BIOTECHNOLOGY

Name: ___________________________ Period: __ Date: ____________

I. Selective Breeding

1) ______________________________________ = The process by which desired traits of certain plants and animals are selected and passed on to their future generations.
   • Breed only those plants or animals with desirable traits

2) People have been using selective breeding for 1000’s of years with farm crops and domesticated animals.

II. Human Genome Project (HGP)

1) HGP = ______________ of all 30,000 genes on the 46 human chromosomes (1988-2003)
   • Information has led to many advances in the fields of medicine, agriculture, bio-engineering

2) An organism’s _________________ is the total DNA in the nucleus of each cell

III. Genetic Engineering

1) Biotechnology refers to technology used to ___________________ DNA.

2) The procedures are often referred to as ______________________________.

3) ____________ is the genetic material of all living organisms.
   • All organisms use the _____________ genetic code (A, T, C, G).

IV. Recombinant DNA

1) _______________________________________ refers to the DNA from the two different organisms.
   • Can be used for creating transgenic organisms, gene therapy, and cloning.

2) Recombinant DNA technology was first used in the 1970’s with bacteria.

3) A ________________________ is small ring of DNA in a bacterium

4) Making Recombinant Bacteria
   a) Remove bacterial DNA (plasmid).
   b) Cut the Bacterial DNA with “______________________________ (RE)”.
      o Restriction enzymes were discovered in ___________________.
Bacteria use them as a defense mechanism to cut up the _______ of viruses or other bacteria.

Hundreds of different __________________________________ have been isolated.

Each restriction enzyme or RE cuts DNA at a __________________________ base sequence.

- For example, EcoRI always cuts DNA at GAATTC as indicated below

```
G | A A T T C
C T T A A | G
```

- The sequence GAATTC appear three time in the below strand of DNA, so it is cut into four pieces.

```
GTAAGAATCTTTAGAATTCGGAATCTAC
CATCTTAAGAAATCTTAAGGGCTTAAGCTCTAGAATG
```

- Fragments of DNA that has been cut with restriction enzymes have unpaired nucleotides at the ends called ________________________. Sticky ends have complimentary bases, so they _____________________________.

```
GTAAG AATCTTTAG AATTCGGAATCTAC
CATCTTAAGAAATCTTAAGGGCTTAAGCTCTAGAATG
```

c) Cut the gene of interest from the organism's DNA with __________ “restriction enzyme” (RE).
d) Combine the “sticky ends” of the two DNA pieces together with ______________________ (enzyme) – also known as ___________________________.
   o This creates a __________________________ = a DNA molecule used to carry a gene of interest from one organism to another.
   o __________________________ & __________________________ are the most commonly used vectors.
e) Insert vector into bacteria.
f) The bacteria can now __________________________ the recombinant DNA.
g) The foreign genes will be __________________________ in the bacteria.

5) **Benefits of Recombinant Bacteria**
   - Bacteria can make human __________________________ or __________________________.
   - Bacteria can be engineered to “eat” ________________ spills.

**V. GENETIC ENGINEERING: What Can We Do With Genes?**

1) DNA fingerprinting - Recombinant DNA techniques are used in __________________________

2) __________________________ = A "normal" gene is inserted into the genome to replace an "abnormal," disease-causing gene.
   - In the future, may be used treat a disorder by inserting a gene into a patient’s cells instead of using drugs or surgery.
   - **Types of gene therapy:**
     - __________________________a mutated gene that causes disease with a healthy copy of the gene
• Knocking out, or “knocking out,” a mutated gene that is functioning improperly.
• Introducing a new gene into the body to help fight a disease.
• Currently, the only way for you to receive gene therapy is to participate in a clinical trial.
• Research studies that help doctors determine whether a gene therapy approach is safe for people.
• The Food and Drug Administration (FDA) has ______ yet approved any human gene therapy product for ________.

**APPLICATIONS**

**One type of gene therapy procedure**

- **Risk Factors of Gene Therapy**
  - **System reaction.** Your body’s immune system may see the newly introduced viruses as intruders and attack them (inflammation & organ failure).
  - **Targeting the ____________.** Viruses could infect healthy cells and cause other illnesses, including cancer.
  - **____________ caused by the virus.** Viruses may recover their original ability to cause disease.
  - **Possibility of causing a ___________.** If the new genes get inserted in the wrong spot in your DNA, there is a chance that the insertion might lead to tumor formation.
3) __________________________: Creating genetically IDENTICAL copies
   • Ex: _____________________ (1996-2003) - it took 276 attempts before successful

![Diagram of cloning process]

4) ___________________________ can be used to generate virtually any type of specialized cell in the human body.
   • The goal of this process is to harvest stem cells that can be used to study human development and to treat disease.
   • Stem cells are extracted from the egg after it has divided for 5 days.
   • The extraction process destroys the embryo, which raises a variety of __________________________.
   • Researchers hope that stem cells can be a treatment for heart disease, Alzheimer's, cancer, and other diseases.

5) __________________________________________ (GMO) = are organisms with artificially altered DNA. They can be created by:
   • __________________________ a foreign gene: Organisms that are altered in this way are known as transgenic organisms.
   • __________________________ the base sequence of an existing gene: (Gene therapy)
   • __________________________ or "Turning off" an existing gene: (so they don't produce their protein).
     o Ex: deactivating the gene responsible for the ripening of tomatoes. This new gene can then be inserted into tomato DNA to give them a longer shelf life.
   • GMO are also called, __________________________: organisms that contain functional recombinant DNA
A. Transgenic PLANTS

- disease-resistant and insect-resistant crops
- Hardier fruit
- 70-75% of food in supermarket is genetically modified.

**Examples of Transgenic Plants:**

- Incorporating bacterial genes for resistance to herbicides, so a crop plant is not killed by weed killer (herbicide).
  - Round-up (an herbicide) kills weeds
  - Farmers can spray crops with Round-up and it will kill the weeds and not the corn/soybeans.
- Incorporating bacterial genes, which produce their own _______________ into corn plants.
  - _______________ contains a gene from the bacterium *Bacillus thuringiensis*.
  - The "Bt" gene expresses a protein that is toxic to corn-boring insects but is harmless to birds, fish, and mammals (including humans).
  - Herbivorous insects are thus prevented from eating such plants.
  - _______________ – *Bacillus thuringiensis* bacteria make a toxin against insects – natural insecticide

- The Arctic Flounder Fish produces an anti-freeze that allows it to protect himself in freezing waters.
  - Anti-freeze gene was spliced into a strawberry’s genome.
  - Strawberry is blue, doesn’t turn to mush or degrade after being placed in the freezer.
- _______________ - two daffodil genes and a bacterial gene spliced into the rice genome to produce more b-carotene, precursor to _______________.
  - Still not available due to regulations

- _______________ : bananas that contain a vaccine for hepatitis B and cholera.
  - When an altered form of a virus is injected into a banana sapling, the virus’ genetic material quickly becomes a permanent part of the plant’s cells.
  - Bananas provide an easy means for delivering a vaccine (especially to children) without the need for needles.
- _______________ - These genetically modified cabbages would produce scorpion poison that kills caterpillars when they bite leaves — but the toxin is modified so it isn’t harmful to humans.

**How to Create a Genetically Modified Plant:**

a) Create recombinant bacteria with desired gene.
b) Allow the bacteria to "infect" the plant cells.
c) Desired gene is inserted into plant chromosomes.
B. Transgenic ANIMALS

- Mice – used to study human immune system
- Chickens – more resistant to infections
- Cows – increase milk supply and leaner meat
- Goats, sheep and pigs – produce human proteins in their milk

**Examples of Transgenic Animals:**

- .......................... – increases milk production in cow by 10%
- .......................... – Methane is a major contributor to the greenhouse effect, so scientists have been working to genetically engineer a cow that produces 25% less methane.
- Goats - produce milk containing high levels of a .......................... that dissolves blood clots
- .......................... zebra fish – inserted the protein for glowing from a jelly fish.
- Pigs that can produce .........................., contain Omega-3 fats, and produce more milk
- .......................... - Atlantic salmon that have been given a growth-hormone gene from the Chinook salmon to make lager in ½ the time

**How to Create a Transgenic Animal**

- Desired DNA is added to an egg cell.

**VI. PROS & CONS of Biotechnology**

**PROS**

- Disease resistant crops
- .......................... vaccines & medications (insulin, human growth hormone)
- .......................... livestock- more meat, milk, wool etc.
- Possible .......................... for diseases
- Environmentally friendly organisms (envio-pig, less methane producing cows, etc)

**CONS:**

- Unpredictable – technology is new & no guarantee that products free of ..........................
- .......................... - companies patent genes & demand high prices
- Unexpected impacts of genetically modified organisms and biotechnology processes on the environment
- .......................... could be created using biotechnology
- Concerns over the safety and ethics of incorporating GMO’s into food for human consumption
  - ..........................
VII. Genetically Modified Foods (GM Foods)

- **What is a Genetically Modified (GM) Food?**
  - Foods that contain an ________________ gene sequence
  - Foods that have a ________________ gene sequence
  - Animal products from animals fed GM feed
  - Products produced by GM organisms

- **What Foods Contain GMOs?**
  - As of 2012, the USDA reports the following percent of all crops grown in the U.S. are genetically modified:
    - Cotton – 94%
    - Soybeans – 93%
    - Sugar Beets – 90%
    - Canola – 88%
    - Corn – 88%
    - Hawaiian papaya – more than 50%
    - Zucchini and Yellow Squash – small %
    - Quest brand tobacco – 100%
    - Alfalfa (recently approved by the FDA; widely fed to animals to produce meat and milk)

- **Labeling GM Foods:**
  - Food manufacturers may indicate through ____________________________ labeling whether foods have or have not been developed through genetic engineering.
  - GM foods in the U.S. are required to be labeled only if the nutritional value is changed or a new _____________________ is introduced.

- **Benefits of GE Crops Used for Foods:**
  - ________________ use of chemical pesticides
  - Less runoff of chemicals into waterways
  - Greater use of farming practices that prevent soil erosion
  - ________________profits for farmers
  - Less fungal contamination
  - More nutritious foods
  - Easing of world __________________________
    - Crops that can be grown in poor soil
    - Drought resistant crops
    - Salt-tolerant crops
• Improved __________ quality
  ▪ Frost resistant crops
  ▪ Disease resistant crops
  ▪ Flood resistant crops
• Improved nutritional quality

**Concerns of GE Crops Used for Foods:**
• GMOs are now present in the __________________________ of processed foods consumed in the U.S. (unless they're organic).
• US cancer rates are the ______ highest in the world, having skyrocketed during the *same* timeframe GMOs were introduced into our food.
• Insects might develop __________________ to pesticide-producing GM crops
• Herbicide-tolerant crops may cross-pollinate weeds, resulting in “super weeds”
• Soil is being saturated with toxins, due to the ever-increasing use of herbicides and pesticides to counteract resistant weeds and insects.
• Certain gene products may be ________________, thus causing harm to human health
• There may be unintended harm to wildlife and beneficial insects
  ▪ ___________, which we rely upon to pollinate all of our crops, are dying at cedented rates as a direct result of GMO crops.
Genetic Engineering Review Worksheet

Vocabulary Matching: Choose the best work to match the definition. Place the letter on the line provided.

1. Organisms that contain functional DNA  A. Restrictive enzymes
2. Mapping of all the human genes  B. Gene therapy
3. Enzyme that chemically links (bonds) DNA fragments together  C. Gene splicing
4. Carries a gene of interest from one organism to another  D. Recombinant DNA
5. Unpaired bases at the end of the cut DNA  E. DNA Ligase
6. Genetically identical copies  F. plasmid
7. Replacing a defective gene with a normal gene  G. Gene cloning
8. Ring of bacterial DNA  H. Human Genome Project
9. Able to cut DNA at specific bases  I. Sticky ends
10. DNA from two different organisms  J. Transgenic organism
11. Process of rejoining cut fragments of DNA  K. Vector
12. The process by which desired traits of certain plants and animals are selected and passed on to their future generations.  L. GM Foods
13. Foods that contain an added or deleted gene sequence  M. Selective Breeding

Completion: Please answer the following questions with detailed responses!

1. Place the following steps for creating recombinant DNA in bacteria in order (#1-7).

   ______ Cut the Bacterial DNA with “restriction enzymes (RE)”.
   ______ Remove bacterial DNA (plasmid).
   ______ The foreign genes will be expressed in the bacteria.
   ______ Combine the “sticky ends” of the two DNA pieces together with DNA ligase (enzyme)
   ______ Insert vector into bacteria.
   ______ The bacteria can now reproduce the recombinant DNA.
   ______ Cut the gene of interest from the organism’s DNA with same “restriction enzyme” (RE).
2. Provide an example of how humans have used selective breeding.

3. What is the purpose of a vector?
   
   a. What are the 2 most commonly used vector? ____________________ & ______________

4. What was the name of the first cloned organism? ______________________________

5. TRUE or FALSE: Two different RE are needed to create recombinant DNA.


7. GMO’s are also called __________________________

8. List 2 examples of transgenic plants.
   a. ____________________________
   b. ____________________________

9. List 2 examples of transgenic animals.
   a. ____________________________
   b. ____________________________

10. What are stem cells?

11. What are 2 pros about biotechnology?

12. What are 2 cons about biotechnology?
Class: Biology B−  Pa standard: 3.3.10C: Describe how genetic information is inherited and expressed.

Unit Essential Question(s):

How can manipulating DNA impact our world?

Optional Instructional Tools:
- Human Genome Project online ws
- Recombinant DNA Activity
- Biotechnology Project
- Enzyme/detergent lab

Concept
- Human Genome Project
- Recombinant DNA
- Biotechnology

Lesson Essential
- How has the Human Genome Project impacted our ability to make genetic changes?
- How is DNA manipulated?
- Describe several applications of genetic engineering.

Vocabulary:
- Selective Breeding
- Human genome project
- Genome
- Genetic engineering
- Recombinant DNA
- Transgenic organism
- Restriction enzyme (RE)
- Sticky ends
- DNA Ligase
- Vector
- Plasmid
- Gene therapy
- Gene splicing
- Gene Cloning
- Stem cells
- Genetically modified organism
- Genetically modified food
Biotechnology Vocabulary:

1) **Selective breeding** = The process by which desired traits of certain plants and animals are selected and passed on to their future generations.

2) **Human Genome Project** = (1988-2003) the mapping and sequencing of all the genes in the human genome

3) **Genome** is the total DNA in the nucleus of each cell

4) **Genetic engineering** = (biotechnology) manipulating DNA

5) **Recombinant DNA** = refers to the DNA from the two different organisms

6) **Restriction enzyme** = enzymes that cut specific sequences of DNA

7) **Sticky ends** = Fragments of DNA that has been cut with restriction enzymes have unpaired nucleotides at the ends

8) **DNA ligase** = enzyme that chemically links (bonds) DNA fragments together

9) **Vector** = a DNA molecule used to carry a gene of interest from one organism to another. Ex: plasmid, virus

10) **Plasmid** = small ring of DNA in a bacterium

11) **Gene therapy** = A "normal" gene is inserted into the genome to replace an "abnormal," disease-causing gene

12) **Gene splicing** = Rejoining cut fragments of DNA

13) **Gene cloning** = Creating genetically IDENTICAL copies

14) **Stem cells** = cells used to generate virtually any type of specialized cell in the human body.

15) **Genetically modified organisms (GMO)** = organisms with artificially altered DNA; also called transgenic organisms

16) **Transgenic organisms** = organisms that contain functional recombinant DNA

17) **Genetically Modified Food** = Foods that contain an added gene sequence; Foods that have a deleted gene sequence; Animal products from animals fed GM feed; Products produced by GM organisms