Unit_1
(Object Oriented Biology)

Overall Course Description

This course (Unit_1-Unit_10) provides the basics of object oriented programming descendants based on molecular biology. Also, it offers basic skills in problem solving and object-oriented programming using a high-level language such as Java. Topics include algorithm development, simple data types, expressions and statements, program flow control structures, objects, methods, and arrays.

Overall Learning Goals

At the completion of this course, the students will be able to understands the origin of object oriented programming, apply, design and development principles in the construction of software systems of varying complexity, read a problem description, design an algorithm to solve the problem and document their solution. Also, design, implement, and document applications using object-oriented programming concepts.

Unit_1 Objective

-Understand the concept of cells
-Understand the concept of nucleus
-Understand the concept of ribosomes
-Understand the concept of mitochondria
-Understand the concept of enzymes
-Understand the concept of chromosomes
-Understand the concept of amino acids and proteins
-Understand the concept of integration of concepts
-Understand the concept of Deoxyribonucleic Acid, DNA elements
-Understand the concept of interpretation of concepts

The goal of Unit_1 is to learn and understand how any object oriented language descends from molecular biology. It will be demonstrated in this unit that there is one knowledge source, which can be related to any OOP language and a relationship of one to many can be established.

Furthermore, below are all the competencies listed that one should master after studying Unit_1.

A. PLAN:

A.1. Cells
A.2. Nucleus
A.3. Ribosomes
A.4. Mitochondria
A.5. Enzymes
A.6. Chromosomes
A.7. Amino Acids and Proteins
A.8. Integration of Concepts
A.9. Deoxyribonucleic Acid and DNA Elements
A.10. Interpretation of Concepts

Competence Scope
Identifier: A.1
Name: Cells
Description: An ability to apply design and development principles of cells in the construction of software systems of varying complexity.

Skills Examples:

S1: using cells for understanding Object Oriented Programming.

Knowledge Examples:

K1: cells in Object Oriented Programming.

Proficiency Levels:

P1: using cells for understanding Object Oriented Programming with an application to any Object Oriented Programming Language.

Competence Scope
Identifier: A.2
Name: Nucleus
Description: An ability to apply design and development principles of nucleus in the construction of software systems of varying complexity.

Skills Examples:

S1: using nucleus for understanding Object Oriented Programming.

Knowledge Examples:

K1: nucleus in Object Oriented Programming.

Proficiency Levels:

P1: using nucleus for understanding Object Oriented Programming with an application to any Object Oriented Language

Competence Scope
Identifier: A.3
Name: Ribosomes
Description: An ability to apply design and development principles of ribosomes in the construction of software systems of varying complexity.

Skills Examples:

S1: using ribosomes for understanding Object Oriented Programming.

Knowledge Examples:

K1: ribosomes in Object Oriented Programming.

Proficiency Levels:

P1: using ribosomes for understanding Object Oriented Programming with an application to any Object Oriented Language

Competence Scope
Identifier: A.4
Name: Mitochondria
Description: An ability to apply design and development principles of mitochondria in the construction of software systems of varying complexity.

Skills Examples:

S1: using mitochondria for understanding Object Oriented Programming.

Knowledge Examples:

K1: mitochondria in Object Oriented Programming.

Proficiency Levels:

P1: using mitochondria for understanding Object Oriented Programming with an application to any Object Oriented Language

Competence Scope
Identifier: A.5
Name: Enzymes
Description: An ability to apply design and development principles of enzymes in the construction of software systems of varying complexity.

Skills Examples:

S1: using enzymes for understanding iterations in Object Oriented Programming.

Knowledge Examples:

K1: enzymes in Object Oriented Programming.

Proficiency Levels:

P1: using enzymes for understanding iterations in OOC with an application to any Object Oriented Language

Competence Scope
Identifier: A.6
Name: Chromosomes
Description: An ability to apply design and development principles of chromosomes in the construction of software systems of varying complexity.

Skills Examples:

S1: using chromosomes for understanding iterations in Object Oriented Programming.

Knowledge Examples:

K1: chromosomes in Object Oriented Programming.

Proficiency Levels:

P1: using chromosomes for understanding Object Oriented Language with an application to any Object Oriented Language

Competence Scope
Identifier: A.7
Name: Amino Acids and Proteins
Description: An ability to apply design and development principles of amino acids and proteins in the construction of software systems of varying complexity.

Skills Examples:

S1: using amino acids and proteins for understanding Object Oriented Programming.

Knowledge Examples:

K1: amino acids and proteins in Object Oriented Programming.

Proficiency Levels:

P1: using amino acids and proteins for understanding Object Oriented Language with an application to any Object Oriented Language

Competence Scope
Identifier: A.8
Name: Integration of Concepts
Description: An ability to apply design and development principles of integration of concepts in the construction of software systems of varying complexity.

Skills Examples:

S1: using integration of concepts for understanding Object Oriented Programming.

Knowledge Examples:

K1: integration of concepts in Object Oriented Programming.

Proficiency Levels:

P1: using integration of concepts for understanding Object Oriented Language with an application to any Object Oriented Language

Competence Scope
Identifier: A.9
Name: DNA Elements
Description: An ability to apply design and development principles of DNA elements in the construction of software systems of varying complexity.

Skills Examples:

S1: using DNA elements for understanding Object Oriented Programming.

Knowledge Examples:

K1: DNA elements in Object Oriented Programming.

Proficiency Levels:

P1: using DNA elements for understanding Object Oriented Language with an application to any Object Oriented Language

Competence Scope
Identifier: A.10
Name: Interpretation of Concepts
Description: An ability to apply design and development principles of interpretation of concepts in the construction of software systems of varying complexity.

Skills Examples:

S1: using interpretation of concepts for understanding Object Oriented Programming.

Knowledge Examples:

K1: interpretation of concepts in Object Oriented Programming.

Proficiency Levels:

P1: using interpretation of concepts for understanding Object Oriented Language with an application to any Object Oriented Language

Unit_1 Contents

Table of Contents

1.0 Object Oriented Biology, OOB

Unit_1 will demonstrate that all OOP languages descend from the **Deoxyribonucleic Acid** (DNA) representing a programming language of life. Furthermore, it will provide a background in molecular biology for the purpose of understanding the origin of OOP languages more precise a background on genetics.

1.1 The Cell

The cell is the basic unit of life where each type of cell is different and performs a different function. The cell is divided into two main categories: prokaryotic and eukaryotic. The prokaryotic cell is small and contains no nucleus like bacteria where the eukaryotic cell has a nucleus, which houses the cell's DNA. The cells are shown in the Fig. 1 below:

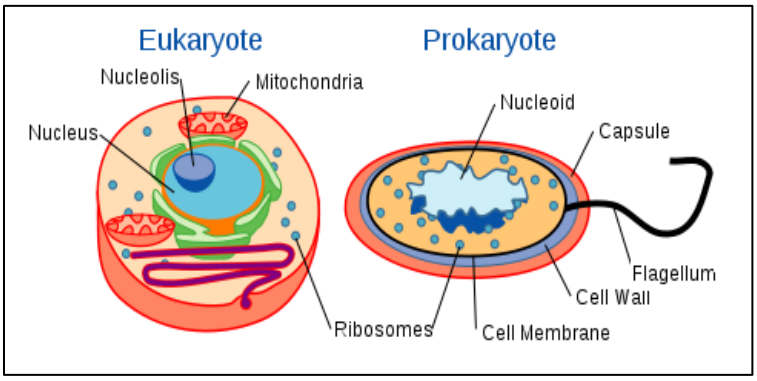

Fig. 1

The membrane or skin is the outer boundary of the cell and it allows some substances in and keeps others out. The mitochondria are where the cell gets its energy from. Food that is digested reacts with oxygen in the mitochondria to make energy for the cell. The ribosomes are tiny factories that make different things the cell needs to function, like proteins. The nucleus is the brains of the cell and it uses chromosomes to instruct the rest of the cell what to do next. The cytoplasm fills up the cell and other components of the cell that float around in the cytoplasm, which is mostly water. The lysosomes get rid of waste and other unwanted substances that get into the cell. The machines inside the cell like the nucleus, ribosomes, and lysosomes are known as organelles.

1.2 Self-Check Questions for The Cell Sub-Section

1. What is a cell?
2. What are the two main categories of a cell?
3. What is a membrane?
4. What is a mitochondrion?

1.3 The Nucleus

The nucleus of the cell is the main control center and acts like the cell's brain. Remember that the eukaryotic cells have a nucleus and it is an organelle in the cell, which has a special function that is surrounded by a membrane **(outer boundary of the cell)** that protects it from the rest of the cell where it floats within the cytoplasm **(fluid in the cell, mostly water)**. The most important function of the nucleus is to store the cell's genetic information in the form of DNA where it holds the instructions for how the cell should work. The molecules **(two atoms joined together)** of the DNA are organized into special structures known as chromosomes **(tiny structures made from DNA and protein)** where sections of the DNA are known as genes which hold hereditary information.

The nucleus holds another type of nucleic acid called **Ribonucleic Acid** (RNA), which makes proteins known as protein synthesis **(cell makes protein)**. The nucleus can make exact copies of its DNA. The nucleus makes RNA which can be used to carry messages and copies of DNA instructions known as transcription process and the RNA is used to configure amino acids into special proteins for use in the cell known as the translation process.

1.4 Self-Check Questions for the Nucleus Sub-Section

1. What is a Nucleus?
2. Does the eukaryotic cell have a nucleus?
3. What is a molecule?
4. What is another type of nucleic acid that the nucleus holds?
5. What is nucleus able to copy?

1.5 The Ribosome

The ribosome was discovered in 1974 by Albert Claude, Christian de Duve, and George Emil Palade and its purpose is to make proteins that perform all kinds of functions for the cell's operation. They are found in the liquid inside the cell called the cytoplasm. The ribosomes are a type of organelle which are structures that perform specific functions for the cell such as making proteins and it consists out of two main components known as the large subunit and the small subunit. These two units come together when the ribosome is ready to make a new protein where both subunits consist of strands of RNA **(copy of DNA)** and various proteins. The large subunit contains the site where new bonds are made when creating proteins and the small subunit is responsible for the flow of information during protein synthesis **(cell makes protein)**. The ribosome **(things cell requires to function)** is responsible for the translation process **(RNA is converted into a sequence of amino acids)**, which is explained in forthcoming section.

1.6 Self-Check Questions for the Ribosome Sub-Section

1. Where does the ribosome reside?
2. What are the two main components of the ribosome?
3. What is a ribosome?

1.7 The Mitochondria

Mitochondria are parts of cells that take food and make energy for the cell can use. Inside the cells are structures that perform specific functions for the cell known as organelles, which are responsible for producing energy for the cell that is the mitochondria. The main function of mitochondria is to produce energy for the cell using a special molecule **(two atoms joined together)** for energy called **Adenosine Triphosphate** (ATP). The ATP for the cell is made in the mitochondria and it produces energy through the process of cellular respiration or breathing. The mitochondria take food molecules in the form of carbohydrates and combine them with oxygen to create the ATP **(special molecule made from strings of amino acids)**. They use proteins known as enzymes to produce a chemical reaction.

1.8 Self-Check Questions for the Mitochondria Sub-Section

1. What is the main function of the mitochondria?
2. Where is Adenosine Triphosphate (ATP) made?
3. What is ATP made of?

1.9 Enzymes

Enzymes are specific types of proteins made from strings of amino acids. The function of the enzyme is determined via the sequence of amino acids, types of amino acids, and the shape of the string. They act as catalysts to help produce and speed up chemical reactions. When a cell needs a task done, it uses an enzyme **(strings of amino acids)** to speed things up, since they can be re-used.

Enzymes have a specific pocket on their surface known as an active site. The molecule **(two atoms joined together)** that they react with fits right into that pocket. The molecule or substance that the enzyme reacts with is known as the substrate. The reaction occurs between the enzyme and the substrate at the active site. After the reaction is complete, the new molecule **(two atoms joined together)** or substance is released by the enzyme. This new substance is known as the product. The enzyme **(strings of amino acids)** operation is shown in the Fig. 2 below:

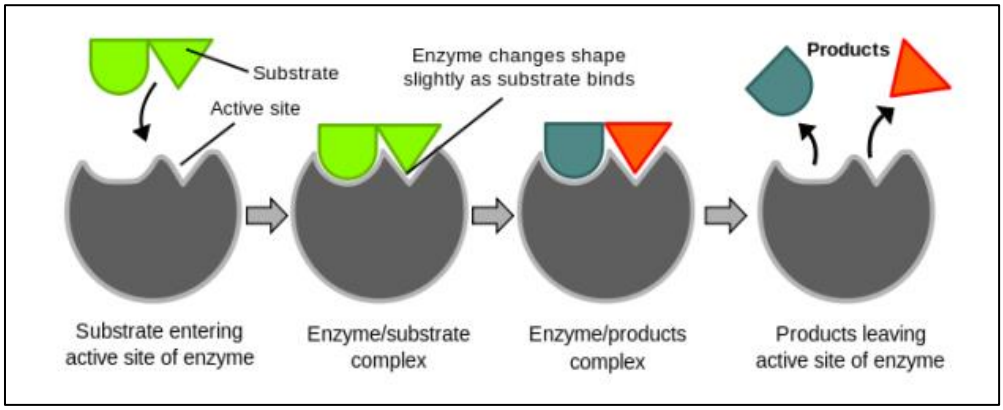

Fig. 2

1.10 Self-Check Questions for the Enzymes Sub-Section

1. What are enzymes?
2. What do enzymes do?
3. What is the result when enzymes react with a molecule?

1.11 Chromosomes

The word chromosome originated from the Greek words chroma, meaning color and soma meaning body. They are small structures found in cells more precise in the nucleus **(stores the cell genetic information)** made from the DNA **(responsible for the cell functionality inside the nucleus)** and protein. The data inside the chromosomes tell the cells how to function and replicate. Each chromosome contains sections of DNA known as genes where each gene has a code on how to make a specific protein.

1.12 Self-Check Questions for the Chromosomes Sub-Section

1. What are chromosomes?
2. What are chromosomes made of?

1.13 Deoxyribonucleic Acid, DNA

DNA is a molecule for life, and it contains instructions for telling our bodies how to develop and function. It is a long molecule **(two atoms joined together)** made up of four different nucleotides such as adenine **(A)**, thymine **(T)**, cytosine **(C)**, and guanine **(G)**. Nucleotides or bases are held together by a backbone made of phosphate and deoxyribose. There are four nucleotides and three letter codons, which code for one of twenty amino acids in living cells meaning $4^3 - 3 \text{ stop messages} = 61 \text{ three letter codons}$. The basic structure of the DNA is shown in the Fig. 3 below:

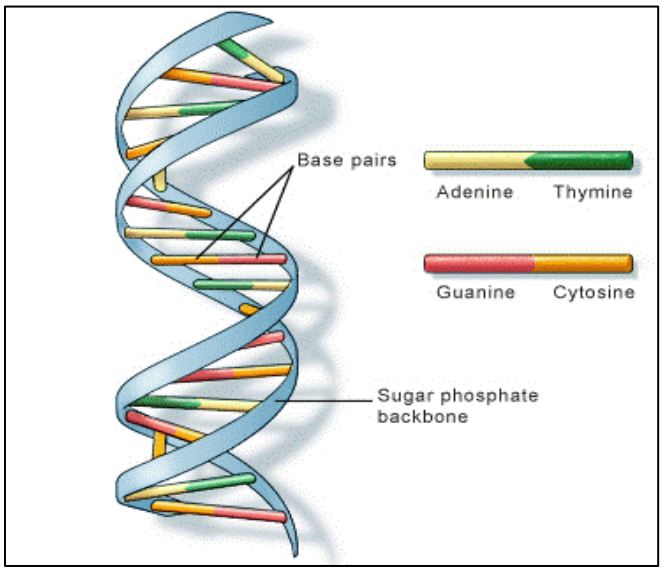

Fig. 3

The structure of DNA was discovered by James Watson and Francis Crick in 1953 and is organized into structures identified as chromosomes **(tiny structures made from DNA and protein)** inside the cell. Its shape is a double helix and on the outside of the double helix is the backbone which holds the DNA together. There are two sets of backbones that twist together where between the backbones are the nucleotides represented by the letters A, T, C, and G. A different nucleotide connects to each backbone and then connects to another nucleotide in the center. Specific sets of nucleotides can only connect A to T and G to C.

The human body have around 210 different types of cells where each cell does a different job to help the body function. Cells receive their instructions on what do to from the DNA **(responsible for the cell functionality inside the nucleus)**, which acts like a computer program or code and the cell is the computer or the computer hardware. The DNA code is held together by different letters of the nucleotides. As the cell reads the instructions on the DNA the different letters represent instructions that is every three letters make up a word known as codon. An example of string of codons is shown below:

GGC AAT…

Each string of the DNA contains sets of instructions known as genes. A gene instructs the cell on how to make a specific protein for performing various functions.

1.14 Self-Check Questions for the Deoxyribonucleic Acid, DNA Sub-Section

1. What is DNA standing for?
2. What are the four nucleotide names?
3. What is a codon?
4. How many three-letter codons are there?
5. What is the shape of the DNA?
6. Where does the cell receive its instruction from?

1.15 Amino Acids and Proteins

Amino acids are organic molecules **(two atoms joined together)** used by living organisms to make proteins, which consists out of carbon, hydrogen, oxygen, and nitrogen. There are twenty different kinds of amino acids that combine to make proteins in human bodies from food. Proteins are long chains of amino acids and provide functions for the human body survival. Proteins are made inside cells therefore when a cell produces a protein it is called protein synthesis **(cell makes protein)**. The instructions for how to make a protein are held in DNA molecules inside the cell nucleus **(stores the cell genetic information)**. There are two processes in making a protein known as transcription and translation. The first step in making a protein known as transcription meaning when the cell makes a copy of the DNA. The copy of DNA is known as RNA, since it uses a different type of nucleic acid (DNA) called **ribonucleic acid** (RNA). The RNA **(cell makes copy of DNA)** is used in the next step, which is called translation process. The RNA is translated into a sequence of amino acids **(organic molecules)** that creates the protein. This process of making the new protein from the RNA instructions in the ribosome **(things cell needs to function)**, which is found inside the cell. The following steps take place in the ribosome. The RNA moves to the ribosome known as the **messenger RNA** (mRNA) and attaches itself to the ribosome. The ribosome figures out where to start on the mRNA by finding a specific three letter start sequence known as codon. The ribosome then moves down the strand of mRNA where every three letters represents another amino acid molecule and the ribosome builds a string of amino acids based on the codes in the mRNA **(RNA moves to ribosome)**. Once the ribosome detects the stop code, it ends the translation process **(RNA is converted into a sequence of amino acids)** meaning the protein is complete. The two-step process is shown in the Fig. 4 below:

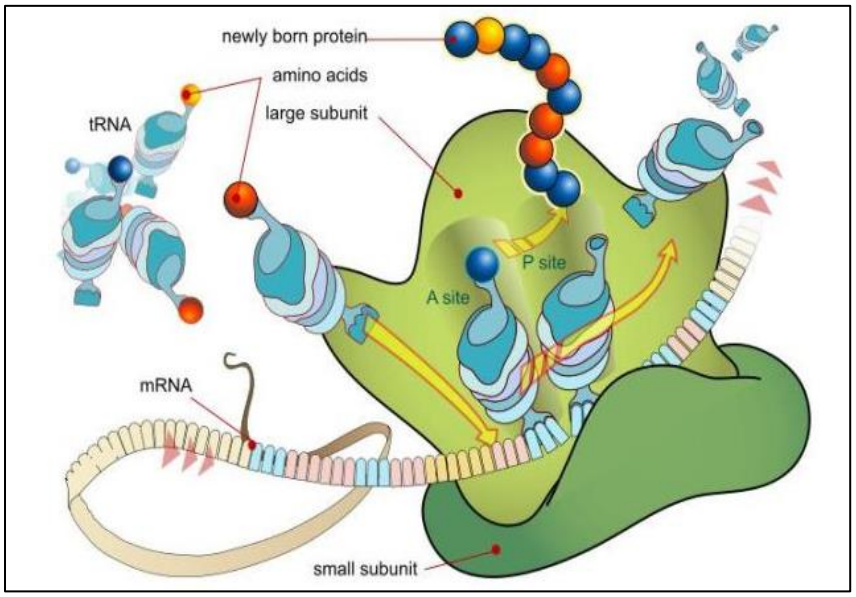

Fig. 4

There are many different types of proteins in our bodies such as defensive proteins, which help protect us from diseases. Also, transport proteins that carry essential nutrients around our bodies an example would be hemoglobin **(carries oxygen in red blood cells)**. Finally, catalysts **(substance which increases the rate of a chemical reaction)** proteins, like enzymes **(strings of amino acids)** act as catalysts to assist in chemical reactions by helping to break up and digesting food so it can be used by cells. A specific RNA **(copy of DNA)** called **transfer RNA** (tRNA) moves the amino acids **(organic molecules)** to the ribosome **(things cell requires to function)** and the bonds that link the amino acids in a protein together are known as peptide bonds. The arrangement and type of different amino acids along the protein strand determines the functionality of the protein.

1.16 Self-Checked Questions for Amino Acids and Proteins Sub-Section

1. What is an Amino Acid?
2. How many kinds of Amino Acids exist in the human body?
3. What are proteins?
4. What does protein synthesis mean?
5. What are the two processes that make protein?
6. What is the name of a copy of a DNA known as?
7. What is the name for when RNA moves to the ribosome?
8. What kind of protein is hemoglobin?
9. What are peptide bonds?

1.17 Integration of Concepts

It is possible to show that OOP languages logic originates from molecular biology the programming language of life and then transformed into pseudo notation from there into a scientific language such as OOC and then applied to a variety of OO programming languages.

Let's begin with the development of a cell **(basic unit of life)**, which is created from a genetic blueprint in the form of DNA **(responsible for cell functionality inside nucleus)**. The gene is a specific section of DNA, which entails a sequence or RNA **(copy of DNA)** that codes for a molecule that has a function, describes attributes or properties and behavior of a cell it creates with a unique internal state. The cell can belong to different classes such as a plant or animal, but all of them are derived from the class cell. The cell has a plasma membrane or cell wall, which encapsulates and protects the internal cell structure from other cells. Furthermore, it can transfer information through its plasma membrane **(cell wall)** using the cell receptors for communication processes. The cell organelles or internal organs of a cell are responsible for the cell internal processes, which occur within the boundaries of the plasma membrane. Some of them for example would be the Golgi apparatus that modifies, packages, and sorts proteins sent from the endoplasmic reticulum or tubes that allow transportation of chemical compounds to and from the nucleus **(stores the cell genetic information)** and mitochondria, which produce energy for the cell. When cells are instantiated at first, they all look the same, but once they diverge or split, they transform themselves into specialties like red blood cells, skin cells, and many others where each cell type has a constructor method or nucleus **(stores the cell genetic information)** precise to its class.

1.18 Self-Checked Questions for Integration of Concepts

1. Where does the cell originate from?
2. What is a gene?
3. How does the cell transfer information?
4. How does the cell communicate with other cells?
5. What are cell organelles?
6. What is a endoplasmic reticulum?

1.19 DNA Elements

Furthermore, it is possible to explain via molecular biology the descendants of data types, decisions, and iterations in OOP languages.

One can state that the DNA unit is a basic instruction if at least one promoter, a start point of the transcriptional unit **(cell makes a copy of the DNA)** and one terminator, end of the transcriptional unit is included. The activation of a basic instruction can be initialized by passing the process of biosynthesis that is when cells build protein. An operon can be understood as a basic instruction that is a unit of the protein synthesis **(cell makes a protein)** process which includes structure genes **(input sequence for the protein synthesis process)**, operator genes, one or more promoter and a terminator gene. The activation of a basic instruction includes metabolic processes such as transcription **(cell makes copy of DNA)** and translation **(RNA is converted into a sequence of amino acids)** and is like an instruction execution process inside a computer system.

1.20 Self-Checked Questions for DNA Elements

1. What is a promoter?
2. What is a terminator?
3. What is the meaning of biosynthesis?
4. What are metabolic processes?

1.21 Interpretation of Concepts

Suppose that the DNA **(responsible for cell functionality inside the nucleus)** is a genetic program of a cell, which leads to a cytoplasm **(fluid in the cell, mostly water)**. It is like a data type that can be compared to a computer instruction which can change data so that at least one data type like integer must be available. The data type can be represented by metabolites or intermediate products and modified by biochemical reactions. If storing ten values of the same data type would be required it would be necessary to use ten variables, but that would be too complicated. A better approach would be to use molecular elements or group of similar atoms, which can be classified as the array meaning store elements of the same type together.

Enzymes **(strings of amino acids)** can catalyze or able to increase the rate of biochemical reactions using a material with a definite chemical composition in such a way that a substrate or a molecule that is acted upon by an enzyme **(strings of amino acids)** will be modified into a new product. Therefore, instructions can be classified as chemical reactions affected by enzymes which are represented by structure genes providing input sequence for the protein synthesis process. Structure genes can be compared to OO programming languages with a set of instructions, which are capable of changing data.

The metabolism is being controlled indirectly by the structure genes **(input sequence for the protein synthesis process)** with specific genes **(consist of DNA and are part of a larger structure called the chromosome)** being active during specific time periods, which can be classified as a behavior of specific DNA-units controlling the activity of genes thereby providing control instruction or a specific instruction, which specifies the order of the next executable instruction of the program.

Concerning specific cells, it is possible to see specific genes, which are active during specific time periods and this behavior demonstrates that specific DNA units control the activity of genes, which can be understood as the control instruction or a specific instruction which controls the order of the next executable instruction in the program. Lastly, the DNA unit, which is known as a telomer can be understood as the punctuation mark of the system or a specific sequence of the end of the chromosome **(consists out of DNA and protein)**.

What is to follow next is how objects, if-instructions or statements, and loops are formed applying OOB meaning heritage of all OOP languages creation.

Objects resemble cells and are created from a class which acts as a blueprint. Cells are created from a genetic blueprint in the form of DNA **(responsible for the cell functionality inside the nucleus)**. Genes **(consists out of DNA and are part of a larger structure known as chromosomes)** and classes define the attributes and behaviors of the objects they create even though these cells or objects consist out of different internal states, they originate as copies from the same blueprint. Cells can be of various classes, but they all originate from a class Cell that is a basic unit of life. Cells have a plasma membrane or a cell wall that defines their boundaries encapsulating the cell and protecting it where class definitions define the limits of the objects they instantiate. To pass information into or out of an objects public instance method must be used just like cell receptors are used to pass information through its plasma membrane or cell wall. Furthermore, internal cell processes exist that do not need to interact with the outside world meaning a cell has private methods or organelles like Golgi apparatus that modifies, packages, and sorts proteins sent from the endoplasmic reticulum or tubes that allow transportation of chemical compounds to and from the nucleus **(stores the cell genetic information)** and mitochondria, which produce energy for the cell and are responsible for internal cell processes which occur within the plasma membrane or cell wall.

Via specific operons **(unit of the protein synthesis)** it is possible to demonstrate control instructions such as composition, if- instruction, and while-instruction can be mimicked by gene controlled regulatory networks. The composition of basic instructions can be understood as a sequence of basic instructions signified by structure genes **(input sequence for the protein synthesis process)** or operons **(unit of the protein synthesis process)** separated by spacer units or separator sequence of genes.

The operon **(unit of the protein synthesis process)** can be represented as an if-instruction or statement meaning instruction S will be executed if and only if condition B is true, otherwise S will not be executed or if B then S. By focusing on the Escherichia coli or E. coli bacterium, which regulates its own synthesis. The boolean value of condition B can be classified by the state of the operator **(sequence of the gene regulation process)**, which is true if Operator_X gene is free or false if Operator_X gene is blocked by the repressor that is a protein that turns off the expression of one or more genes and the repressor protein works by binding to the gene's promoter region, preventing the production of mRNA **(RNA moves to ribosome)**. The if statement can be simulated once the operon **(unit of the protein synthesis)** is blocked after activation of the basic instruction. The synthesis of structure gene **(input sequence for the protein synthesis process)** S will realize the instruction S and the synthesis of Regulator_X will block the synthesis of operon L14.

By deleting the Regulator_X, which is found inside the operon L14 the while-instruction or statement can be imitated meaning let S be an instruction and B a condition, which can be true or false, therefore the instruction S will be executed as long as B is true or while B do S.

More precisely the **Tryptophan** (trp) can be classified as an α-amino acid that is used in the biosynthesis of proteins where trp operon is a group of genes **(consist of DNA and are part of a larger structure called the chromosome)** that is used, or transcribed, together—that codes for the components for production of trp and therefore structure genes S and the boolean value of condition B can be true that is operator **(sequence of the gene regulation process)** is free or false operator is blocked. Suppose the operon represents the state true the basic instruction is activated, and it will be active until the operator gene will be blocked and this logic simulates the while statement.

A telomere is understood as a region of DNA at the end of a chromosome where its purpose is to protect the end of the chromosome from deteriorating or fusing with other chromosomes. They are made of repeated sequences of DNA therefore the telomere sequence or chromosome and the terminator or promoter sequence **(cistron level)** can be simulated as punctuation mark or begin and end symbol.

1.22 Self-Checked Questions for Interpretation of Concepts

1. How can a data type be represented?
2. What is an array?
3. What does catalyze mean?
4. What is a telomer?
5. What do objects resemble?
6. Where are the cells created from?
7. What do internal cell processes do?
8. What are operons?
9. What is a Escherichia coli or E. coli?
10. What is a Tryptophan, trp?
11. What is a telomere?
12. What does the Escherichia coli or E. coli do?
13. What happens when Regulator_X gene is deleted inside the operon L14?
14. What blocks the Operator_X gene?
15. What is a repressor?
16. What does a repressor do?

1.23 Summary

In this sub-section explanations were provided on the origin of objects using the cell as the origin. Furthermore, the if statements descendants was explained by the operon and the E. coli bacterium. And, lastly loops formation was demonstrated by using operon and Tryptophan. The upcoming sub-section will explain how OOB is transitioned into OOC.

1.24 Answers to Self-Check The Cell Sub-Section

1. What is a cell?
   Basic unit of life

2. What are the two main categories of a cell?
   Prokaryotic and eukaryotic cells

3. What is a membrane?
   It is a cell wall

4. What is a mitochondrion?
   It is a place where the cell get its energy from

1.25 Answers to Self-Check The Nucleus Sub-Section

1. What is a Nucleus?
   Brain of the cell

2. Does the eukaryotic cell have a nucleus?
   Yes, it does

3. What is a molecule?
   That is when two atoms are joined together

4. What is another type of nucleic acid that the nucleus holds?
   Ribonucleic Acid, RNA

5. What is nucleus able to copy?
   It can copy its RNA

1.26 Answers to Self-Check The Ribosome Sub-Section

1. Where does the ribosome reside?
   It is found inside the cytoplasm

2. What are the two main components of the ribosome?
   Large subunit and a small subunit

3. What is a ribosome?
   Things the cells needs to function

1.27 Answers to Self-Check Mitochondria Sub-Section

1. What is the main function of the mitochondria?
   To produce energy for the cell

2. Where is Adenosine Triphosphate (ATP) made?
   In the mitochondria

3. What is ATP made of?
   Carbohydrates combined with oxygen

1.28 Answers to Self-Check Enzymes Sub-Section

1. What are enzymes?
   It is a specific type of proteins

2. What do enzymes do?
   They speed up chemical reactions

3. What is the result when enzymes react with a molecule?
   Substrate

1.29 Answers to Self-Check Chromosomes Sub-Section

1. What are chromosomes?
   They are small structures that exist in nucleus

2. What are chromosomes made of?
   DNA and protein

1.30 Answers to Self-Check DNA Sub-Section

1. What is DNA standing for?
   Deoxyribonucleic Acid

2. What are the four nucleotide names?
   (A), thymine (T), cytosine (C), and guanine (G)

3. What is a Codon?
   It is a three-letter word

4. How many three-letter codons are there?
   61

5. What is the shape of the DNA?
   It is a double helix

6. Where does the cell receive its instruction from?
   It receives its instructions from the DNA

1.31 Answers to Self-Check Amino Acids and Proteins Sub-Section

1. What is an Amino Acid?
   It is an organic molecule

2. How many kinds of Amino Acids exist in the human body?
   20

3. What are proteins?
   They are long chains of Amino Acids

4. What does protein synthesis mean?
   That is when a cell makes protein

5. What are the two processes that make protein?
   Transcription and Translation processes

6. What is the name of a copy of a DNA known as?
   It is known as Ribonucleic Acid, RNA

7. What is the name for when RNA moves to the ribosome?
   It is known as messenger RNA, mRNA

8. What kind of protein is hemoglobin?
   It is a transport protein

9. What are peptide bonds?
   They are bonds that link the amino acids in a protein together

1.32 Answers to Self-Check Integration of Concepts Sub-Section

2. Where does the cell originate from?
   It originates from a blueprint in the form of DNA

3. What is a gene?
   It is a specific section of the DNA

4. How does the cell transfer information?
   The cell transfers information via the membrane or cell wall

5. How does the cell communicate with other cells?
   It uses receptors

6. What are cell organelles?
   They are internal organs

7. What is a endoplasmic reticulum?
   It is a tube

1.33 Answers to Self-Check DNA Elements Sub-Section

1. What is a promoter?
   It is a start point of the transcriptional unit

2. What is a terminator?
   It is an end of the transcriptional unit

3. What is the meaning of biosynthesis?
   It is when cells build protein

4. What are metabolic processes?
   They are transcription and translation processes

1.34 Answers to Self-Check Interpretation of Concepts Sub-Section

1. How can a data type be represented?
   It can be represented by a metabolite

2. What is an array?
   It is a group of similar atoms

3. What does catalyze mean?
   reactions It means to increase the rate of biochemical

4. What is a telemor?
   It is a punctuation mark of the system

5. What do objects resemble?
   The resemble cells

6. Where are the cells created from?
   They are created from a class

7. What do internal cell processes do?
   They do not interact with the outside world

8. What are operons?
   They are unit of the protein synthesis process

9. What is a Escherichia coli or E. coli?
   It is a bacterium

10. What is a Tryptophan, trp?
    It is an α-amino acid

11. What is a telomere?
    It is a region of DNA at the end of a chromosome

12. What does the Escherichia coli or E. coli do?
    It regulates its own synthesis

13. What happens when Regulator_X gene is deleted inside the operon L14?
    The while instruction or statement can be imitated

14. What blocks the Operator_X gene?
    The repressor

15. What is a repressor?
    It is a protein

16. What does a repressor do?
    It turns off the expression of one or more genes