Stem Cells and Cloning

1) Stem Cells

a) Characteristics
   i) They continue to grow and proliferate,
   ii) Given the correct signals (from a hormone or a ‘growth factor’) they can differentiate into a particular specialized cell type

b) Potency
   i) Some stem cells have more abilities than others
      (1) A unipotent stem cell can form only one differentiated cell type
      (2) A pluripotent stem cell can form most or all of the 210 differentiated cell types in the adult body
      (3) A totipotent stem cell can form not only adult cell types, but also the specialized tissues needed for development.

c) Where do we get stem cells?
   i) Adult Stem Cells
      (1) Hematopoietic cells in bone marrow form red blood cells
      (2) Skin stem cells
      (3) Stem cells that make sperm
      (4) Fully formed adult tissues also contain stem cells
      (5) May also form several different types of tissue, even fat contains stem cells.
   ii) Embryonal Carcinoma Cells (EC cell)
      (1) These come from a tumor when an egg or sperm spontaneously starts to grow and divide.
      (2) These tumors can grow differentiated tissue such as bone and hair.
      (3) This is how people learned that early embryos contain similar types of stem cells
   iii) Embryonic Stem Cells (ES cell)
      (1) One of the first cells formed during development of the embryo
      (2) First isolated from humans in 1998
      (3) They form about 5 to 7 days after conception
      (4) Pluripotent- can form most or all of the 210 differentiated cell types in the adult body
   iv) Embryonic Germ Cells (EG cell)
      (1) Derived from progenitor cells that will become germ cells (egg or sperm) from early fetal tissue (5-9 weeks after conception)
      (2) Also pluripotent

d) Embryonic Stem Cells
   i) Hope
      (1) A lot of cells can be grown and then given hormonal signals to specialize into a specific tissue
      (2) This could be used to create new cells or tissue on demand and treat illnesses such as diabetes, Alzheimer’s and spinal cord injuries
   ii) Problems
      (1) Inefficient to get them to start growing and keep growing in the laboratory
         (a) Only 1 in 10 embryos actually provide useable stem cells
      (2) Hard to form the desired specific cell type in the culture dish.
      (3) Could form tumors in patients
      (4) Only scant evidence that embryonic stem cells can actually work in the body
Studies on Parkinson’s in rats show some improvement with stem cell treatment, but one-fifth of the rats died from brain tumors caused by the stem cell treatment.

(5) **Transplant Rejection** - the host’s body will not accept the new cells

(6) **Gene expression** - stem cells may not be able to regulate gene expression properly which could lead to serious problems.

2) **Cloning**
   a) **Cloning** means to make an identical copy of something, including copying DNA
      i) Cloning a new organism from a pre-existing one is known as **asexual reproduction** because it does not involve sex

b) **How to Clone**
   i) Need 1. an egg and 2. the DNA from a body cell (somatic cell)
      (1) **Enucleation** – the removal of a nucleus from a cell
   ii) The DNA is injected into the **enucleated** egg cell, which is called **nuclear transplantation** or **somatic cell nuclear transfer**.
   iii) The new clone is then stimulated to grow by applying an electric shock.
   iv) The embryo must then be implanted into the womb of a surrogate mother.

c) **Why Clone?**
   i) In agriculture, people want to have ‘the best’ livestock, and cloning them is a way of ensuring their genes get passed on.
      (1) Problems
         (a) Very inefficient
            (i) It took 277 tries to get one Dolly.
         (b) Don’t know how normal the clones are
   ii) For humans
      (1) **Reproductive cloning** to produce offspring for infertile couples.
      (2) **Therapeutic cloning** would produce **embryonic stem cells** which could then be used to treat diseases.
         (a) Problems
            (i) The egg adds the mitochondria, which have some effect on the clone.
            (ii) Only eggs can be used, and to produce all those eggs a woman must take hormones, which can have drastic side effects.
               1. Some suggest using cow or rabbit eggs.

3) **Bioethics** - discipline dealing with the ethical implications of biological research and applications, especially in medicine
   a) Things to consider
      i) **What does it mean to be human?**
         (1) Much of the stem cell debate centers around whether embryos are human.
         (2) Science has no answer for this because it is a moral, philosophical or theological question
         (3) During **in vitro fertilization (IVF)** a woman produces many (20-30) eggs which are fertilized in a dish. When an embryo successfully develops into a fetus, there are many left over embryos.
            (a) About 100,000 embryos in the U.S. alone
         (4) What should be done with the embryos?
            (a) Some are thrown away
            (b) Some are ‘adopted’ by other couples