MODULE TITLE: CELL BIOLOGY

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Introduction

There are various events which are prevalent for the purpose of dividing cells. The inception of cell division results in the formation of daughter cells. When the formation of daughter cells occurs, there are various changes which are prevalent within the DNA. According to Broni *et al.,* (2021), there are two predominant phases in the sphere of cell division. The first phase is said to be the interface and the second phase is said to be the mitotic phase. Within the mitotic phase, there are two other sub-phases which are said to be cytokinesis and mitosis. Their individual functions are assigned with the mitotic phase as well as the cytokinetic phase.

As mentioned by Risa *et al.,* (2019), the accumulation of the necessary nutrients occurs within the interface where the cell receives the requisite ingredients for mitosis. In addition to this, during the event of interphase, there is a prevalence of replication in the DNA as well as the organelles. The next few sections of this report are going to provide the details about the prokaryotes as well as eukaryotes along with methods of comparison and contrast. Followed by this, there will be an explanation of the processes for cell division as well as the metabolism of cells. There will also be recommendations that will provide information about tissues related information within the stem cells and among others.

Section 1- prokaryotes and eukaryotes

1.1 Characteristics of living cells

Shashkova *et al.* (2021) stated that a cell is an essential part of all forms of life, since it displays characteristics more typical of living things than non-living things. Their lifespans could be different from one another, but they all must have the following characteristics in order to be considered living.

Figure 1.1: Characteristics of living cells

(Source: Self-created)

Respiration: By activating chemical processes in living cells, they may break down food molecules and release energy (cambridge, 2022). This process is called respiration. The energy storage molecule adenosine triphosphate.

Growth: Every living thing exhibits some kind of growth at some point. According to Tsumoto *et al.* (2020), it entails making use of food in order to make new cells. Growth actually refers to a steep increase in cell size and number.

Nutrition: All organisms need to take in nutrients and energy from their environment to survive and thrive. Foods like proteins, carbohydrates, and lipids provide living things with energy and building blocks through a process called nutrition.

Movement: Shashkova *et al.* (2021) argued that since the importance of motion in locating food sources and avoiding threats, movement is essential for all living things.

Sensitivity: Sensitivity entails receptivity to and flexibility in response to environmental stimuli. As a result, the cellular environment may be maintained relatively steady and consistent, a process known as homeostasis (cambridge, 2022).

Excretion: Excreting is a universal life function. The many chemical processes taking place inside cells need the removal of waste materials that might poison the cells. Toxic compounds, metabolic waste, and excess substances are all eliminated through the excretory system (cambridge, 2022).

Reproduction: To prevent a species from becoming extinct, it is necessary to enable it to reproduce.

1.2 Compare and contrast prokaryotic and eukaryotic cells

Prokaryotic cells:

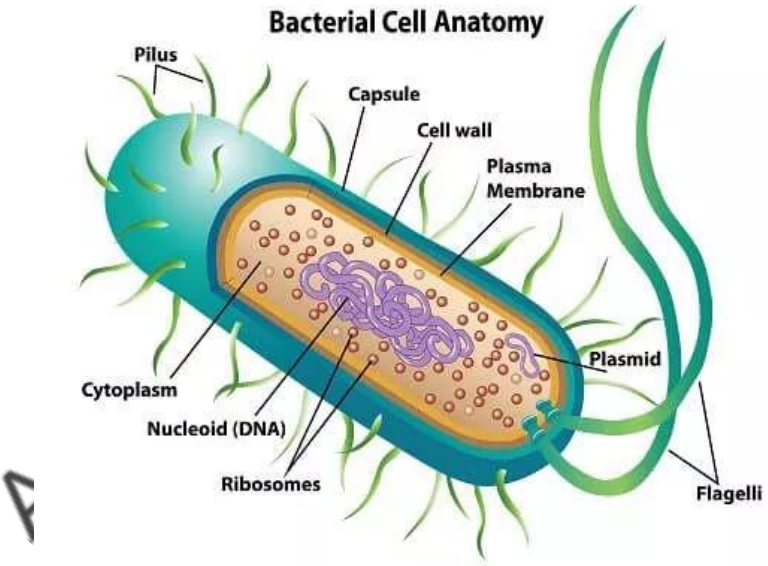

Figure 1.2.a: Prokaryotic cells

(Source: Buckley, 2022)

As mentioned by Vosseberg *et al.* (2021), bacteria and archaea have the simplest sort of cell, called prokaryotic cells. As can be seen in Figure 1.2, these cells do not have a real nucleus, and instead of having the DNA separated by a membrane, it is coiled up within the nucleoid.

Despite its simple structure, this cell is quite hardy, able to survive things like high temperatures.

Eukaryotic cells:

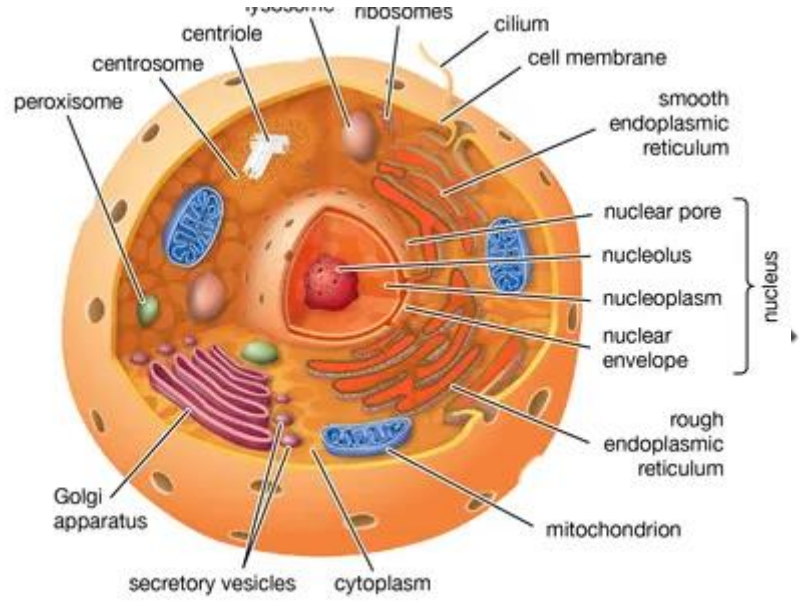

Figure 1.2.b: Eukaryotic cells

(Source: Britannica, 2022)

Figure 1.2.b shows that the structure of eukaryotic cells seems to be more complex than that of prokaryotic cells, with a true nucleus holding the DNA inside a nuclear membrane. Shrimal and Gilmore (2019) opined that in eukaryotic cells, the nucleus is where the core of the cell's DNA is stored. They can be single-celled or multi-celled and can originate from anything from animals to plants to fungi.

Compare of prokaryotic and eukaryotic cells

Comparison	**Prokaryotic cells**	**Eukaryotic cells**
Types of cells	Single	Single or Multiple
Size	0.1–5.0 µm (Openstax, 2022)	10–100 µm

Nucleus	Nucleus has DNA	The well-delimited nucleus is enclosed by a cellular membrane (Buckley, 2022).
Cell division	Binary Fission	Mitosis
Replication	Single	Multiple
Cell wall	Peptidoglycan or mucopeptide-based.	Made mostly from cellulose (Britannica, 2022).
Ribosome	70S	80S
Chromosomes	Single	Multiple

Table 1: Compare of prokaryotic and eukaryotic cells

(Source: Self-created)

1.2.1 The Effect of Viruses

Bruslind (2022) stated that depending on the virus and the host it requires, viruses may infect everything from animals to people to plants. Infectious cellular organisms that can only replicate inside of a living host cell are known as obligatory intracellular parasites, which include viruses.

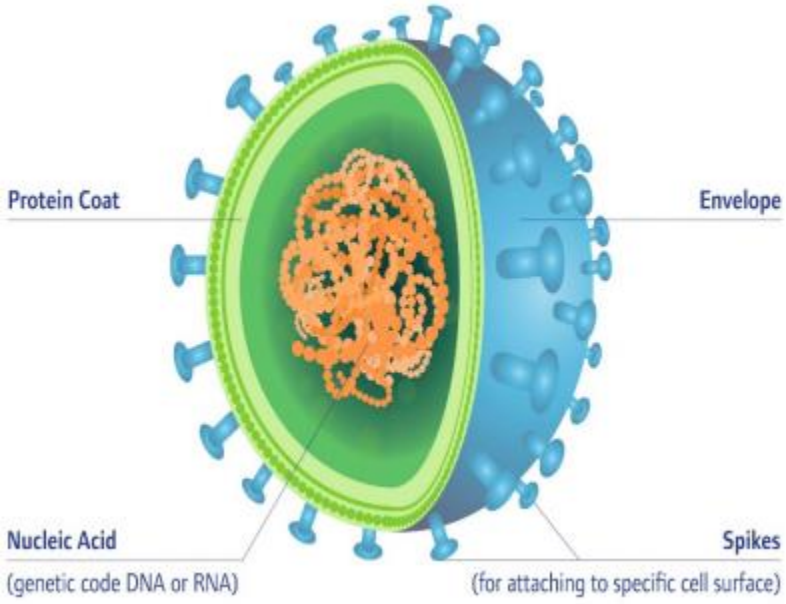

Figure 1.2.1: Virus structure

(Source: Rheinemann and Sundquist, 2021)

Figure 1.2.1 shows how the protein coat encloses and safeguards the genetic information contained inside a virus, which is made up of nucleic acid, either DNA or RNA. According to Rheinemann and Sundquist (2021), once it has attached to a particular cell with the assistance of its spikes, it will exploit the host's metabolic capacities and ribosomes to manufacture virions so that it may continue to proliferate.

1.3 Eukaryotic subcellular structure and organelles

A cell's ability to carry out certain duties is essential to the cell's continued existence, making the organelles and subcellular structure of the Eukaryotic cell vitally important. See the table below for an overview of the key responsibilities of each organelle.

Organelles and subcellular of Eukaryotic	**Functions**
Lysosomes	Hydrolytic enzymes are present, and they degrade biomolecules like dead cells and noxious chemicals. They are often referred to as "suicide bags" (Britannica, 2022)

Vacuole	A spherical sac made of membranes and filled with water and solutes.
Golgi apparatus	Xiao *et al.* (2021) stated that the Golgi body is a protein modification and secretion organelle that accepts proteins from the endoplasmic reticulum and prepares them for cellular usage or exocytosis.
Reticulum	Carbohydrate.
Ribosomes	Shrimal and Gilmore (2019) opined that protein synthesis occurs in the smallest and most numerous organelle in the cell.
Mitochondria	In cells that employ aerobic respiration, the energy they need is generated via the body's generation of ATP.
Nucleolus	The chromatin region where ribosomes are made is quite low.
Nucleus	Xiao *et al.* (2021) stated that the largest organelle responsible for preserving genetic information (like DNA).
Cytoplasm	Other organelles, which are metabolic enzyme-containing and are suspended in the cytoplasm, are also present.

Table 2: Organelles and subcellular structure of Eukaryotic

(Source: Self-created)

Section 2 – Cellular metabolism and protein synthesis

2.1 Role of the cell membrane

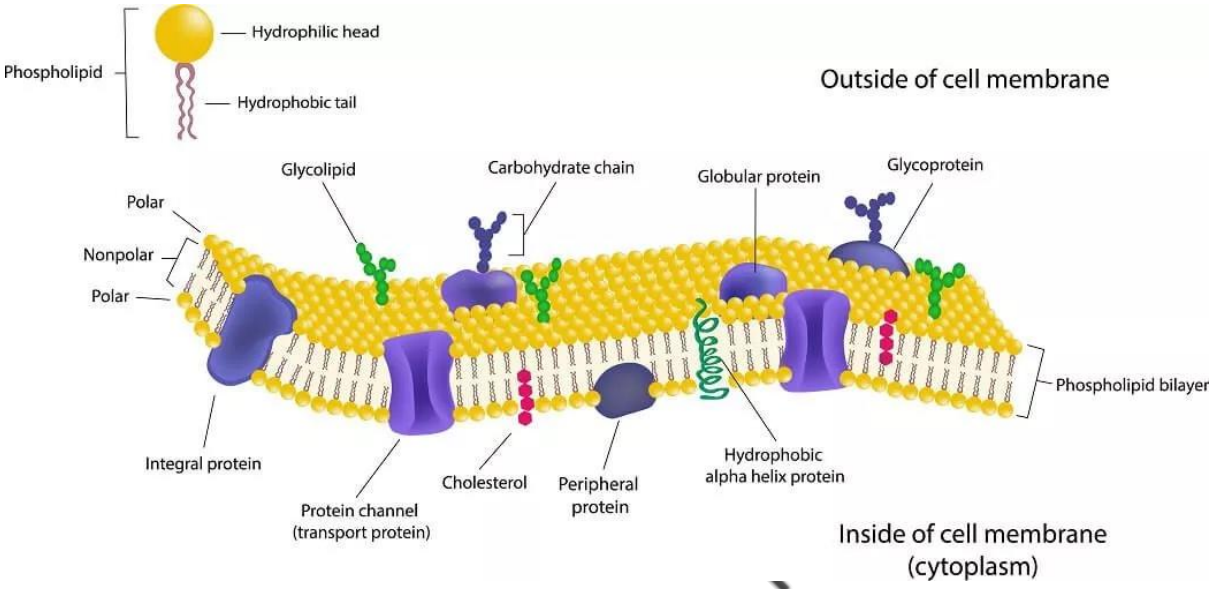

Figure 2.1: Cell membrane

(Source: Katy McLaughlin, 2022)

Szlasa *et al.* (2020) opined that the cell membrane constitutes the cell's external membrane. Consists of a bilayer that allows some molecules to pass through while keeping others out; this allows the cell to operate properly by controlling the flow of nutrients and waste. Hydrophilic (water-loving) lipid heads face outward to create the phospholipid bilayer, as seen in Figure 2.1. One of the strategies for transferring molecules across the membrane is via transport protein channels, which are emphasised here as well.

According to their nature, substances would enter the cell membrane in one of the following ways.

Lipid diffusion: Dyett *et al.* (2019) mentioned that transferring soluble molecules like water, oxygen, and carbon dioxide may be done with little effort through a process called lipid diffusion, also known as simple diffusion. Substances diffuse across the lipid bilayer from high to low concentration without using any energy. Lipid bilayers have their water-repellent (hydrophobic) tails on the inside.

Facilitated diffusion: Möller *et al.* (2019) argued that trans-membrane proteins are responsible for facilitating diffusion, a process by which molecules of a certain material are transported across a membrane. These proteins usually function as transporters for just one kind of chemical molecule. There are two types of transport proteins.

Osmosis: According to Roffay *et al*. (2021), through the process of osmosis, water molecules are able to migrate freely over a membrane that separates a high-concentration, highly-dilute solution from a low-concentration, relatively-dry zone.

Active transport: Shih *et al*. (2019) stated that the movement of molecules from low- to high-density regions requires a process known as active transport. This is achieved by using a trans-membrane protein referred to as a pump-molecule. In spite of the fact that dissolved molecules could be more concentrated within the cells on the outside than, proteins must nevertheless be taken in for the sake of the organism.

2.2 Growth, movement, and cell division

Energy for all animal cells comes from cellular respiration. According to Björklund (2019), cells are able to grow (synthesis), move (motility), stay at an ideal internal temperature (homeostasis), and help with cell division because they take in oxygen and glucose and convert them into ATP. Only around 60% of the energy produced by cellular respiration is actually used; the other 40% is dissipated as heat, which is essential for keeping the body warm and the cells in homeostasis (Socratic, 2022). There are three distinct phases of cellular respiration, which are shown in the accompanying figure. The release of electron carriers and ATP, as well as their connections between phases, are shown in Figure 2.2. Most ATP is produced by the electron transport chain.

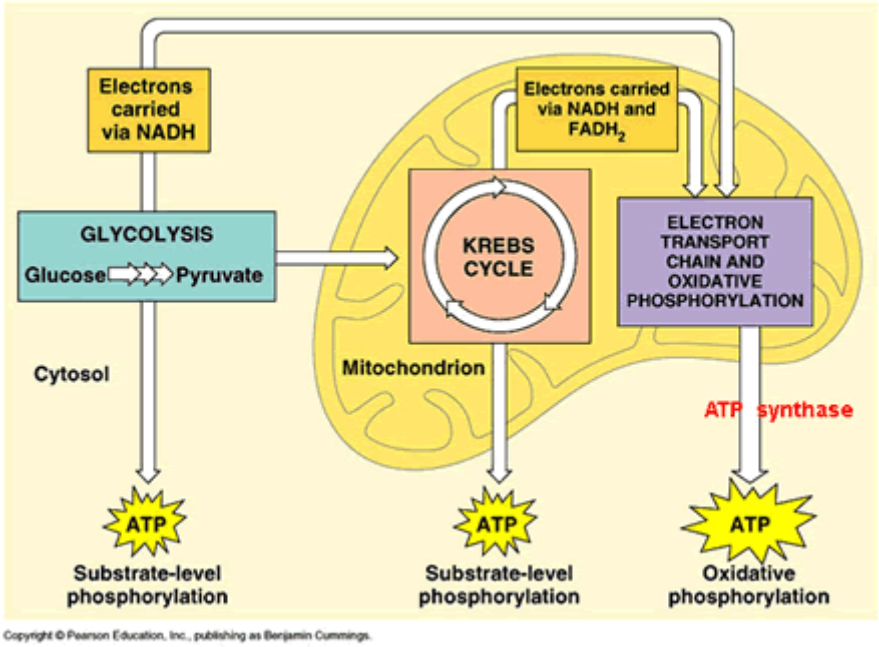

Figure 2.2: Process of energy released

(Source: Socratic, 2022)

Glycolysis: A number of chemical processes take place in the cytoplasm to metabolise glucose. Glycolysis results in the production of 4 ATP molecules, however two are consumed by the body during the process (Socratic, 2022). Two molecules of NADH and two molecules of pyruvate with three carbons are produced.

Krebs cycle (citric acid cycle): This process occurs within the mitochondria and results in the production of the electron transport chain FADH2, NADH, and ATP. Byproducts of this cycle include carbon dioxide.

ETC: The electron transport chain (ETC) occurs within the mitochondrial membrane, with oxygen (O2) serving as the terminal electron acceptor by reacting with hydrogen (H) to produce water (H2O) (Zhu and Thompson, 2019). After 36 molecules of ATP are created in the electron transport chain, this is the step where energy is created.

2.3 Synthesis of proteins

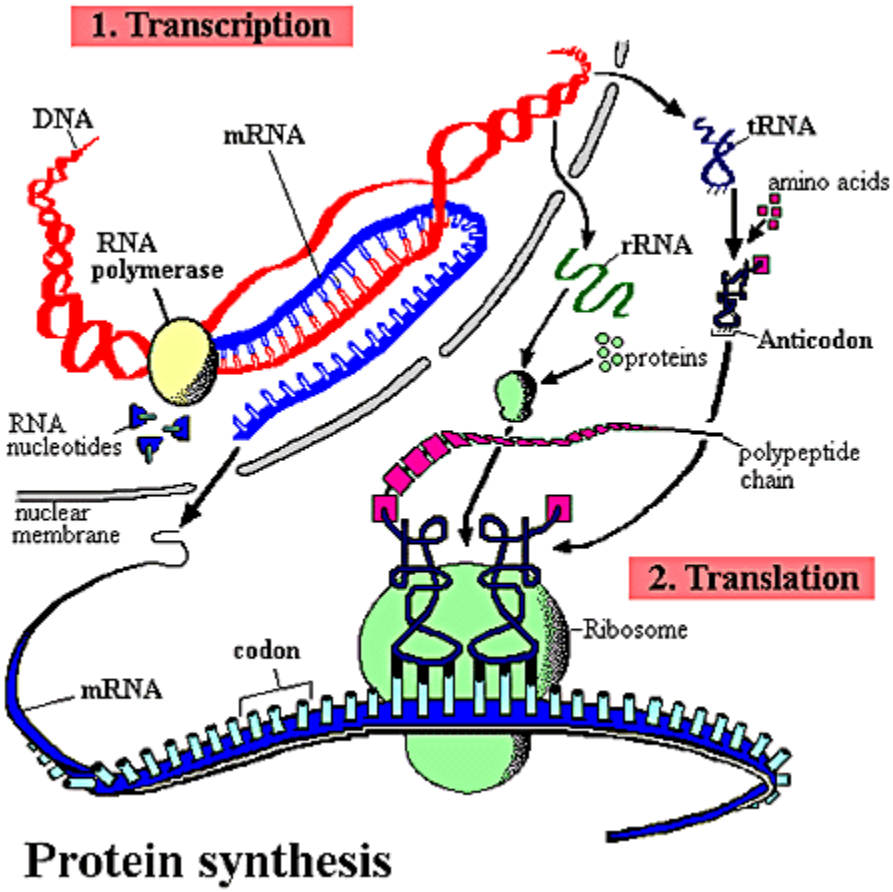

Figure 2.3: Protein synthesis

(Source: proteinsynthesis, 2022)

Anisimova e*t al*. (2018) opined that in living cells, new proteins are synthesised by protein synthesis that is regulated by the loss of old proteins through breakdown and export. Transcription, activation, and translation are the three stages of the ribosome process. In transcription, double-stranded DNA is read and copied to produce a single-stranded mRNA. Transcribing DNA into a message is called transcription. The RNA message that makes up messenger RNA is dependent on DNA. Codons are indeed the building blocks of mRNA that are read in triplets (proteinsynthesis, 2022). Therefore, nuclear RNA (mRNA) is exported into the cytoplasm. Second-stage activation happens in the cytoplasm. The ribosome is responsible for the third stage of translation. The ribosome becomes attached to the mRNA. The ribosome is a protein and RNA complex. Zapata *et al.* (2018) argued that the ribosomes then add the appropriate amino acids using tRNA after reading the mRNA. Transfer RNA is

abbreviated as tRNA. Essential for determining which tRNAs are recruited and hence which amino acids are transported, mRNA is a key factor in the translation process. There is a specific amino acid attached to one end of the tRNA and an anti-codon that will match a certain codon on the mRNA. The success of the translation hinges on these three factors.

Section 3- Cell division, Stem cells and Cell mutation

3.1 Formation of tissues which are specialised in embryonic cells

Knotz, *et al.,* (2022) noted that the stem cells which are initially formed do not have any specialised functions to perform. However, the embryonic stem cells are found within the Embryos which are for the divided through mitosis to become specialised tissues. These tissues are formed using the expression of various genes. The genome present within a gene has a specialised set of DNA, some of which are expressed. According to Zhou *et al.*, (2022), the embryonic stem cells start receiving specialised features because of the activities performed by certain genes. The genes which are found to be active within the embryonic stem cells are generally expressed.

The genes which are found to be inactive are not expressed for forming specialised tissues. When the genes are found to be active it contributes to the transcription of the mRNA. As noted by Rojas-Prats *et al.,* (2021), mRNA is further translated by the active sets of genes to form proteins. The proteins which are generated by the active genes help in modification of the stem cells in order to provide a structure for such cells thereby causing them to be differentiated as well as specialised. Various specialised cells from different groups each of which perform similar functions. The group of cells which are involved in performing similar functions are found to form specialised tissues.

3.2 The vitality of interphase

One of the prolonged and vital stages of the cell cycle is the interphase. According to Muhr and Hagey, (2021), the definition of the cells as well as their growth is all found to be prevalent in the interphase. In addition to this, interphase is also responsible for transporting the necessary nutrients for aiding the processes for cell division. The interface comprises various other phases such as G1, G0, S, as well as G2 as shown in figure 3.2.1. The G2 phase is said to be the resting phase whereas the G1 phase is considered to be the active phase

(Melamed *et al*., 2022). The activity and the inactivity of each of such phases are dependent on the type of the specific species the organisms to which they belong

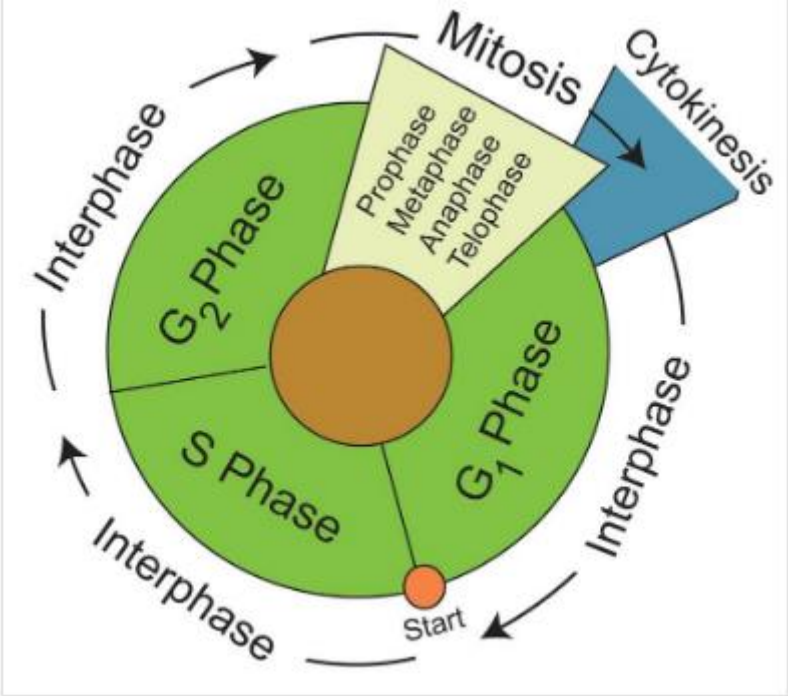

Figure 3.2.1: Stages of interphase

(Source: Propg, 2022)

One of the initial phases of the interface is said to be G1. Interphase is one such component of the cell division where the process of mitosis takes cessation. In this phase, the division of cells generally stops causing the cycle of the cell division to go through the G0 phase. As mentioned by Melamed *et al*., (2022), the G0 Face causes the cells to become mature and lead to the generation of their arrest. The face of arresting the modification of cells is known as apoptosis. The G1 phase is responsible for enabling the cell to have growth and modification. The S phase stands for synthesis where the process of duplication in chromosomes is caused by the requisite cells. When the second phase of growth (G2) commences, there is a procedure for checking the duplication scenario of chromosomes which will eventually lead to the formation of Mitosis (Jin, 2019). There is a continuation of the RNA synthesis up until the instruction of mitosis all within the interphase.

3.3 The factors initiating division of cells

There are various factors responsible for initiating the division of cells. These factors are considered to be external for cell division. According to Wang *et al.*, (2018), there are various events which can be considered to be factors that triggered the multiplication of cells. This can be related to the death of a certain cell or release of certain hormones (HGH) which are responsible for aiding growth of those cells. When there is a growth of cells, there is a prevalence of inefficiency from the end of the cells resulting in waning surface to volume ratio. Moreover, this reduced inefficiency leads to the restoration of the functioning of the cells through division.

Basak *et al.*, (2018) mentioned that there are also certain internal factors which can result in the division of cells. One of the prevalent internal factors is the cell cycle which comprises the phases of gaps 1 and 2, along with synthesis and mitosis. There are various factors within the environment that can lead to the triggering of the internal segments of cell division. Certain environmental components can influence the availability of requisite nutrients which can influence the overall growth as well as multiplication of cells. As mentioned by Mohammad *et al.*, (2019), radiation can also be responsible for altering the molecules of DNA. Along with this there can also be cell signalling processes which are dependent on the density. In this process, the absence of certain signals can encourage the division of the cells.

3.4 Means for the daughter cell to receive same genetic information

The production of the daughter cells is initiated in the phase known as mitosis. In this phase, the daughter cells which are developed usually comprise the same information in the genetic sphere. According to Desvoyes and Gutierrez, (2020), during the formation of the daughter cells, there is a replication of the chromosomes. This replication is followed by a stage of splitting which allows each of the daughter cells to receive a copy of information which is similar genetically as indicated by figure 3.4.1. Mitosis enables the daughter cells to receive identical information in the genetic realm just like the one which acts as a parent cell.

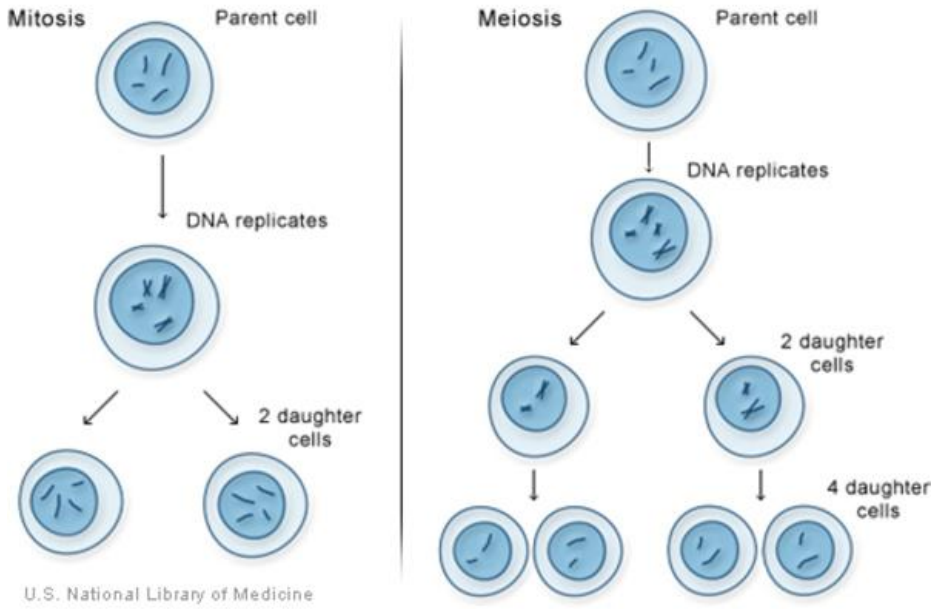

Figure 3.4.1: How daughter cells receive genetically same information

(Source: Medlineplus, 2022)

3.5 Comparison and contrast between cancer cells and normal cells

Comparison	**Cancer cells**	**Normal cells**
a. Division	They are easily spread and divided.	They do not spread as easily (Jin, 2019).
a. Energy	The source of energy is glycolysis.	The energy comes from both the Krebs cycle and the glycolysis.
c. Cell cycle	The cells go through the cycle of angiogenesis continuously for facilitating perpetual division of cells.	When new tissue is formed, Angiogenesis is utilised. (Melamed *et al*., 2022).

d. characteristics	The chromosomes have abnormal characteristics and numbers (Desvoyes and Gutierrez, 2020).	The numbers are set with arranged forms.
e. Sizes	The sizes are alterable (Broni, et al., 2021).	Cells have a fixed size.
f. Growth	The cells grow in uncontrollable form.	The cells grow in controlled form and divide appropriately.
g. Detectability	These cells are not detectable by the immune system.	The cells are detectable and can be removed when they are found damaged.
h. Extent of division	Division occurs rapidly before maturation.	Division stops upon maturation.

Table 2: Differentiation between Cancer cells and Normal cells

(Source: Created by author)

Conclusion

There are predominantly two forms of sages that are responsible for dividing the cells. They are namely the interphase and Mitosis. Interface is considered to be the longest stage of cell cycle where there are various sub-phases with regard to gap and synthesis. These phases result in either the multiplication of cells or inhibition of the growth of cells. Generation of proteins within the cells occurs during the embryonic stages in organisms of various species. Characteristics which are prevalent among the cells which are living include respiration excretion, growth, reproduction, sensitivity, as well as movements. Several differences have been noted between the Eukaryotic cells and the prokaryotic cells in terms of the processes for replication, chromosomes, ribosomes, and among others. The eukaryotic cells are found to have more complex characteristics than those of the prokaryotic ones.

The extent of survival between the eukaryotic and prokaryotic cells has been found to be different whenever they are exposed to varying temperatures. When it comes to the characteristics of the cancer cells and normal cells, there are certain differences such as the former is more prone to be divided uncontrollably without being completely mature whereas the latter is divided in a controllable form with proper arrangements. The cancer cells found to be completely detectable by the immunity system as the cells which are normal are usually detectable and can be destroyed once they are found to be damaged. In addition to this, the cycles for cancerous cells are deemed to be continuous whereas for the latter angiogenesis is only utilised for developing new tissues. Moreover, when it comes to the daughter cells, similarity in genetic information can be found in the phase of Mitosis. Some of the segments of the Eukaryotic cells include the Golgi bodies, vacuoles, reticulum, and nucleolus.

Recommendations

In order to create continuous rejuvenation of the stem cells, it is recommended that Epigenetic regulation can be incorporated which can help in altering the transcriptional program to perform the functions of the existing stem cells. There can be an indication of some of the cytokine receptors which lead to the deterioration of the functioning of stem cells. In addition to this, the nurses can incorporate certain drugs which can be helpful for detecting the prevalence of cancerous cells without any professional intervention. Another recommended scenario is that there can be utilisation of oxytocin in order to provide better functioning of the targeted stem cells.

Apart from this, an appropriate paradigm can be created through the implementation of molecular stem cells that can provide a better picture of the cell division as well as improved scope for regulation. In addition to this, neurogenesis can be implemented through recombinant injections in order to bring improvement about cognitive functions. The capacity for the cells to renew themselves can be fostered through the fibroblast growth factor (FGF-2). Satellite cell activation is another procedure that can also be provided for the purpose of bringing renewal to the healthy stem cells.

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