**Cell and Tissue Culture**

Live cells and tissues can be maintained and studied outside the body. In a complex organism, tissues and organs are formed by several kinds of cells. These cells are bathed in fluid derived from blood plasma, which contains many different molecules required for growth. Cell culture has been very helpful in isolating the effects of single molecules on specific types of cells. It also allows the direct observation of the behavior of living cells under a phase contrast microscope. Many experiments that cannot be performed in the living animal can be accomplished *in vitro*.

The cells and tissues are grown in complex solutions of known composition (salts, amino acids, vitamins) to which serum components or specific growth factors are added. In preparing cultures from a tissue or organ, cells must be initially dispersed mechanically or enzymatically. Once isolated, the cells can be cultivated in a clear dish to which they adhere, usually as a single layer of cells. Cultures of cells that are isolated in this way are called **primary cell cultures.** Many cell types once isolated from normal or pathologic tissue have been maintained *in vitro* ever since because they have been immortalized and now constitute a permanent **cell line.** Most cells obtained from normal tissues have a finite, genetically programmed life span. Certain changes, however (some related to oncogenes), can promote cell immortality, a process called **transformation,** which are similar to the initial changes in a normal cell's becoming a cancer cell. Because of improvements in culture technology, most cell types can now be maintained in the laboratory. All procedures with living cells and tissues must be performed in a sterile area, using sterile solutions and equipment, to avoid contamination with microorganisms (Figure 1).

Incubation of living cells *in vitro* with a variety of new fluorescent compounds that are metabolized in specific compartments of the cell provides a new approach to understanding these compartments both structurally and physiologically. Other histological techniques applied to cultured cells have been particularly important for understanding the locations and functions of microtubules, microfilaments, and other components of the cytoskeleton.



**Figure 1** The origin and progression of cell lines with population doubling level. (Note, however, that in some cases transformation can occur in the absence of immortalization)

**MEDICAL APPLICATION**

Cell culture has been widely used for the study of the metabolism of normal and cancerous cells and for the development of new drugs. This technique is also useful in the study of parasites that grow only within cells, such as viruses, mycoplasma, and some protozoa. In cytogenetic research, determination of human karyotypes (the number and morphology of an individual's chromosomes) is accomplished by short-term cultivation of blood cells or fibroblasts and by examining the chromosomes during mitotic division. In addition, cell culture is central to contemporary techniques of molecular biology and recombinant DNA technology.

Other applications include:

1. Production of antiviral vaccines

1. Understanding of neoplasia (cancer research)
2. Transfer of DNA to the cultured cells (or small interfering RNAs (siRNAs)
3. Monoclonal antibody production (immunology)
4. Production of human growth hormone, insulin, interferon
5. Stem cell culture differentiate into neurons
6. In vitro fertilization (embryo culture)
7. Homografting and reconstructive surgery using individual’s own cells (tissue engineering)