MECHANISM OF CELLULAR DIFFERENTIATION

- Differentiation is the process by which unspecialized cells become specialized to carry out distinct functions.
- Throughout development and adulthood, the process of cellular differentiation leads cells to assume their final morphology and physiology.

- Stem cells are unique in that they can also continually divide and regenerate new stem cellsinstead of further specializing. There are different stem cells present at different stages of a human's life.
- They include the embryonic stem cells of the embryo, fetal stem cells of the fetus, and adult stem cells in the adult.
- One type of adult stem cell is the epithelial stem cell, which gives rise to the keratinocytes in the multiple layers of epithelial cells in the epidermis of skin.

RNA PROCESSING

- When a cell differentiates (becomes more specialized), it may undertake major changes in its size, shape, metabolic activity, and overall function. Because all cells in the body, beginning with the fertilized egg, contain the same DNA.
- Similarly, all cells contain the same full complement of DNA, but each type of cell only "reads" the portions of DNA that are relevant to its own function. In biology, this is referred to as the **unique genetic expression of each cell.**

- The primary mechanism by which genes are turned “on” or “off” is through transcription factors.
- A **transcription factor** is one of a class of proteins that bind to specific genes on the DNA molecule and either promote or inhibit their transcription (Figure 1).

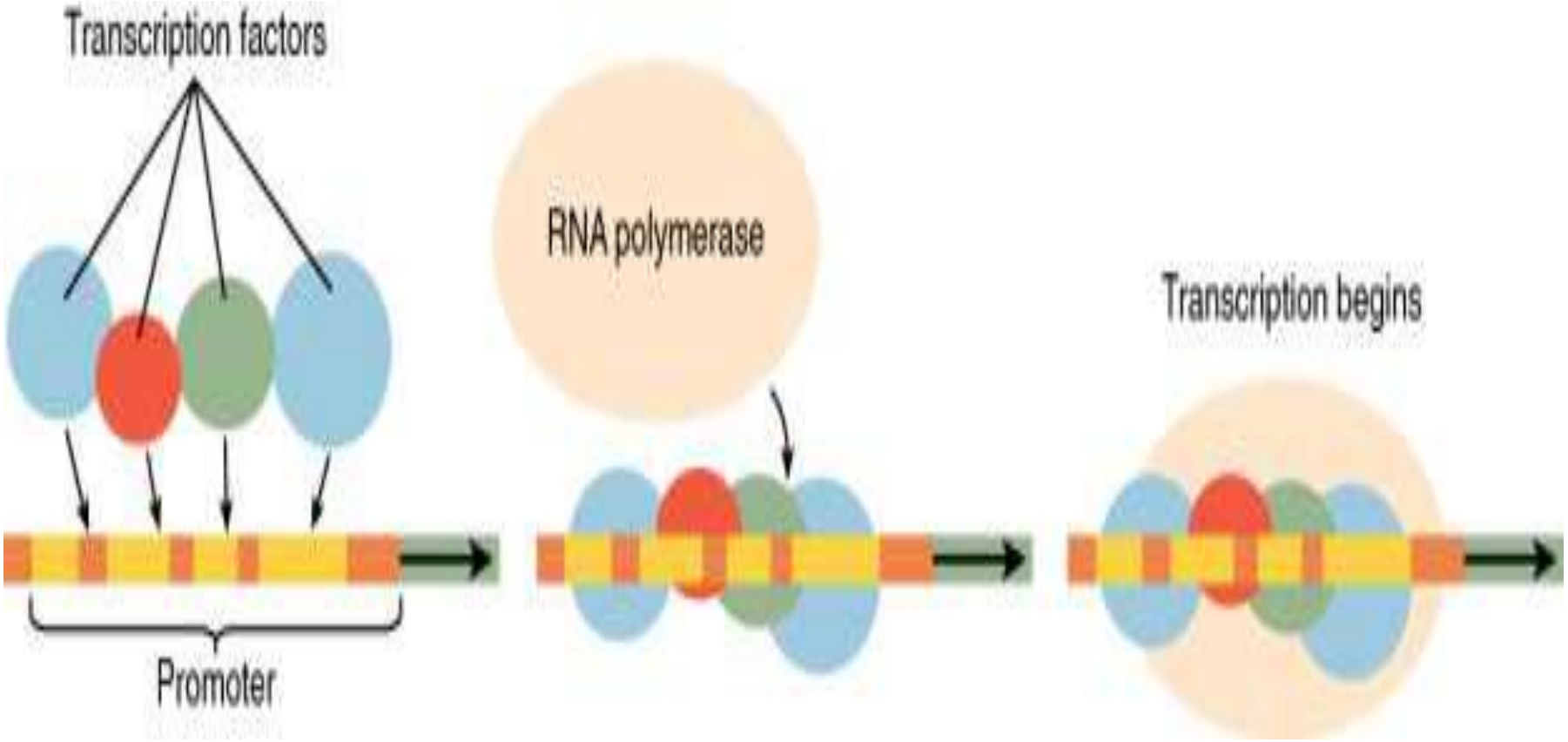

Figure 1. Transcription Factors Regulate Gene Expression. While each body cell contains the organism's entire genome, different cells regulate gene expression with the use of various transcription factors. Transcription factors are proteins that affect the binding of RNA polymerase to a particular gene on the DNA molecule.

The mechanisms that induce a non-differentiated cell to become a specialized cell are poorly understood. In a laboratory setting, it is possible to induce stem cells to differentiate into specialized cells by changing the physical and chemical conditions of growth.

Several sources of stem cells are used experimentally and are classified according to their origin and potential for differentiation.

- Human embryonic stem cells (hESCs) are extracted from embryos and are pluripotent.

- The adult stem cells that are present in many organs and differentiated tissues, such as bone marrow and skin, are multipotent, being limited in differentiation to the types of cells found in those tissues.

- The stem cells isolated from umbilical cord blood are also multipotent, as are cells from deciduous teeth (baby teeth).
- Researchers have recently developed induced pluripotent stem cells (iPSCs) from mouse and human adult stem cells.
- These cells are genetically reprogrammed multipotent adult cells that function like embryonic stem cells; they are capable of generating cells characteristic of all three germ layers.

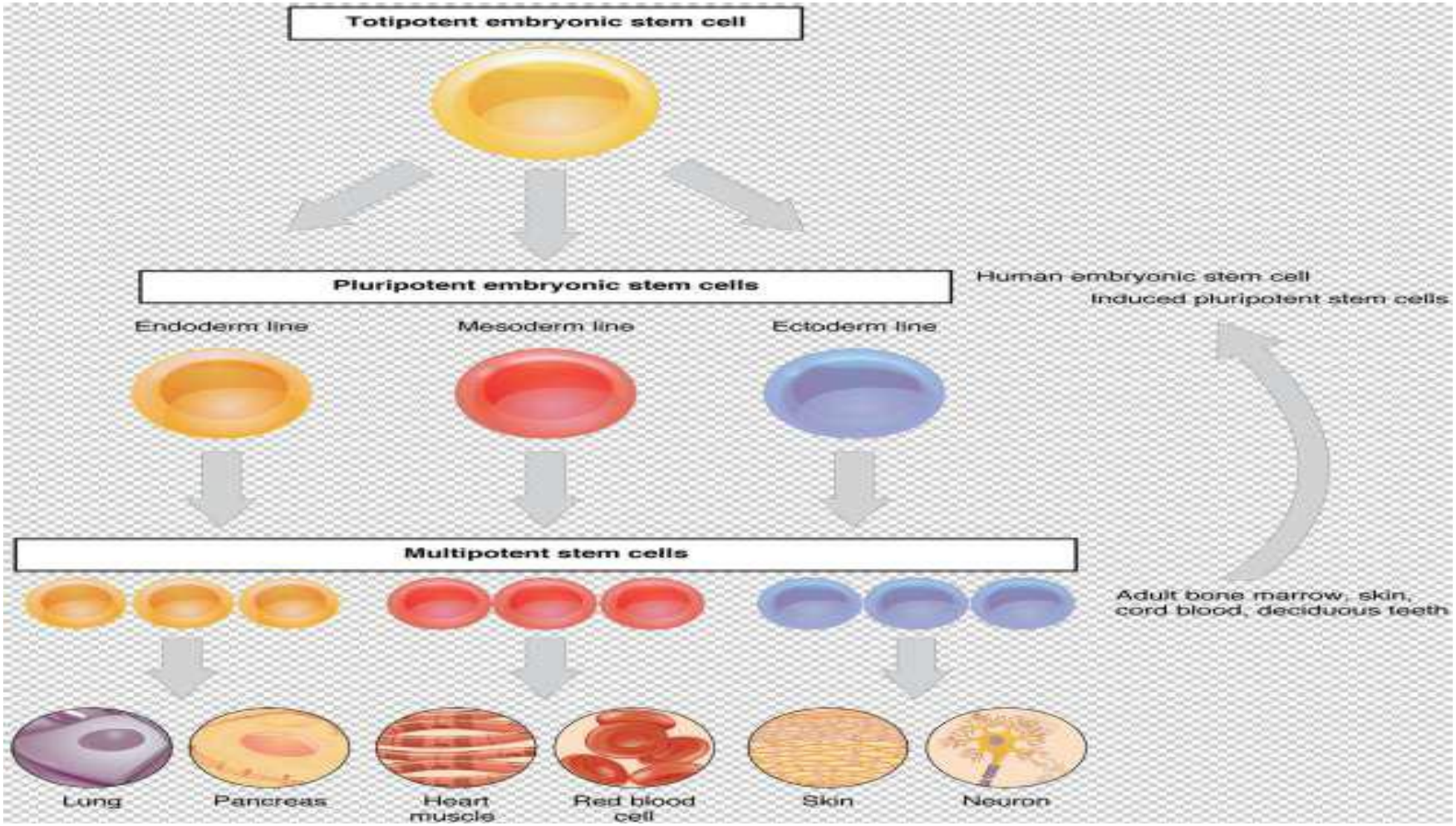

Figure 3. Stem Cells. The capacity of stem cells to differentiate into specialized cells make them potentially valuable in therapeutic applications designed to replace damaged cells of different body tissues.

Cell differentiation

- Cell differentiation is the process of cells becoming specialized as they body develops.
- A stem cell is an unspecialized cell that can divide without limit as needed and can, under specific conditions, differentiate into specialized cells. Stem cells are divided into several categories according to their potential to differentiate.

- These differences in gene expression ultimately dictate a cell's unique morphological and physiological characteristics.

- The primary mechanism that determines which genes will be expressed and which ones will not is through the use of different transcription factor proteins, which bind to DNA and promote or hinder the transcription of different genes. Through the action of these transcription factors, cells specialize into one of hundreds of different cell types in the human body.

1. Transcription factors bind to DNA and either promote or inhibit the transcription of a gene. If they promote the transcription of a particular gene, then that gene will be transcribed and the mRNA subsequently translated into protein. If gene transcription is inhibited, then there will be no way of synthesizing the gene's corresponding protein.

2. Embryonic stem cells derive from human embryos, which are destroyed to obtain the cells. The destruction of human embryos is an ethical problem. And, the DNA in an embryonic stem cell would differ from the DNA of the person being treated, which could result in immune problems or rejected of tissue.