Deoxyribonucleic acid (DNA): DNA is present in every living organism. Chemically it is a polymer of nucleotides connected via a phosphate-deoxyribose sugar backbone; genetic materials of cells and some viruses. DNA is a chain of codes attached together that is arranged specifically by different bonds thus unchangeable. This self-replicating material contains all the hereditary information that can be transferred from the parent to their off spring. In humans, 99% of the material found in our DNA is same. It is the 1% that makes us looks remarkably different from each other.

**Single Cell DNA Sequencing (SCS):** DNA molecules together form a sequence. The laboratory method of determining its exact sequence is DNA sequencing. In SCS process, an entire genome can be extracted from a single cell. This revolutionizes our ability to differentiate genotype within a population of cells and pinpoint cells that have spontaneous mutations in their genome that separate them from the others.

It involves the following steps:

1. **Isolate a single cell,**
2. **Amplify its genome efficiently and accurately,** and
3. **Sequence the DNA of the single cell**

By correctly applying these steps, we can compare the differences between the genomes of cells within the same organ or tissue.

**Why is SCS popular?** The studies conducted in Omic sciences (genomics, metabolomics, proteomics, etc.) have clubbed together a culture of tissues or cell assuming Cancer Research (incorrectly) that all cells in a single organism (or organ) are alike. This ‘clubbing together’ means the heterogeneity or individuality of the cells. Heterogeneity can be explained at three levels:

A. Different organisms are heterogeneous.
B. Different organs and tissues in a single organism are heterogeneous.
C. Different cells in the same organ are also heterogeneous.

**SCS has come into limelight** because it revolutionizes the field of medical science and research, and saves thousands of lives from diseases like cancer, genetic diseases, Parkinson’s or Huntington’s, autoimmune disorders; neuronal differentiation in the brain; spinal cord injuries and much more. Accurate determination of SCS will help understand the lineage of cell in question as well as detect any residual disease.

**Applications of SCS technology**

Here’s an overview of a few applications of SCS technology:

**Cancer Research:** In the past, we need bulk tissues for disease diagnosis but these tissues contained multiple cells with all myriad of messages that researchers were then trying to (in most cases in correctly) decode. Besides, all the cells within the tissue culture are different. With the advent of SCS, we could now better study intra tumor heterogeneity, rates of mutation, rare tumor cells etc.

The composition of cancer involves multiple clones of the affected cell. Especially in advanced tumors, there will be an even larger number of clones. Many of which will be unique in nature given their heterogeneity. Each of these unique subclones will then have their own set of mutations. This effectively means that all of these cells will react differentially to the same therapy. Then there are other complexities like a subclone that might only make up for 0.5% of a primary tumor, which could then turn into the dominant clone if the patient were to experience a relapse. That is why molecular profiling is even more important. SCS changes the way we treat cancer.

**Stem Cell Research:** Cells having remarkable potential to develop into many different cell types in the body during early life and growth are called Stem Cells (SC). In many tissues they are involved in internal repair systems, dividing essentially without limit to replenish other cells as long as the organism survives. Each new cell from the division of SC has the potential either to remain a stem cell or become another type of cell with more specialized functions, such as a red blood cell, a muscle cell, or a brain cell. SCs are distinguished from other cell types by two important characteristics. First, they are unspecialized cells capable of renewing themselves through cell division, sometimes even after long periods of inactivity. Second, under certain physiological or experimental conditions, they can be induced to become tissue or organ specific cells with special functions.

To identify the bonafide stem cell is one of the biggest challenges in stem cell research. An SC researcher uses a lot of data acquired from single cells. Everything from its molecular structure to its cellular behaviour becomes central to stem cell research. Advancement in SCS technology made it possible to study the high throughput data from a single cell in a non-invasive manner. Such research gives huge success in medicine and healthcare solutions to the world. This is just the tip of the iceberg.

**Stem Cell Research Challenges:** The first problem is the isolation of single cell, which is yet unsustainable and a very time-consuming process. The second major obstacle that researchers face in attempting to develop single cell sequencing technology is the inherent limitation of the amount of DNA present in a single cell. The accuracy of current sequencing machines depends on the number of copies of a given DNA fragment, and each cell has only one copy of the desired genome. Therefore, the first and most important step of single cell sequencing is an amplification of the cell’s genome with minimal technical errors that cause inaccuracies in the DNA sequence.

Another great challenge for SCS studies is to be statistically significant. A very large number of single cells need to be isolated and studied before drawing conclusion or findings. This number could vary from hundreds to thousands. This would mean mountain loads of data and the need to scan through and study this data in an efficient manner without losing the individuality of each single cell. However, scientists are now successfully storing such big data in DNA molecules itself instead of storing in limited data storage drives or energy and space consuming along with maintenance requiring data servers. These days, SCS tech also incorporated with CRISPR gene editing technology. The CRISPR (Clusters of Regularly Interspaced Short Palindromic Repeats), with the use of Cas9 (CRISPR-associated an enzyme), made it possible to alter DNA sequences and modify gene function for the cure of such health problems and opened exciting new avenues towards health research.

**Works Cited:**

1. www.digit.in, Mar 20, 2018, Page 70 to 71, Digit Magazine India by Tabitha Thomas