Bioethics

BIOLOGY II
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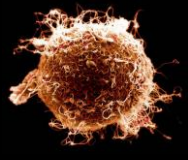
Dolly the sheep and her lamb – produced by normal reproduction.

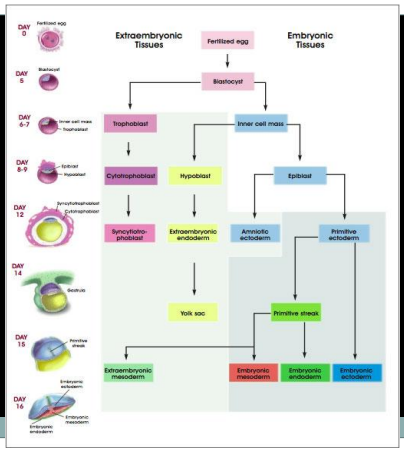
When does life begin?

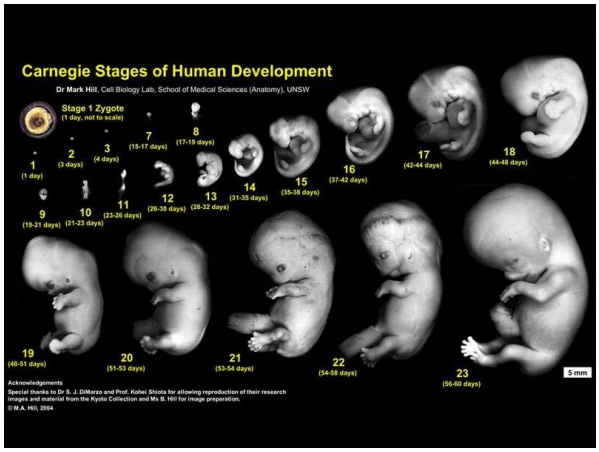
- History
  - Prior to 20th century – not uncommon for newborn infants to die after birth.
  - Many cultures "personhood" a specific time after birth.
    - Japan – when infant utters first cry
    - Tribes of Ghana – 7 days after birth
    - Ayatal aborinies – after child is named (2-3 years)
    - Native Americans of Mojave – after child is on the mother's breast

When does life begin? (cont.)

- Religion
  - Jewish, Roman Catholic Church, Protestant, Islamic, Hinduism, Buddhism
- Scientific Views
  - Four stages of development:
    - Fertilization – egg + sperm
    - Gastrulation – day 14
    - EEG activation - week 24
    - Time surrounding the birth – survive on



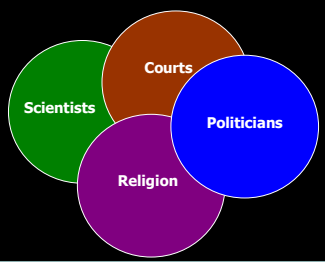




Human development

We need to be educated!

- Most bioethical questions demand hard decisions.
- What if we can't make them – Who will?

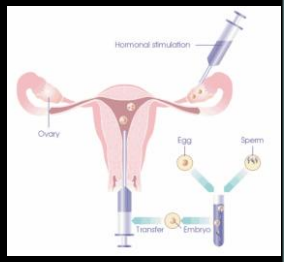


Can we pick the traits of our children?

- We already do – in who we decide to marry.

Assisted Reproductive Technologies (ART)

- In vitro fertilization (IVF)
  - Oldest and most standard ART
  - Retrieving eggs and sperm and placing them together in a petri dish.
  - 1st child born from IVF was in England in 1978.



In vitro fertilization


Mature egg with cumulus cells


Injection of a single sperm


Fertilized egg with 2 nuclei


Developing embryo 6-8 cells. Three days after fertilization


Cell removed for genetic testing

Preimplantation Genetic Diagnosis

- A way to screen the embryo, using genetic testing, before it is implanted in the uterus.
- Done at the 4-8 cell stage
- Defective embryos are discarded and "normal" embryos are implanted
- Prevention of sex-linked disease – can this lead to sex selection?
- GATTACA video clip

Cloning

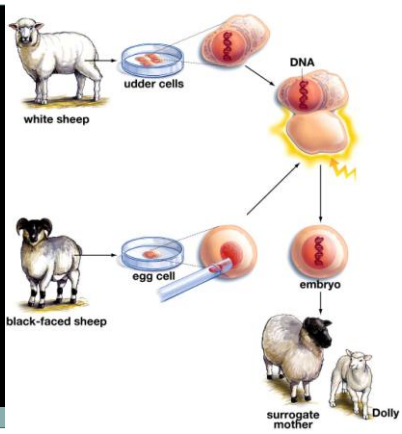
- 2 Basic Principles:
  - Every nucleus in an embryo or adult carries the same genes.
  - An "egg" can be tricked into normal cell division and development by procedures other than sperm entry (naturally).
- 2 Types:
  - Therapeutic: Cloned cells, not individuals (using stem cells)
  - Reproductive: Entire organism is created (more controversial)

Cloning (cont.)

- Also called Somatic Cell Nuclear Transfer (SCNT).
- Steps for cloning:
  1. Remove the nucleus from unfertilized egg.
  2. Place into this enucleate egg a nucleus taken from a somatic cell.
  3. Activate development
  4. Place into surrogate until development is complete.
- Images of cloned animals
- Video Clip of Cloning Process

The Biotechnology of Reproductive Cloning

Cloning provides the most direct demonstration that all cells of an individual share a common genetic blueprint.



Why clone animals?

- To bring back extinct or endangered animals.
- Herd improvement
- For pharmaceutical production.
- To satisfy our desires (e.g. pet cloning).

Five genetically identical cloned piglets.

Safety of reproductive cloning

- Physical well-being and accelerated aging
  - Dolly died in 2003 at the age of 6 – early for a sheep – due to a progressive lung disease.
  - Mice cloned have also died shortly after birth and have other health problems
  - Thought to be due to premature aging – telomere length of chromosomes.
- Playing the numbers
  - Cloning of Dolly took 277 fused oocytes. It took 586 embryos to get cloned piglets.

Ethics of reproductive cloning

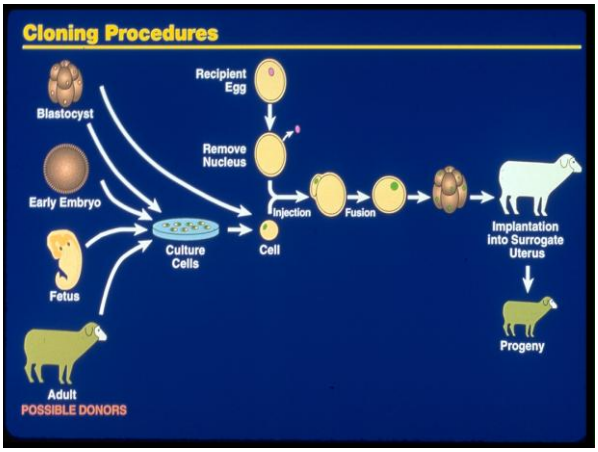
- Religious views
  - Little agreement between various religions
- Cultural values
  - Making animals superior "desirable" qualities
- Psychological well-being
  - Creating a life to save someone else
  - Maintaining individuality
  - "Living in someone else's shadow"

Ethics of Reproductive Cloning (Cont.)

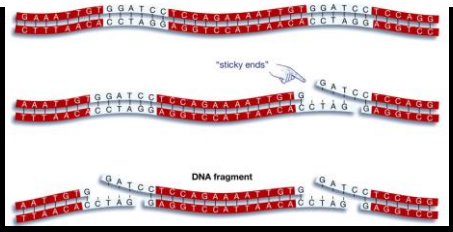
- Highly unlikely. Attempts at human cloning are viewed very unfavorably in the scientific community.

Therapeutic Cloning

- Produces embryonic stem cells for experiments aimed at creating tissues to replace injured or diseased tissues.
  - Blastocyst (100 cell stage) is used. Can become any cell type.
  - Harvested from cloned embryos five days after the egg has started to divide.



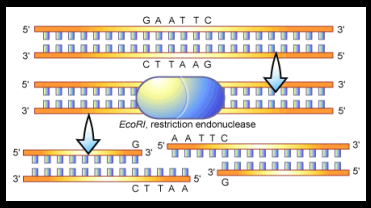
Recombinant DNA, Gene Cloning, Pharmaceutical Production



- DNA can be cut at specific sequences using restriction enzymes.
- This creates DNA fragments useful for gene cloning.

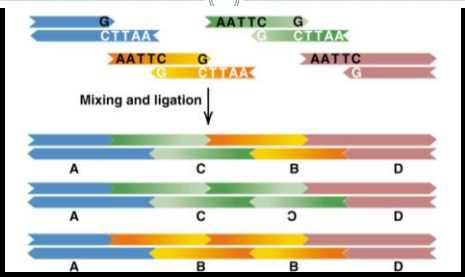
Restriction Enzymes are Enzymes That Cut DNA Only at Particular Sequences

- Different restriction enzymes have different recognition sequences.
- This makes it possible to create a wide variety of different gene fragments.



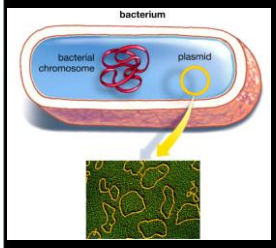
The enzyme EcoRI cutting DNA at its recognition sequence

DNAs Cut By a Restriction Enzyme Can Be Joined Together in New Ways



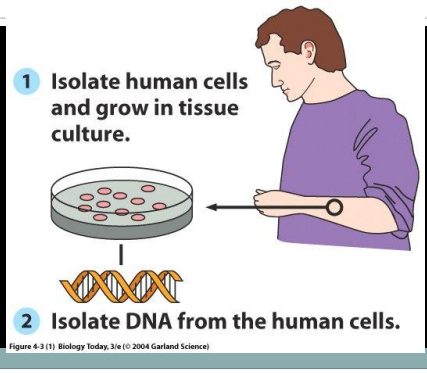
- These are recombinant DNAs and they often are made of DNAs from different organisms.

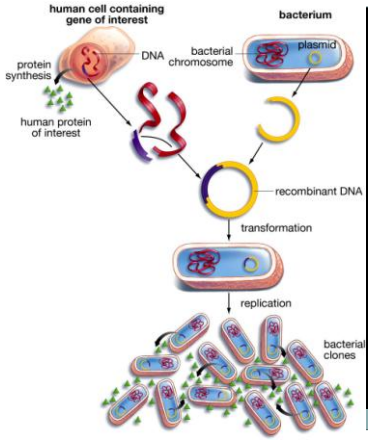
Plasmids are Used to Replicate a Recombinant DNA



- Plasmids are small circles of DNA found in bacteria.
- Plasmids replicate independently of the bacterial chromosome.
- Pieces of foreign DNA can be added within a plasmid to create a recombinant plasmid.
- Replication often produces 50-100 copies of a recombinant plasmid in each cell.

Human Insulin Production in Bacteria





- Overview of Gene Cloning

Gene Cloning

A fermentor used to grow recombinant bacteria.

The final steps are to collect the bacteria, break open the cells, and purify the insulin protein expressed from the recombinant human insulin gene.

Pharming

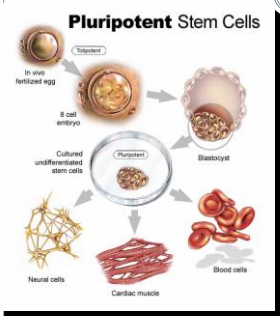
- Pharming is the production of pharmaceuticals in animals engineered to contain a foreign, drug-producing gene.

These goats contain the human gene for a clot-dissolving protein that is produced in their milk.

What is a Stem Cell?

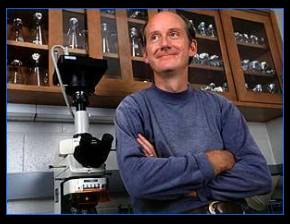
- Common in the embryo.
- Found in adult cells being replaced.
  - Ex: 2 million RBC's produced each second!
  - Hair follicles, sperm, some neural, and muscle.
- Stem cells have two important properties:
  - Can divide for indefinite periods of time.
  - Each division can give rise to a similar stem cell as well as a more specialized cell type.
    - This allows them to continually be made.

Stem Cells



- Two types:
- Embryonic Stem Cells:
  - Termed Pluripotent: Taken from the inner cell mass of the embryo and can produce all the cell types found in a person.

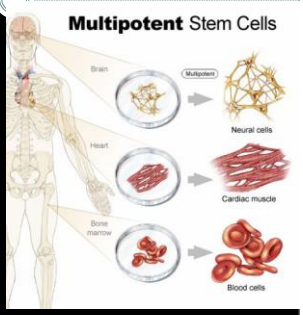
James Thompson was the first to grow colonies of ES cells at UW-Madison in 1998.



http://whyfiles.org/189stem_cell/3.html

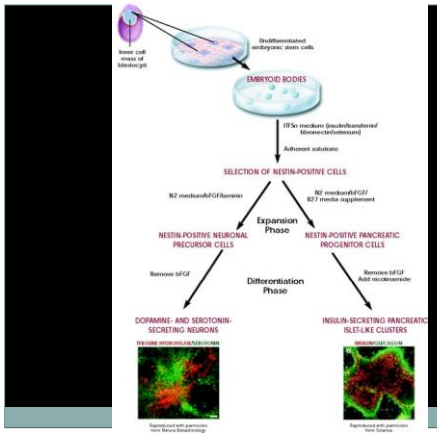
Stem Cells (cont.)

- Adult Stem Cells:
  - Termed Multipotent: Specific to tissues:
    - Epidermis, blood, bone, liver, etc.
    - Becomes specialized tissues



ES and Therapeutic Cloning

- Possible scenarios
  - Production of neurons for Alzheimer's or Parkinson's patients.
  - New pancreatic cells for those with diabetes
  - New blood cells for those with anemia
  - Replace damaged heart tissue or immune components
- Has worked in mice:
  - Insulin-secreting pancreatic cells, muscle cells, glial cells, neural cells
- Hwang Lab in South Korea (2005)
  - Made 11 stem cell lines genetically identical to patients with spinal cord injury and Type 1 diabetes. Used somatic cell DNA and placed in enucleated egg – developed into blastocyst



Adult Stem Cells and Therapeutic Cloning

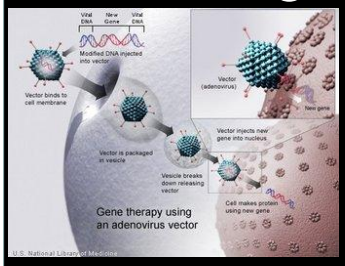
- Bone marrow most remarkable
- Hematopoietic (blood forming)
  - One type can produce all types of cells in the blood: red, platelet, white, and lymphocytes.
  - Injection of one of these cells in mice cures anemia
- Have found other stem cells in bone marrow
  - Muscle, intestinal tissue in mice
  - Bone, cartilage, fat and other connective tissue also – not all agree.
  - Could potentially be very useful.

Adult Versus Embryonic Stem Cells

- Adult
  - Bone marrow as an example – does not destroy embryos.
  - If obtained from patient – no chance of rejection.
  - Cells are relatively rare – do not grow easily outside the body.
  - Some organs do not have adult stem cells – pancreas and beta cells that make insulin.
- Embryonic:
  - Can be obtained in large quantities
  - Animal experiments have been successful
  - Ethics behind destroying young embryos
  - If dosage not correct, can form tumors and transmit viruses.

- Current News - Transplant of Trachea from Stem Cells
- PBS Stem Cell Video Clip

Genetic Engineering "Gene Therapy"



- Two forms:
  - Somatic cell gene therapy: Medical treatment intended to target abnormally functioning genes in a specific body cell.

Somatic Cell Gene Therapy

- A normal functioning gene is inserted (by means of a virus vector) into a patient's genome.
- Hope that the inserted gene will be accepted by the cell and translated into a normal protein.
- Not passed on to offspring.
- Medical intervention like heart surgery or radiation.
- Question of leading to medical enhancement?
  - Strength and athletic performance (myostatin)?

Germline Gene Therapy

- 2nd Type:
- Germline gene therapy: Intended to modify all the person's cells, including germ cells (egg and sperm).
  - Decendants would inherit the altered genes.
- Questions surround this issue:
  - May help to eradicate inherited genetic diseases.
  - Alternative today available – prenatal diagnosis, gamete donation, embryo selection, adoption.

Things to think about…

- It isn't safe
- We are playing God
- We do not know what such genetic technology will be used for
- Do we really know which traits to enhance or get rid of?
- Do we even know the functions of the genes that might be changed?
- Do parents have the right to make decisions about their children's genotype?
- Genetic engineering may lead to eugenics.

What is Normal?

My life has been happy because I have had wonderful friends and plenty of interesting work to do. I seldom think about my limitations, and they never make me sad. Perhaps there is just a touch of yearning at times, but it is vague, like a breeze among flowers. The wind passes, and the flowers are content.

- Helen Keller (1927)

What is Normal (cont.)

- Phenotype – A person's physical appearance is the result of their genotype (all the genes) and its interactions with the environment.
- Relies heavily on perspective
- Deafness
  - Those who are deaf consider it normal and are offended by those who view deafness as a disease that needs to be "cured".
  - Hearing couples abort child that will be deaf – Deaf parents abort child that can hear. How is this different?
- Intersex – 1/100 children born with body altered from standard male/female.