UNIT 2 GENETICS AND STEM CELL RESEARCH

Contents

2.0 OBJECTIVES

- To have an over-all understanding of Genetics
- To see some of its possibilities and dangers of stem-cell research.
- To visualise how genetics will change life in the coming decades.

2.1 INTRODUCTION

Human life today has been enormously impacted by advances in the science of genetics and related work on the physiology of human reproduction. Today human beings could be understood as "Evolution become capable of consciously extending or eliminating itself" (Pandikattu 2006).This is true with regard to genetics and its breakthrough in science. There is explosion of genetic knowledge especially in recent history has helped us to reach a position in which we can extend and eliminate ourselves. The potential applications of Genetics, Biotechnology, and Molecular biology - when used responsibly - will make valuable contributions to human society as a whole. The field of Genetics is in the news daily, with researchers mapping the human genome cloning animals, and identifying new disease genes. For many people, the problem is putting this information into context and understanding what recent genetic "breakthroughs" really mean in terms of our health and life.

The first part of this unit deals with Genetics and Genetic engineering. It would give us an understanding of what is Genetics and its applications today in our scientific field. It also deals with the history of Genetics and future prospects of

Genetic engineering. In the second partwe explainabout the stem cell research with particular reference to the Human Genome Project. The explosion of genetic knowledge especially in recent history has helped us to reach a position in which we can extend and eliminate ourselves. Here we have a choice to make. It is a matter of conscious choice that we make- a collective, creative, coherent choice. As the book of Deuteronomy in the Holy Bible says "I have set before you today life and prosperity, death and adversity." Choice is ours….this choice is not for profit, not for progress, but for humanity, for life.

2. 2 GENETICS AND GENETIC ENGINEERING

GENETICS AND DNA- OVER VIEW

As a scientific study of hereditary, Genetics deals with the passing on of characteristics of one generation to the next. Geneticist investigates the structure, function and transmission of genes. Genes are the basic units of hereditary information and are present in the cells of all organisms. For example, each of the cells in the human body has about 30,000 to 40,000 genes. They determine over all body build up and traits such as eye, hair and skin color. The term Genetics is a term coined by W. Bateson to designate the portion of Biology that deals with heredity, variation development and evolution. According to British geneticist J. B. S Haldane, "Genetics is the branch of Biology which is concerned with innate differences between similar organisms……" however Genetics can be defined as the science that deals with the structure, organization, transmission and function of genes and the origin of variation in them (Singh 2002).

DEOXYRIBONUCLEIC ACID (DNA)

We human beings need to be educated to become more "DNA literate" - as our understanding of the science of Genetics is the key to its future uses. Every human cell contains a nucleus, within which lie the 46 human chromosomes that determine each individual's genetic makeup (genotype). Chromosomes are made up of DNA, which in turn is made up of nitrogenous bases. In other words, DNA (Deoxyribonucleic Acid) is a thin, long, and chainlike, molecule that is contained within almost all of our cells in a compartment called the nucleus and found in every living cell on earth. However it is important to note that DNA even occurs in bacterial cells, which do not have a nucleus and in some viruses (WBE 2004).

DNA directs the formation, growth, and reproduction of cells in the organisms. It is composed of individual units called nitrogenous bases. The DNA molecule is shaped like a twisted ladder, or double helix. The sides of this ladder are made of alternating sugar and phosphate molecules. The rungs of the ladder are made of four nitrogenous bases - guanine, cytosine, adenine, and thymine. These bases, abbreviated G, C, A, and T, respectively, and form pairs on the ladder to create a complete rung. Adenine only pairs with thymine(A-T) and guanine only pairs with cytosine(G-C). Therefore, the sequence of bases on one side of the ladder always predictably complements the sequence on the other side (Postiglione and Brungs 1993).

Check Your Progress I

Note: Use the space provided for your answers.s.

1) What is DNA?

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2) "I have set before you today life and prosperity, death and adversity." Comment in the light of Genetic engineering.

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2.3 BRIEF HISTORY OF GENETICS

References to Genetics can be traced back to biblical times. We know from the book of Genesis, Jacob, the son of Isaac had a method by which his sheep and goats gave birth to spotted and speckled offspring (Genesis 30: 37-39).

The Babylonians had the knowledge that for a date to be fruitful, pollen from the male palm had to be introduced to the pistils of the female palm. The ancient Greek philosophers were the first to look at the world in a scientific fashion. They developed theories of everything and Genetics was no exception. Aristotle through his observation learned that the male and female do not make equal contribution to their offspring. According to him their contributions were qualitatively different: the female gives "matter" and the male gives "motion".

The modern science of Genetics began in 1900, when the fundamental laws determining the transmission of hereditary traits from one generation to the next were discovered. We human beings carry within us "not simply not an injunction to reproduce after our kind, but to reproduce specific features of height, weight, skin color, eyes, hair and so on" (Guttman et al 2006). The fundamental laws of hereditary are laws which apply to all plants and animals as well as many microorganisms for they demonstrate similarities among life forms.

In late 1970's, the ability to directly manipulate the genes of plants and animals was developed. Much controversy started when the proposals to begin human gene manipulation were put forth in the early 1980's. A small number of researchers argued in favour of germ line manipulation, but the majority of scientists and others opposed it. In 1983 a letter signed by 58 religious leaders said, "Genetic engineering of the human germline represents a fundamental threat

to the preservation of the human species as we know it, and should be opposed with the same courage and conviction as we now oppose the threat of nuclear extinction." In 1985 the U.S. National Institute of Health (NIH) approved somatic gene therapy trials, but said that it would not accept proposals for germline manipulation "at present."

Though the advocates of germline manipulation received many setbacks, germline engineering moved to the status of an openly acknowledged political cause in March 1998, when Gregory Stock, Director of the Program on Medicine, Technology and Society at the University of California at Los Angeles,organized the symposium "Engineering the Human germline." All the speakers were avid proponents of germline engineering. Stock declared that the important question was "not if, but when" germline engineering would be used. The symposium was attended by nearly 1,000 people.

After few months of the University of California, Los Angeles(UCLA) conference one of the key participants, somatic gene transfer pioneer W. French Anderson, submitted a draft proposal to the NIH to begin somatic gene transfer experiments on human fetuses. He was of the view that this procedure could have a "relatively high" potential for "inadvertent gene transfer to the germline." Anderson's proposal is widely acknowledged to be strategically crafted so that approval could be construed as acceptance of germline modification, at least in some circumstances.

In 1966, the first successfully cloned sheep Dolly became the symbol of the progress of cloning and has helped the population to understand the significance of cloning for humanity. Dolly was born 5 July 1996 to three mothers (one provided the egg, another DNA and a third carried the cloned embryo to term) She was created using the technique of somatic cell nuclear transfer.

Meanwhile the official announcement of the success of Human Genome Project and the mapping of the "working draft" Human Genomes became the climax of the genetic march forward. The Human Genome Project was formally completed in April 2003. Research on development of Genetics had put us in a situation where we can transform what we are, where we are and the way we live both positively as well as negatively.

If the current pace of research and development continues, there will be an explosion of genetic knowledge and capability over the next several years. We will be able to transform the Biology of plants, animals, and people with the same detail and flexibility as today's digital technologies and the microchip enable us to transform information. The challenge before us is to summon the wisdom, maturity, and discipline to use these powers in ways that contribute to a fulfilling, just, sustainable world, and to forgo those uses that are degrading, destabilizing and – quite literally – dehumanizing (Pandikattu 2005).

2.4 GENETICS- FUTURE PROSPECTS

Genes play an important role in shaping what we are today and for all our so-called genetic traits. The genetic information of parents is passed down to their children, grand children, or even great grand children. Similarly we have also inherited a number of genetic traits from our ancestors. All our physical

characteristics, personality traits, and talents can be the result of the genetic make-up of our ancestors. We have 23 pairs of chromosomes in almost every cell in our body. Each pair consists of a chromosome from our mother and a chromosome from our father. The color of our hair, our height, and even our predisposition to health concerns are some of the genetic traits that we have inherited from our parents. Our genetic make-up is also responsible for a number of health problems that we face. Some examples of genetic, or inherited, health problems include obesity, heart disease, cancer, diabetes and hypertension. Many health concerns come about due to a combination of our inherited genetic make-up.

With the human Genome decoded, researchers have the daunting task of sifting through the newly-discovered genes in search of those that lead to disease. These efforts will change the way we view diseases and receive medical care. Once researchers know which genes are involved in a disease, they can develop a test to screen people who are at risk and also start looking for a cure. This will identify high-risk people who may require more intensive screening or preventative action. Knowing what genes cause a given disease can also help researchers understand what goes wrong in that disease, which can help drive the search for drugs that counteract the problem.

Genomic Medicine

The genomic medicine has helped the humanity in disease gene discovery (Disease taxonomy), clinical introduction of drugs with novel therapeutic actions, more sensitive diagnostic tests, medical treatmenttailored to individual genotypes, predictive testing for genetic diseases and new methods of preventive medicine. Before the flowering of genome science, disease taxonomy was captive to relatively insensitive morphological techniques (Chan and Chia 2003). The emergence of Transcription profiles has helped scientists to understand that diseases that were previously considered to be single entities posses several distinct genetic signatures.

Personalized Treatments

Personalized treatment, unlike the treatment of symptoms that has been common practice, is based on evidence that an individual's genotype (genetic bar code). For example, heart disease can be caused either by a mutation in certain genes, or by environmental factors such as diet or exercise. Doctors can easily diagnose a person with heart disease once they have symptoms. However, doctors can't easily tell what the cause for the heart disease is in each person. Thus, all people receive the same treatment regardless of underlying cause of the disease. In the future, a panel of genetic tests for heart disease might reveal the specific genetic factors that are involved in a given person. People with a specific mutation may be able to receive treatment that is targeted to that mutation, thereby treating the cause of the disease rather than just the symptoms.

Genetic Chips

Theoretically everything that could be known about us genetically is known (Chan and Chia 2003). Today information containing the function of our kidneys or brain, heart disease, manifestation of whole range of cancers and even ability to cope with stress or our proneness to depression are available. It is only a matter of reading out and then analyzing our genetic blue prints. It can be employed to enhance people's understanding of themselves and the world.

Check Your Progress II

Note: Use the space provided for your answers.s.

1) What is the significance of Dolly?

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2) What are some of the future prospects offered by genetic engineering?

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2.5 CLONING AND GENETIC MANIPULATION

Cloning and genetic manipulation works towards ever increasing precision of control over what we are biologically as human beings. In 1997, a sheep named Dolly was supposedly cloned, making her the first "artificial" mammal on Earth (Wilmut, Ian and Highfield 2006).

It has been speculated that the cloning of humans could be employed to create an unstoppable "designer army". This army would be made up of genetically identical, enhanced individuals with great physical strength and artificial immunity to many diseases. The members of this hypothetical army would most likely be capable of enduring extreme physical hardship, and could even be "tailored" to the environment in which they were fighting. For example, an army sent to the tropics would be immune to tropical diseases and would be capable of fighting in extremely hot weather. An army sent to the Arctic Circle would be tolerant of exposure to very cold temperatures for long period of time.

There is a possibility of taking human DNA and clone specific organs or body parts, such as the liver, spine, or skin. This type of cloning cannot be seen as anything but a good thing. It could save thousands of lives by replacing damaged organs or body parts - for example, cloning skin for a burn victim, a spine for a paraplegic, or a liver for a hepatitis victim. This technology could vastly reduce the demand for donated organs while simultaneously eliminating the possibility of organ trade and organ rejection among patients. In addition, it would eliminate the need for immunosuppressive drugs that render organ recipients vulnerable to common diseases.

2.6 GENETIC ENGINEERING

Genetic engineering is a radical new technology, one that breaks down fundamental genetic barriers-not only between species, but also between humans, animals, and plants (Cummins 2010).It is the term applied to techniques that alter the genes (hereditary material) or combination of genes in an organism. The cells of all living organisms contain genes. Genes carry chemical information that determines the organism's characteristics. In this way scientists can give the organism and its descendents different traits. By combining the genes of dissimilar and unrelated species, permanently altering their genetic codes, novel organisms are created that will pass the genetic changes onto their offspring through heredity. Beginning in the 1970's, scientists developed ways to introduce individual genes into cells or into plants, animals, or other organisms. Scientists are now snipping, inserting, recombining, rearranging, editing, and programming genetic material. Animal genes and even human genes are being inserted into plants or animals creating unimagined transgenic life forms. For the first time in history, human beings are becoming the architects of life. Bio-engineers will be creating tens of thousands of novel organisms over the next few years.

2.7 HUMAN GENETIC ENGINEERING

Human genetic engineering is about genetically engineering human beings by modifying their genotypes before birth. The Genotype is the genetic constitution of an individual with respect to a particular character under consideration. This is done to control the traits possessed by the individual after his/her birth. The cells of our body contain encoded information about the body's growth, structure and functioning in the form of genes. Human genetic engineering aims at decoding this information and applying it to the welfare of mankind.

There are two types of genetic engineering. They are: **Somatic modification:** Genes are added to the cells. This can prove to be a cure for diseases caused by defective genes. Somatic modifications cannot be inherited. **Germline modification:** In this form of human genetic engineering, genes in the early embryos are changed. The genes modified in this way are inheritable. This is an effective form of Genetic engineering, as it results in permanent modifications.

Human genetic engineering can be classified as positive genetic engineering and negative genetic engineering. In the positive type of genetic engineering, the positive traits of individuals are enhanced. This can mean increasing longevity or increasing human capacity. The negative genetic engineering is about introducing the good copy of a certain gene into the cells of a living being. Consequently, the suffering characteristic to genetic diseases can be reduced to a great extent.

Advantages

Gene therapy is one of the most important benefits of human genetic engineering. Over the past decade, gene therapy has succeeded in finding treatments for certain heart diseases. Researchers hope to find cures for all the genetic diseases. This will result in a healthier and more evolved human race. A future benefit of human genetic engineering is that a fetus with a genetic disorder will be treated before the baby is born. Parents will be able to look forward to a healthy baby. In case of

in-vitro fertilization, gene therapy can be used for embryos before they are implanted into the mother. Genes can be cloned to produce pharmaceutical products of superior quality. Researchers are hopeful about being able to bio-engineer plants or fruits to contain certain drugs.

Disadvantages

The process of cloning can lead to risking the fundamental factors such as the individuality and the diversity of human beings. Ironically, man will become just another man-made thing (Song 2002).There are certain social aspects to human genetic engineering. This new form of medical treatment can impose a heavy financial burden on the society. Along with its feasibility, its affordability will also determine its popularity. Though it seems easy to cure diseases by genetic modifications, gene therapy may manifest side effects. While treating one defect, it may cause another. Any given cell is responsible for many activities and manipulating its genes may not be that easy. Human genetic engineering is a widely growing field. It can work miracles. But its benefits and threats need to be assessed carefully. The potential advantages of the field can come into reality only if the Genetic engineering of humans is handled with responsibility.

2.8 STEM CELL RESEARCH

We have seen in the first part how hereditary play a very important role in our life. It discussed and summarized the processes of inheritance and this chapter would reveal how changes to genes at the molecular level influence large-scale metabolic and physical Characteristics. It also discussed the organization and internal structure of cells. This section also deals with stem cells. Stem cells have the remarkable potential to develop into many different cell types in the body during early life and growth. In addition, in many tissues they serve as a sort of internal repair system, dividing essentially without limit to replenish other cells as long as the person or animal is still alive. When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell.

Stem cells can be defined as:-

Self-renewal: the ability to divide itself into exact copies numerous times, without changing into specific cell types . **Potency**: the ability to divide itself into cells that will form specific cell types that will build special tissues in the body (heart, brains, blood). Embryos formed during the blastocyst phase of embryological development (embryonic stem cells) and adult tissue (adult stem cells). Both types are generally characterized by their potency, or potential to differentiate into different cell types (such as skin, muscle, bone, etc.). Stem cells are distinguished from other cell types by two important characteristics. First, they are unspecialized cells capable of renewing themselves through cell division, sometimes after long periods of inactivity. Second, under certain physiologic or experimental conditions, they can be induced to become tissue- or organ-specific cells with special functions. In some organs, such as the gut and bone marrow, stem cells regularly divide to repair and replace worn out or damaged tissues. In other organs, however, such as the pancreas and the heart, stem cells only divide under special conditions (Humber and Almedev 2006).

Until recently, scientists primarily worked with two kinds of stem cells from animals and humans: embryonic stem cells and non-embryonic somatic or adult stem cells. The functions and characteristics of these cells will be explained in this document. Scientists discovered ways to derive embryonic stem cells from early mouse embryos nearly 30 years ago, in 1981. The detailed study of the biology of mouse stem cells led to the discovery, in 1998, of a method to derive stem cells from human embryos and grow the cells in the laboratory. These cells are called human embryonic stem cells. The embryos used in these studies were created for reproductive purposes through in vitro fertilization procedures. When they were no longer needed for that purpose, they were donated for research with the informed consent of the donor. In 2006, researchers made another breakthrough by identifying conditions that would allow some specialized adult cells to be "reprogrammed" genetically to assume a stem cell-like state. This new type of stem cell is called Induced pluripotent stem cells (IPSC's).

Stem cells are important for living organisms for many reasons. In the 3- to 5-day-old embryo, called a blastocyst, the inner cells give rise to the entire body of the organism, including all of the many specialized cell types and organs such as the heart, lung, skin, sperm, eggs and other tissues. In some adult tissues, such as bone marrow, muscle, and brain, discrete populations of adult stem cells generate replacements for cells that are lost through normal wear and tear, injury, or disease. Given their unique regenerative abilities, stem cells offer new potentials for treating diseases such as diabetes, and heart disease. However, much work remains to be done in the laboratory and the clinic to understand how to use these cells for cell based therapies to treat disease, which is also referred to as regenerative or reparative medicine. Laboratory studies of stem cells enable scientists to learn about the cells' essential properties and what makes them different from specialized cell types. Scientists are already using stem cells in the laboratory to screen new drugs and to develop model systems to study normal growth and identify the causes of birth defects.

2.9 SOURCES OF STEM CELL

Research on stem cell continues to advance knowledge about how an organism develops from a single cell and how healthy cells replace damaged cells in adult organisms. Stem cell research is one of the most fascinating areas of contemporary biology, but, as with many expanding fields of scientific inquiry, research on stem cells raises scientific questions as rapidly as it generates new discoveries.

EMBRYONIC STEM CELLS

Embryonic Stem Cells as their name suggest, are derived from embryos. Most embryonic stem cells are derived from embryos that develop from eggs that have been fertilized in vitro -in an in vitro fertilizationjavascript:glosspop('ivf') clinic—and then donated for research purposes with informed consent of the donors. They are not derived from eggs fertilized in a woman's body.Embryonic stem cells are derived from a four- or five-day-old human embryo that is in the blastocyst phase of development. The embryos are usually extras that have been created in IVF (in vitro fertilization) clinics where several eggs are fertilized in a test tube, but only one is implanted into a woman (Humber and Almedev 2006).

Sexual reproduction begins when a male sperm fertilizes a female ovum (egg) to form a single cell called a zygote. The single zygote cell then begins a series of

divisions, forming 2, 4, 8, 16 cells, etc. After four to six days - before implantation in the uterus - this mass of cells is called a blastocyst. The blastocyst consists of an inner cell mass (embryoblast) and an outer cell mass (trophoblast). The outer cell mass becomes part of the placenta, and the inner cell mass is the group of cells that will differentiate to become all the structures of an adult organism. This latter mass is the source of embryonic stem cells - totipotent cells (cells with total potential to develop into any cell in the body).

ADULT STEM CELLS

An adult stem cell is thought to be an undifferentiated cell, found among differentiated cells in a tissue or organ that can renew it and can differentiate to yield some or all of the major specialized cell types of the tissue or organ. The primary roles of Adult Stem Cells in a living organism are to maintain and repair the tissues in which they are found. Scientists also use the term Somatic Stem Cells instead of adult stem cells, where somatic refers to cells of the body (not the germ cells, sperm or eggs) (Humber and Robert F. Almedev 2006). Unlike embryonic stem cells, which are defined by their origin, the origin of adult stem cells in some mature tissues is still under investigation.

Adult stem cells have been identified in many organs and tissues, including brain, bone marrow, peripheral blood, blood vessels, skeletal muscle, skin, teeth, heart, gut, liver, ovarian epithelium, and testis. They are thought to reside in a specific area of each tissue (called a “stem cell niche”). In many tissues, current evidence suggests that some types of stem cells are pericytes, cells that compose the outermost layer of small blood vessels. Stem cells may remain quiescent (non-dividing) for long periods of time until they are activated by a normal need for more cells to maintain tissues, or by disease or tissue injury.

Typically, there is a very small number of stem cells in each tissue, and once removed from the body, their capacity to divide is limited, making generation of large quantities of stem cells difficult. Scientists in many laboratories are trying to find better ways to grow large quantities of adult stem cells in cell culture and to manipulate them to generate specific cell types so they can be used to treat injury or disease. Some examples of potential treatments include regenerating bone using cells derived from bone marrow, developing insulin-producing cells for type 1 diabetes, and repairing damaged heart muscle following a heart attack with cardiac muscle cells.

INDUCED PLURIPOTENT STEM CELLS (IPSC’s)

Induced pluripotent stem cells (IPSC’s) are adult cells that have been genetically reprogrammed to an embryonic stem cell–like state by being forced to express genes and factors important for maintaining the defining properties of embryonic stem cells. Although these cells meet the defining criteria for pluripotent stem cells, it is not known if IPSC’s and embryonic stem cells differ in clinically significant ways. Mouse IPSC’s were first reported in 2006, and human IPSC’s were first reported in late 2007. Mouse IPSC’s demonstrate important characteristics of pluripotent stem cells, including expressing stem cell markers, forming tumors containing cells from all three germ layers, and being able to contribute too many different tissues when injected into mouse embryos at a very early stage in development. Human IPSC’s also express stem cell markers and are capable of generating cells characteristic of all three germ layers.

Although additional research is needed, IPSC's are already useful tools for drug development and modeling of diseases, and scientists hope to use them in transplantation medicine. Viruses are currently used to introduce the reprogramming factors into adult cells, and this process must be carefully controlled and tested before the technique can lead to useful treatments for humans. In animal studies, the virus used to introduce the stem cell factors sometimes cause cancers. Researchers are currently investigating non-viral delivery strategies. In any case, this breakthrough discovery has created a powerful new way to "de-differentiate" cells whose developmental fates had been previously assumed to be determined. In addition, tissues derived from IPSC's will be a nearly identical match to the cell donor and thus probably avoid rejection by the immune system. The IPSC strategy creates pluripotent stem cells that, together with studies of other types of pluripotent stem cells, will help researchers learn how to reprogram cells to repair damaged tissues in the human body.

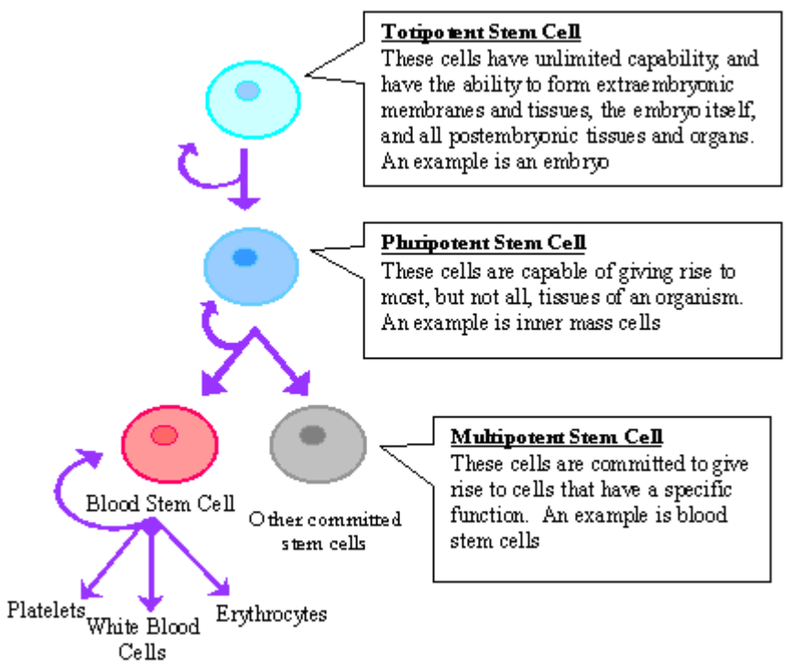
2.10 POTENCY AND PROPERTIES OF STEM-CELLS

Stem cells are categorized by their potential to differentiate into other types of cells. Embryonic stem cells are the most potent since they must become every type of cell in the body. The full classification includes:

Totipotent : the ability to differentiate into all possible cell types. Examples are the zygote formed after the fertilization and the first few cells that result from the division of the zygote.

Pluripotent : the ability to differentiate into almost all cell types. Examples include embryonic stem cells and cells that are derived from the mesoderm, endoderm, and ectoderm germ layers that are formed in the beginning stages of embryonic stem cell differentiation.

Multipotent : the ability to differentiate into a closely related family of cells. Examples include hematopoietic (adult) stem cells that can become red and white blood cells or platelets.



Embryonic stem cells are considered pluripotent instead of totipotent because they do not have the ability to become part of the extra-embryonic membranes or the placenta.

UNIQUE PROPERTIES OF STEM CELLS

Stem cells differ from other kinds of cells in the body. All stem cells—regardless of their origin—have three general properties: they are capable of dividing and renewing themselves for long periods; they are unspecialized; and they can give rise to specialized cell types. Stem cells are capable of dividing and renewing themselves for long period. Unlike muscle cells, blood cells, or nerve cells—which do not normally replicate themselves—stem cells may replicate many times, or proliferate. A starting population of stem cells that proliferates for many months in the laboratory can yield millions of cells. If the resulting cells continue to be unspecialized, like the parent stem cells, the cells are said to be capable of long term self renewal. Scientists are trying to understand two fundamental properties of stem cells that relate to their long term self- renewal (WBE 2004).

Stem cells have offered much hope by promising to greatly extend the numbers and range of patients who could benefit from transplants, and to provide cell replacement therapy to treat debilitating diseases such as diabetes, Dementia, Parkinson's and Huntington's disease. The issue of stem cell research is politically charged, prompting biologists to begin engaging in ethical debates, and generating in the general public an unusually high level of interest in this aspect of biology. but excitement notwithstanding, there is a long way to go in basic research before new therapies will be established, and now the pressure is on for scientists and clinicians to deliver.

Check Your Progress III

Note: Use the space provided for your answers.s.

1) What are some of the advantages of Genetic Engineering?

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2) What is a pluripotent cell?

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2.11 LET US SUM UP

One of the characteristic features of human being is that he/ she can go beyond many limits and move to higher levels of existence. This quality of going beyond or being superior to was manifested through technology especially in Genetic science. We must not be the slaves of the technology. Techniques, however grand they may be, must reduce man to technical animal, the king of the slaves of technique. While creating and relying on the Human- made environment, we ourselves is being modified with new outlook and orientations. The technology limits our outlook in certain way leading to the consumer outlook, materialistic and military orientations etc. The human being now becomes different and he/ she can be called the technological man/woman because of the dominance of technology over his/her life. From a contextual study we become aware of the very nature of human being and how we are constantly becoming different through the advancement in Genetics and other technological developments. So in this unit we have studied the basics of Genetic engineering and Stem-cell research.

2.12 KEY WORDS

Genetic Engineering: The deliberate modification of the characteristics of an organism by manipulating its genetic material.

Germline: Genetic material in a cell lineage that is passed down through the gametes before it is modified by somatic recombination or maturation.

Stem cell: An undifferentiated cell of a multicellular organism that is capable of giving rise to indefinitely more cells of the same type, and from which certain other kinds of cell arise by differentiation.

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