Chapter 20
Cancer Stem Cells and Advanced Novel Technologies in Oncotherapy

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ABSTRACT

Self-renewal is the most important property of stem cells. Parallel to this, cancer stem cells (CSCs) have an indefinite proliferative ability that drives tumorigenesis. The conventional treatment of cancer includes chemotherapy, radiotherapy, and surgery, which decreases the tumour size. Contrary, targeted therapy against CSCs initially does not shrink the tumour but ultimately causes tumour degeneration. Nanobiotechnology, RNA interference, microRNA are emerging fields with a vital role in targeted therapy against CSCs. The non-protein encoding microRNAs has a major role in cancer treatment since they regulate gene expression during post-transcription. RNAi technology can silence the gene of interest with potency and specificity inhibiting tumour growth. In nanoparticles-based RNA interference, nanocarriers protect RNAi molecules from immune recognition and enzymatic degradation. The cancer cell gene expression profiling using next-generation sequencing helps in understanding the underlying cancer cell mechanisms. The current chapter deals with novel concepts in the treatment of cancer.

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INTRODUCTION

The human body consists of trillions of cells estimated to be 10^{14} and there are 250 types of specialized cells committed to a unique and distinct function. Normal cells divide in a highly controlled way and they succumb once their function is over or damaged. Further, new cells replace the old and carry out their special assigned chores. In case of cancer, the cells divide uncontrollably and keep on growing rapidly in an unregulated pace. Cancer cells contain genetic alterations and epigenetic modifications which crowd out normal cells, these are the parts where cells modify and generate cancer. Cancer cells are also often able to evade the immune system, a network of organs, tissues, and specialized cells that protects the body from infections and other conditions. Metastasis is the condition where cancer spreads to a different body part from where it started. Cancer is a devastating genetic disease, it is one of the major non-communicable diseases (NCD) in developing as well as developed nations, the leading causes of mortality worldwide (Lekha et al., 2018). The term cancer was derived from the Greek word Karkinos (Crab or Crayfish) (Lekha et al., 2018 and Prasad et al., 1982). The Greek physician Hippocrates (460-370 BC) who is considered as the "Father of Medicine", was the one who used the term "carcinos" and later Greek term translated it to cancer by the Roman physician, Celsus (28-50 BC) (Manohar, 2015). Generally, the normal functional cell transformed into a cancer cell mentioned as carcinogenesis, where two kinds of genes are involved in this process: (i) Oncogenes, which supports cell growth and differentiation (ii) tumour suppressor genes, which inhibits cell division (Pierouli et al., 2019). Various studies revealed that stem cells were involved in both normal development and carcinogenesis (Ciurea et al., 2014). Carcinogenesis or cancer development is a multifaceted phenomenon involves accretion of an arrangement of genetic, epigenetic, histological, and biochemical changes ultimately leading to the progression of pathological manifestations (Khan et al., 2019). The stem cells are present in many different somatic tissues, these cells are unique because it has three important properties a) self-renewal b) undifferentiated c) extensively proliferated. The primary and distinctive property of self-renewal is mainly notable due to more relevant to oncogenesis and malignancy. Then cancer stem cells (CSCs) are found in tumour or cancer possesses characteristics similarity with normal stem cells especially the capability to give rise to all cell types (Chen et al., 2011). The origin of the cancer stem cell (CSC) remains an enigma. After enormous clinical studies, the researchers have discovered that adult stem cells can turn into cancer stem cells with specific surface markers. The leukaemia CD34+/CD38− is one of the best-known examples of the surface marker of CSCs (Ciurea et al., 2014).

CSC plays a major role in tumour growth, so it is an utmost compulsion to develop targeted therapy against CSCs. In this chapter, we will discuss cancer stem cells, their origin, how it is involved in tumour growth and therapeutic strategies with new technologies including Nanobiotechnology, RNA interference (RNAi), microRNA, and Cancer cell gene profiling. Additionally, we will discuss about Cancer vaccines as well as CAR-T-cells involved in cancer treatment.

A NEW PERSPECTIVE OF CANCER STEM CELLS (CSCs)

The most adventurous research in cancer therapy is targeting of CSCs. In 1997 cancer stem cells were first reported by Bonnet and John Dick. Stem cell biologists isolated a subpopulation of acute myeloid leukaemia (AML) cells that expressed surface marker CD34 but lacked CD38 surface marker. This CD34+ /CD38− subpopulation could initiate tumour. In human AML the frequency of this CSCs is less