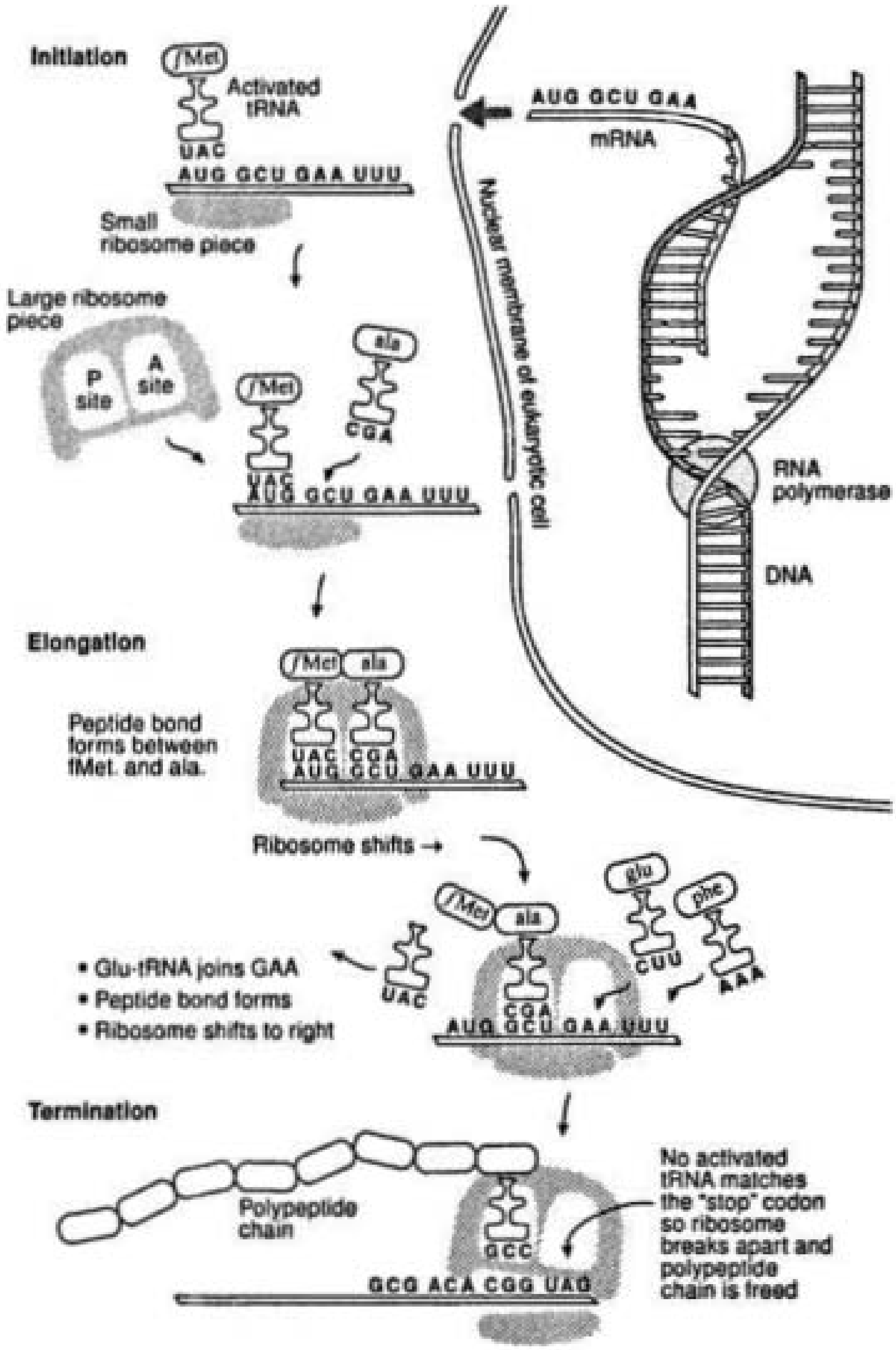
# APPENDIX K

## SELECTED SLIDES AND IMAGES

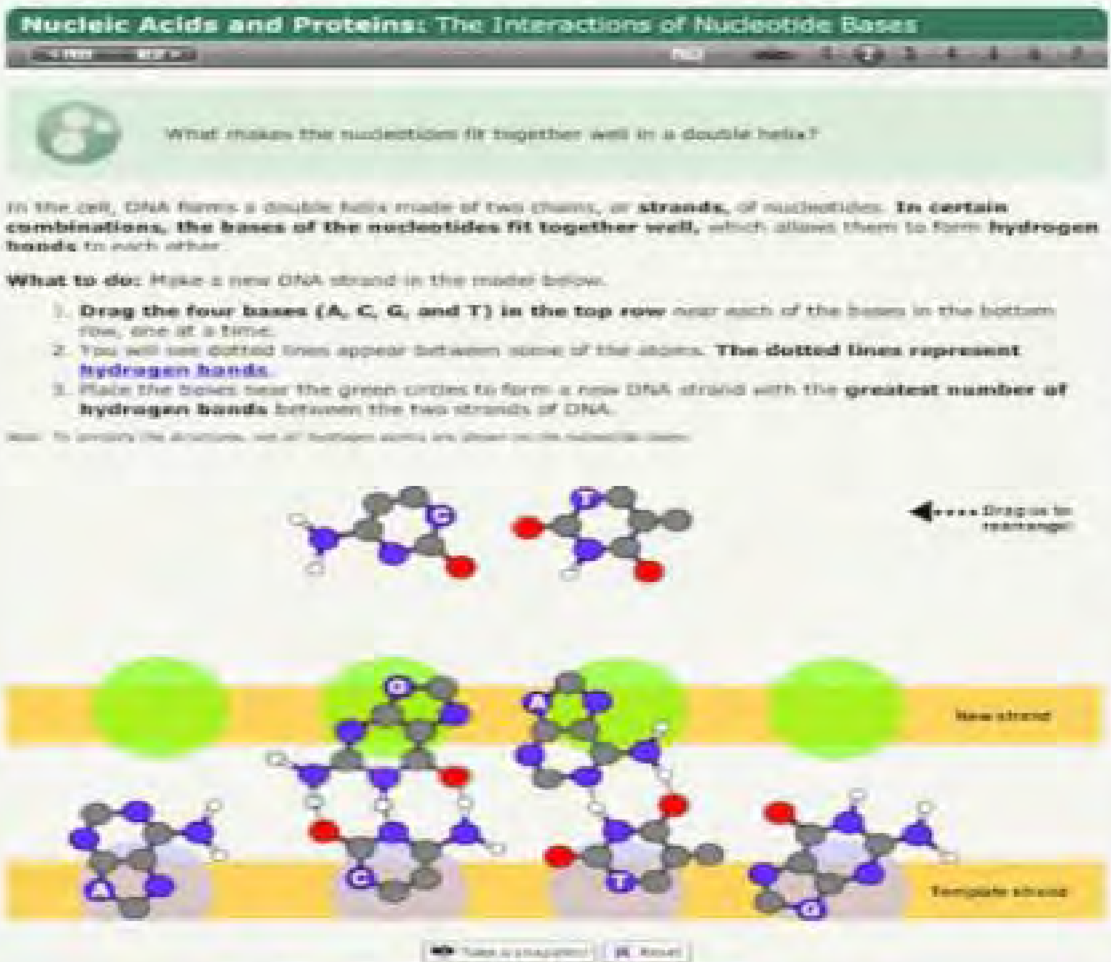


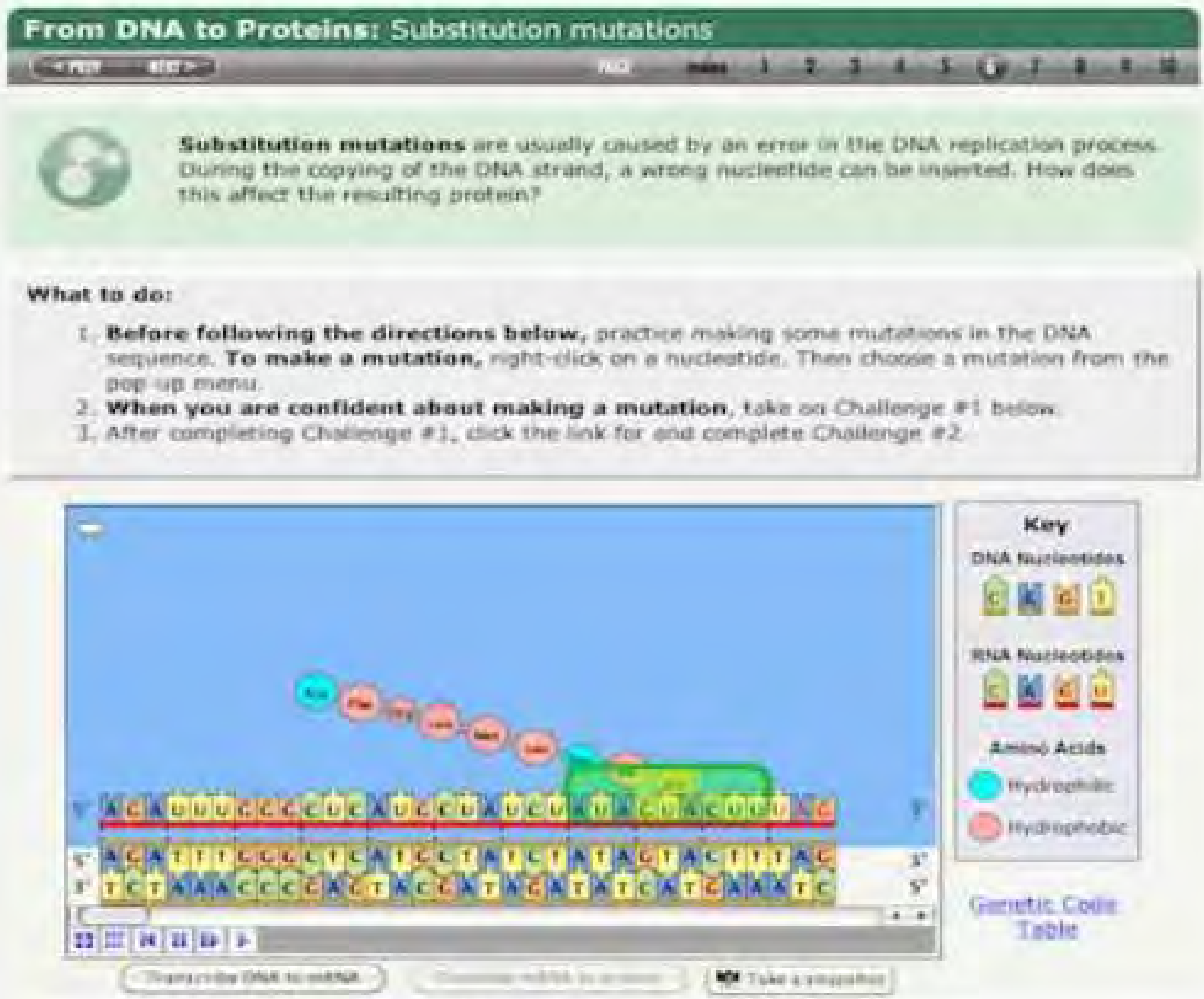

1
2
3
4
Theonine Arginine
Tyrosine Threonine
DNA Strand
RNA Strand
Ribosome
A C G U A U C G U A C A
DNA
mRNA


DNA is the plan for building proteins
Three DNA "bases" (A,G,C,T)
code for one amino-acid
DNA
Threonine
Tyrosine
amino-acids
are the
building
blocks of
proteins



Initiation
fMet
Activated tRNA
UAC
AUG GCU GAA UUU
Small ribosome piece
Large ribosome piece
P site
A site
ala
CGA
AUG GCU GAA
mRNA
Nuclear membrane of eukaryotic cell
RNA polymerase
DNA
Elongation
Peptide bond forms between fMet. and ala.
Ribosome shifts →
glu
phe
CUU
AAA
• Glu-tRNA joins GAA
• Peptide bond forms
• Ribosome shifts to right
Termination
Polypeptide chain
GCC
GCG ACA CGG UAG
No activated tRNA matches the "stop" codon so ribosome breaks apart and polypeptide chain is freed


Nucleic Acids and Proteins: The Interactions of Nucleotide Bases
What makes the nucleotides fit together well in a double helix?
In the cell, DNA forms a double helix made of two chains, or strands, of nucleotides. In certain combinations, the bases of the nucleotides fit together well, which allows them to form hydrogen bonds to each other.
What to do: Make a new DNA strand in the model below.
1. Drag the four bases (A, C, G, and T) in the top row near each of the bases in the bottom row, one at a time.
2. You will see dotted lines appear between some of the atoms. The dotted lines represent hydrogen bonds.
3. Place the bases near the green circles to form a new DNA strand with the greatest number of hydrogen bonds between the two strands of DNA.
C
T
G
A
New strand
A
C
T
G
Template strand



From DNA to Proteins: Substitution mutations
Substitution mutations are usually caused by an error in the DNA replication process. During the copying of the DNA strand, a wrong nucleotide can be inserted. How does this affect the resulting protein?
What to do:
1. Before following the directions below, practice making some mutations in the DNA sequence. To make a mutation, right-click on a nucleotide. Then choose a mutation from the pop-up menu.
2. When you are confident about making a mutation, take on Challenge #1 below.
3. After completing Challenge #1, click the link for and complete Challenge #2.
Key
DNA Nucleotides
RNA Nucleotides
Amino Acids
Hydrophilic
Hydrophobic
Genetic Code Table

# APPENDIX L