1 **Chapter 5**
Biotechnology

2 **5.10**
- Biotechnology
  - Modification of organisms for practical benefits
    - Medications
    - More nutritious food
    - Reducing pesticide use
    - Analyze forensic evidence
  - Genetic engineering
    - Manipulation of genetic material
      - Add delete or transplant genes

3
- Basic steps
  - Chop up DNA with gene of interest
    - Restriction enzymes
  - Amplify the DNA
    - Polymerase chain reaction (PCR)
  - Insert into bacteria
    - plasmids
  - Grow the bacteria
  - Identify the bacteria with your gene

4 **5.11 treating disease**
- Diabetes
  - Insulin from cattle or pig pancreas
    - Expensive & allergic reactions
  - 1882
    - Transgenic E. coli w/human insulin gene
    - First transgenic med. approved by FDA
  - Today
    - 1,500 companies
    - > $40 billion in revenues each year
- Human growth hormone
- Erythropoietin

5 **5.12 curing disease**
- Severe combined immunodeficiency disease
- 1990's some individuals completely cured
  - Bone marrow disease
- > 500 other gene therapies
  - No clear success
- Problems
  - Treating specific cells
  - Side effects in target cell
  - Side effects in other cells

6 **5.13 prevent disease**
- Evaluating parents before producing offspring
  - In vitro fertilization (Tay-Sachs)
- Prenatal diagnosis
  - Cystic fibrosis, sickle-cell anemia, down syndrome

- Amniocentesis or chronic villus sampling
- Likelihood of developing disease
  - Genetic Information Nondiscrimination Act 2008
    - Does not cover: life insurance, disability insurance & long term care insurance
- Many moral issues also arise

7 **5.14**

- Agriculture
  - Thousands of years (breeding)
  - Recombinant DNA technology
    - Same effect more quickly
  - Genetically Modified Organisms (GMO's)

8

- Golden Rice
  - Vitamin A
    - blindness (mostly children)

9 **5.15**

- Reduce environmental & finical cost of food production
- United states
  - 45 % of all corn
  - 76% of all cotton
  - 85% of all soybeans

10

- Insect resistance
  - Bt crystals
- herbicide resistance
- Faster growth

11 **5.16**

- Unintended traits
  - Traditional breeding
  - Transgenic organisms
  -
- Organisms may become invincible
  - Canola plants
- Other organisms inadvertently killed
  - Monarch butterflies

12

- Adequate testing &regulation
  - How do you know
- Eating GMO's is dangerous
  - Allergy causing genes transferred
- Loss of genetic diversity
  - Irish potato famine
- Hidden costs reduce financial benefit
  - Sterile seeds
-

13

- Additional less rational fears
  - GMO's are not "natural"
    - Natural unnatural

- Smallpox smallpox vaccine
  - Must consider the risks & benefits

14 **5.17**

- 1987 Colin Pitchfork
  - Raped & murdered two 15 year old girls
  - Crime scene blood
  - All men in area 18-35
    - 5,000 samples

15

- DNA fingerprinting
  - Variable number of tandem repeats (VNTR)
    - Usually > 10 different locations used
  - FBI database (CODIS)

16

- Limitations of DNA
  - Cannot establish guilt
    - DNA only tells who was involved

17

- Things to keep in mind
  - DNA remains stable for years
    - NO false positives
    - May limit usefulness of DNA

18 **The power of DNA**

- Probability of a match is 1 in over a quadrillion
  - This exceeds the total number of people who have ever lived on earth
  - Only identical twins have exact same DNA

19 **5.18**

- Mapping the genome
  - Human Genome Project
    - 20,000-25,000 genes
  - Family tree for earth
    - Phylogenetic trees

20 **5.19**

- Reproductive Cloning
  - Dolly in 1997
    - Ian Wilmut (Scotland)
      - One out of 272 tries
    - Dolly died in 2003
    -
- Identical twins are natural human clones
  - ethical issues

21

- preserving endangered species
- Siberian ibex
  - endangered species that has been cloned

22

- mammals cloned since 1997
  - Horses, mules, cows, pigs, cats, mice, and goats
  - Some were transgenic

- Pharmaceutical-drug producing animals

23

- *Jurassic Park*? No.
  - DNA degrades over time
  - The oldest DNA retrieved from Neanderthal man that died 30,000 years ago
  - Maternal compatibility

24

- Embryonic stem cells (ESCs)
  - can develop into any type of tissue
    - Muscle, nerve, etc.

25

- Adult stem cells
  - Many, not all other kinds of cells
  - Less versatile than embryonic stem cells
  - Less promising for treatment of disease

26

- No human disease has yet been cured with embryonic stem cells
  - potential demonstrated in mice and rats

27

- Parkinson's disease
  - shaking and stiffness due to brain which stop making dopamine
  - ESCs injected into brains of rats transformed into functional neurons
-
- Multiple sclerosis
  - destroys the insulating myelin that wraps around neurons
  - ESCs converted into myelin-producing cells in mice

28

- ESC source & government
  - fertility clinics
  - federal government 2001
    - Only existing cell lines
      - Problem?
  - Great Britain
  - Harvard
  - Stanford
  - California

29

- Rejection of ESCs is a potential problem
- therapeutic cloning
  - Nucleus from adult cell inserted into anucleate egg
  - Ethical issue
    - Human cloning?