ii. Another example of differentiation would refer to the ***olfactory receptor cells*** which are only expressed in the skin inside the nose. Each of these cells express just one of the genes and thus detect one type of odorant. This is how we can distinguish between so many smells.

5. Stem Cells

a. What are stem cells?

i. Stem cells are those cells which have the ability to differentiate into many different types of cells.

1. The sperm fertilizes an egg cell to produce a zygote. In the early stages of embryonic development, these cells are capable of dividing multiple times and thus can produce large amounts of tissue.

2. They are also extremely versatile in nature, and can differentiate to form a variety of different cell types.

3. The cells of a zygote and an early embryo were given the title of 'stem cells' in the early 19th century, as all tissues of an adult stem from them.

b. What are the key properties of a stem cell?

i. Stem cells have two key properties-

1. Stem cells can divide over and over again to produce copious quantities of new cells.

a. Therefore, they are useful in the growth of tissues, as well as the replacement of lost or damaged cells.

2. They aren't fully differentiated and thus can differentiate to form a variety of different cell types.

c. Discuss the therapeutic and non-therapeutic uses of embryonic stem cells.

i. Therapeutic uses- The therapeutic uses of stem cells refer to it's solutions or medication for diseases or other health problems.

1. Regenerate tissue for those who have suffered from burns.

ii. Mitochondria- The mitochondria is a double membraned organelle that is the site of respiration and produces ATP molecules via aerobic cell respiration.

1. Site of fat digestion, if it is being used as an energy source in the cell.
2. The fluid inside is called the matrix and has membrane fold structures called the cristae.
3. Mitochondria is known as the energy currency of the cell, and is found in every cell of the body, but not in equal numbers. For example, striated muscle cells have more mitochondria as they require more energy (facilitate movement).
    a. A lot of mitochondria is also found in the sperm cells as they need to swim to reach the egg in around 8 hours.
4. Mitochondria has its own 70S ribosomes.
5. It also has its own circular naked DNA known as mDNA.
    a. mDNA is the only DNA that hasn't changed for multiple years.

The mitochondria was probably, at some point, an independent prokaryotic cell.

iii. Ribosomes- are **organelles that lack a membrane**, and facilitate protein synthesis. They may be free floating or attached to the endoplasmic reticulum.

1. Two types are found in eukaryotes-
    a. 70S- Found in the mitochondria.
    b. 80S- Found in the cell of eukaryotes.
2. They are constructed in a region of the nucleus known as the nucleolus.

UNIT 1.6

1. **The Cell Life Cycle**
    a. What is Interphase?
        i. Interphase refers to the day to day activities and functions of the cell.
    b. What are the three divisions of interphase?
        i. The cell life cycle can be divided into four main categories- the G1 Stage, the Synthesis stage, the G2 phase.
    c. When does Cytokinesis begin?
        i. The splitting of two cells during cell division, and begins when G2 ends.
    d. What are the four divisions of mitosis? What is mitosis?
        i. Mitosis can be defined as the process by which the nucleus of a eukaryotic cell divides genetically into two identical nuclei. It allows the cell to divide to form two daughter cells, both of which are genetically identical to one another.
        ii. The four phases of mitosis are PMAT- Prophase, Metaphase, Anaphase and Telophase.
        iii. Mitosis is followed by Cytokinesis.
    e. What happens in the following phases-
        i. G1 Phase- The cell grows.
        ii. Synthesis phase-
            1. The DNA is synthesized and replicated. Then, when it divides eventually, it has enough DNA for both daughter cells.
        iii. G2 Phase-
            1. The number of organelles increases so that there will be enough organelles for both daughter cells.
                a. Number of chloroplasts and mitochondria increase, due to its growth and division. Plant cells also synthesize cellulose and use vesicles to add it to their cell walls.

iv. G1 cyclin and CDK bond to trigger DNA Replication. This begins the synthesis phase. Once enough DNA is replicated, the Kinase breaks down to form CDK and G1 Cyclin. The G1 Cyclin is broken down by the body.

Note- The kinases become active and then attach phosphate groups to the proteins to activate them, and thus carry out their roles in the cell cycle.

3. **Chromosomes**
   a. Double Helix- coils- chromatin- supercoils- chromosome.
   b. The supercoiled chromosome is made of two chromatins, each of which are known as chromatids. The X shaped chromosome is pinched at the centre. They maintain their shape due to a structural and scaffold protein. They also have histones.
   c. During S-Phase- only a change in structure.
4. **Mitosis**
   a. What happens in the Prophase?
      i. In the prophase, the chromosomes become fatter and shorter. They further condense until it is visible to the naked eye under a microscope.
      ii. The nuclear membrane and the nucleolus disintegrate/break down.
      iii. Microtubules/Spindle fibres grow from Microtubule organising centres.
      iv. Centrosomes move to the opposite poles of the cell.
   b. What happens in the Metaphase?
      i. The chromosomes align along the equator to form what is known as the metaphase plate.