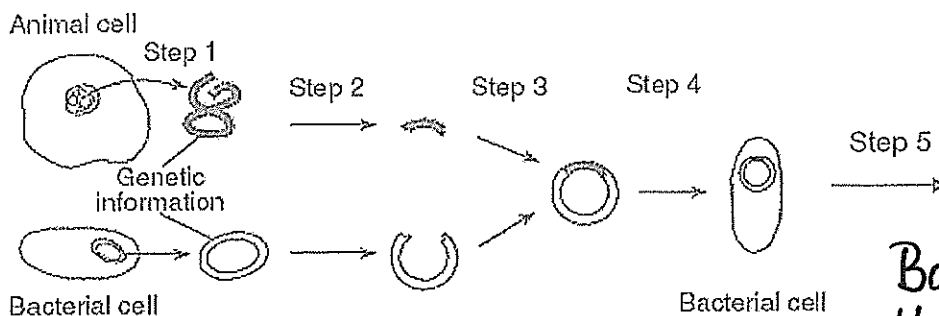


Topic 7: Biotechnology

1. genetic engineering	Transfer of genetic material from one organism to another resulting in recombinant DNA
2. <u>Selective breeding</u>	The process of choosing a few organisms with desirable traits to serve as the parents of the next generation
3. <u>Recombinant DNA</u>	Combining two pieces of DNA to create one molecule

Genetic engineering using bacteria:



Bacteria will produce the desired protein

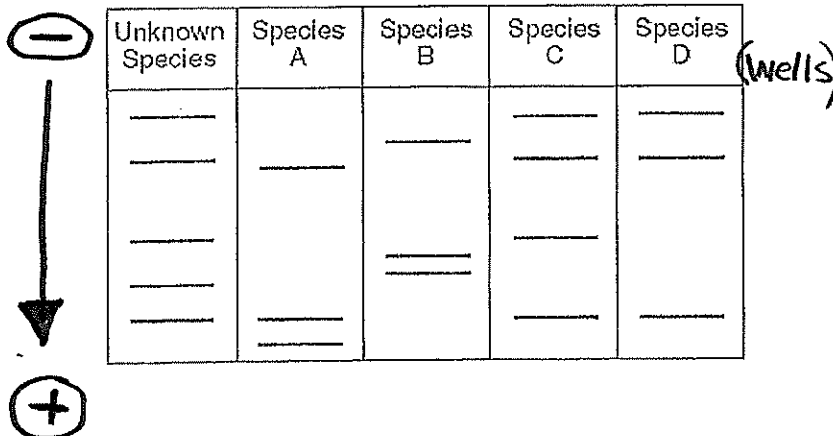
What is used to cut the DNA? Restriction Enzyme

What process does step 5 represent? Gene Cloning

What will this produce? Many bacteria with the recombinant plasmid.

Gel Electrophoresis: used to separate pieces of DNA according to size.

- Draw an arrow showing the direction of movement on the gel below.
- Also show where the largest and smallest pieces of DNA will be located.
- DNA is negative and will move to the positive side of the gel.



What are some uses for this process?

- Identification
- establishing relationships
- comparing evolutionary relationships

What species is most closely related to the unknown species?
 How did you know this?
C has the most fragments in common with the unknown species.

Three Types of Cloning:

Recombinant DNA:

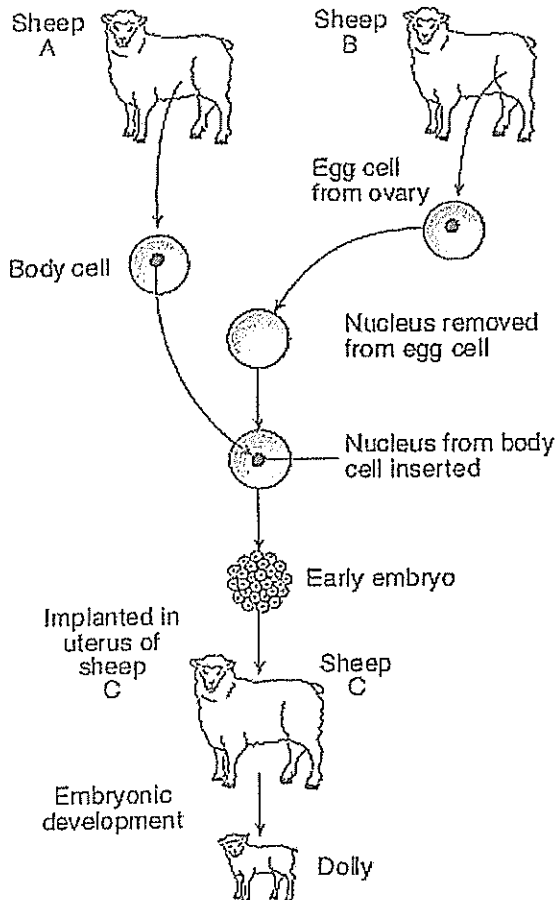
- Cloning a gene
- Use Vectors like plasmids and viruses
- Uses: Bacteria to clone the desired gene (recombinant plasmid)
Bacteria mass produce the desired protein (ex: human insulin)

Therapeutic Cloning

- Stem Cells: undifferentiated (have the potential to become any type of cell)
- Sources of stem cells: embryos, amniotic fluid, some found in adults
- Uses: Produce organs, tissues, body parts that are identical to the individual's cells. They will not be rejected.

Cloning an organism

- SCNT (Somatic Cell Nuclear Transfer)
- Remove egg nucleus
- Replace with body cell nucleus
- Stimulate egg to divide
- Implant into surrogate mother
- Genetically identical to the body cell source
- Uses: Produce genetically identical offspring in sexually reproducing species.



What sheep is Dolly a genetic clone of? Sheep A

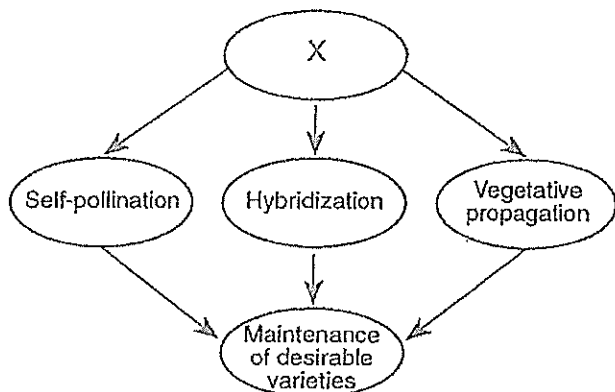
How did you know this?
Sheep A donated the body cells with all the necessary DNA

Why did we need to use a body cell nucleus and not the egg cell nucleus?
Body cells are diploid (2n)
They contain all the necessary DNA to reproduce the entire organism

Artificial Selection and Biotechnology

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- Santa Gertrudis cattle were developed from crosses of American cattle with cattle from India. Which method did the breeder most likely use to develop the Santa Gertrudis cattle?
 - exposure to mutagenic agents
 - animal hybridization
 - genetic engineering
 - vegetative propagation
- The diagram below represents some methods used by plant growers to produce and maintain desirable varieties of plants.



Which term belongs in area X?

- use end disuse
 - artificial selection
 - synapsis
 - gradualism
- A cattle breeder wished to develop a strain of cattle that would produce large quantities of meat per animal. He chose a bull and a cow that most nearly met his goals for breed size. From their calves, he again chose the male and female offspring that most nearly met his goals. After several generations of this style of breeding, the breeder developed a herd of high-yield cattle. In order to maintain this herd of high-yield cattle, which technique should the cattle breeder use?
 - vegetative propagation
 - hybridization
 - genetic recombination
 - inbreeding
 - One variety of strawberry is resistant to a damaging fungus, but produces small fruit. Another strawberry variety produces large fruit, but is not resistant to the same fungus. The two desirable qualities may be combined in a new variety of strawberry plant by
 - cloning
 - asexual reproduction
 - direct harvesting
 - selective breeding
 - Which laboratory procedure has made possible the development of bacteria that can synthesize human insulin?
 - karyotyping
 - genetic engineering
 - amniocentesis
 - screening of body fluids

- Some farmers currently grow genetically engineered crops. An argument *against* the use of this technology is that
 - it increases crop production
 - it produces insect-resistant plants
 - its long-term effects on humans are still being investigated
 - it always results in crops that do not taste good
- Bacteria in culture A produce slime capsules around their cell walls. A biologist removed the DNA from some of the bacteria in culture A and injected it into bacteria in culture B, which normally do not produce slime capsules. After the injection, bacteria with slime capsules began to appear in culture B. What conclusion can best be drawn from this investigation?
 - The bacteria in culture A are mutations.
 - Bacteria reproduce faster when they have slime capsules.
 - The slime capsules of bacteria in culture B contain DNA.
 - DNA is most likely involved in the production of slime capsules.
- Genetic engineering has been utilized for the production of
 - salivary amylase
 - human growth hormone
 - hydrochloric acid
 - uric acid crystals

Base your answers to questions 9 and 10 on the information below and on your knowledge of biology.

In 1973, Stanley Cohen and Herbert Boyer inserted a gene from an African clawed frog into a bacterium. The bacterium then began producing a protein directed by the code found on the inserted frog gene.

- The newly synthesized genetic material in the bacterium is known as
 - recombinant DNA
 - messenger RNA
 - a gene mutation
 - a multiple allele
- Additional copies of the bacterium containing the frog gene could be produced by
 - asexual reproduction
 - cross-pollination
 - inbreeding
 - grafting
- In genetic engineering, the transfer of hereditary information from one species to another results in the formation of
 - motile gametes
 - recombinant DNA
 - dihybrids
 - zygotes
- Scientists have genetically altered a common virus so that it can destroy the most lethal type of brain tumor without harming the healthy tissue nearby. This technology is used for all of the following *except*
 - treating the disease
 - curing the disease
 - controlling the disease
 - diagnosing the disease

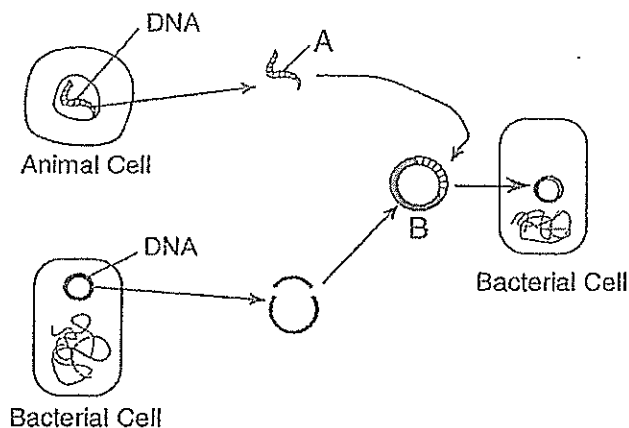
Weird ?

13. Recombinant DNA is presently used in the biotechnology industry to

- 1) eliminate all infectious disease in livestock
- 2) synthesize insulin, interferon, and human growth hormone.
- 3) increase the frequency of fertilization
- 4) create populations that exhibit incomplete dominance

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Base your answers to questions 14 and 15 on the diagram below and on your knowledge of biology.



14. Structure *B* represents

- 1) a ribosome
- 3) recombinant DNA
- 2) transfer RNA
- 4) a male gamete

15. The technique illustrated in the diagram is known as

- 1) cloning
- 2) genetic engineering
- 3) protein synthesis
- 4) in vitro fertilization

16. A great deal of information can now be obtained about the future health of people by examining the genetic makeup of their cells. There are concerns that this information could be used to deny an individual health insurance or employment. These concerns best illustrate that

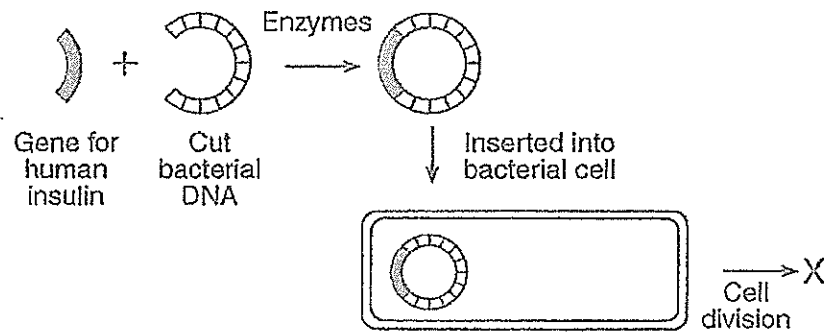
- 1) scientific explanations depend upon evidence collected from a single source
- 2) scientific inquiry involves the collection of information from a large number of sources
- 3) acquiring too much knowledge in human genetics will discourage future research in that area
- 4) while science provides knowledge, values are essential to making ethical decisions using this knowledge

17. A gene that codes for resistance to glyphosate, a biodegradable weedkiller, has been inserted into certain plants. As a result, these plants will be more likely to

- 1) produce chemicals that kill weeds growing near them
- 2) die when exposed to glyphosate
- 3) convert glyphosate into fertilizer
- 4) survive when glyphosate is applied to them

18. The diagram below illustrates some key steps of a procedure in one area of biotechnology.

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The letter X most likely represents

- 1) bacterial cells that are unable to synthesize insulin
- 2) human cells that are able to synthesize antibodies
- 3) bacterial cells that are able to synthesize insulin
- 4) human cells that are unable to resist antibiotics

19. Which statement best describes human insulin that is produced by genetically engineered bacteria?

- 1) This insulin will not function normally in humans because it is produced by bacteria.
- 2) This insulin is produced as a result of human insulin being inserted into bacteria cells.
- 3) This insulin is produced as a result of exposing bacteria cells to radiation, which produces a mutation.
- 4) This insulin may have fewer side effects than the insulin previously extracted from the pancreas of other animals.

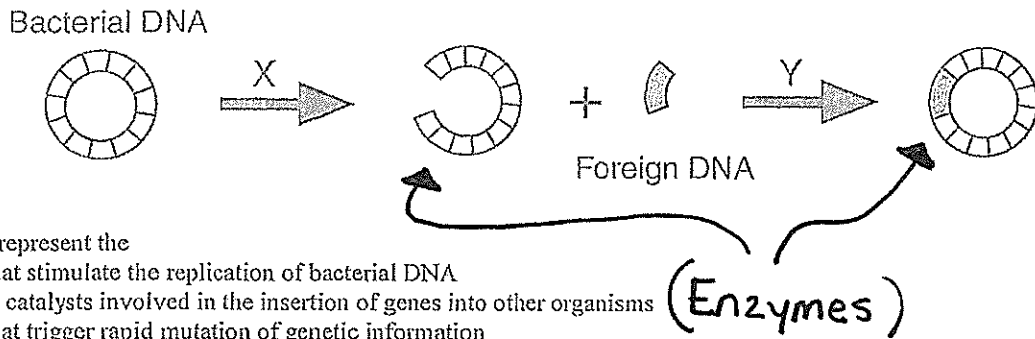
20. People with cystic fibrosis inherit defective genetic information and cannot produce normal CFTR proteins. Scientists have used gene therapy to insert normal DNA segments that code for the missing CFTR protein into the lung cells of people with cystic fibrosis. Which statement does not describe a result of this therapy?

- 1) Altered lung cells can produce the normal CFTR protein.
- 2) Altered lung cells can divide to produce other lung cells with the normal CFTR gene.
- 3) The normal CFTR gene may be expressed in altered lung cells.
- 4) Offspring of someone with altered lung cells will inherit the normal CFTR gene.

21. The cloning of cells involves the process of

- 1) meiotic cell division
- 2) fusion of gametes
- 3) mitotic cell division
- 4) formation of spores

22. The diagrams below represent some steps in a procedure used in biotechnology.



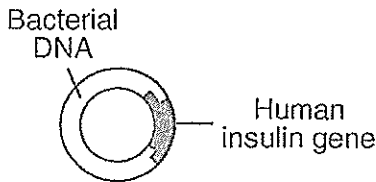
Letters X and Y represent the

- 1) hormones that stimulate the replication of bacterial DNA
- 2) biochemical catalysts involved in the insertion of genes into other organisms
- 3) hormones that trigger rapid mutation of genetic information
- 4) gases needed to produce the energy required for gene manipulation

23. A biotechnology firm has produced tobacco plants that synthesize human antibodies that prevent bacterial diseases. One of the first steps in the production of these plants required

- 1) using natural selection to increase the survival of antibody-producing tobacco plants
- 2) inserting human DNA segments into the cells of tobacco plants
- 3) using selective breeding to increase the number of antibody genes in tobacco plants
- 4) growing tobacco plants in soil containing a specific fertilizer

24. A product of genetic engineering technology is represented below.



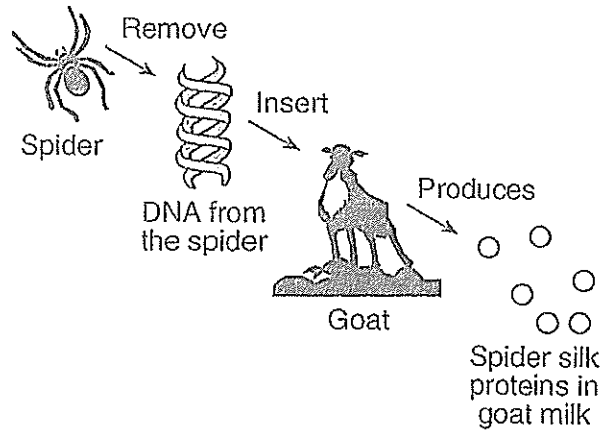
Which substance was needed to join the insulin gene to the bacterial DNA as shown?

- 1) a specific carbohydrate
- 2) a specific enzyme
- 3) hormones
- 4) antibodies

25. In the United States, there has been relatively little experimentation involving the insertion of genes from other species into human DNA. One reason for the lack of these experiments is that

- 1) the subunits of human DNA are different from the DNA subunits of other species
- 2) there are many ethical questions to be answered before inserting foreign genes into human DNA
- 3) inserting foreign DNA into human DNA would require using techniques completely different from those used to insert foreign DNA into the DNA of other mammals
- 4) human DNA always promotes human survival, so there is no need to alter it

26. Which process is illustrated in the diagram below?



- 1) chromatography
- 2) direct harvesting
- 3) meiosis
- 4) genetic engineering

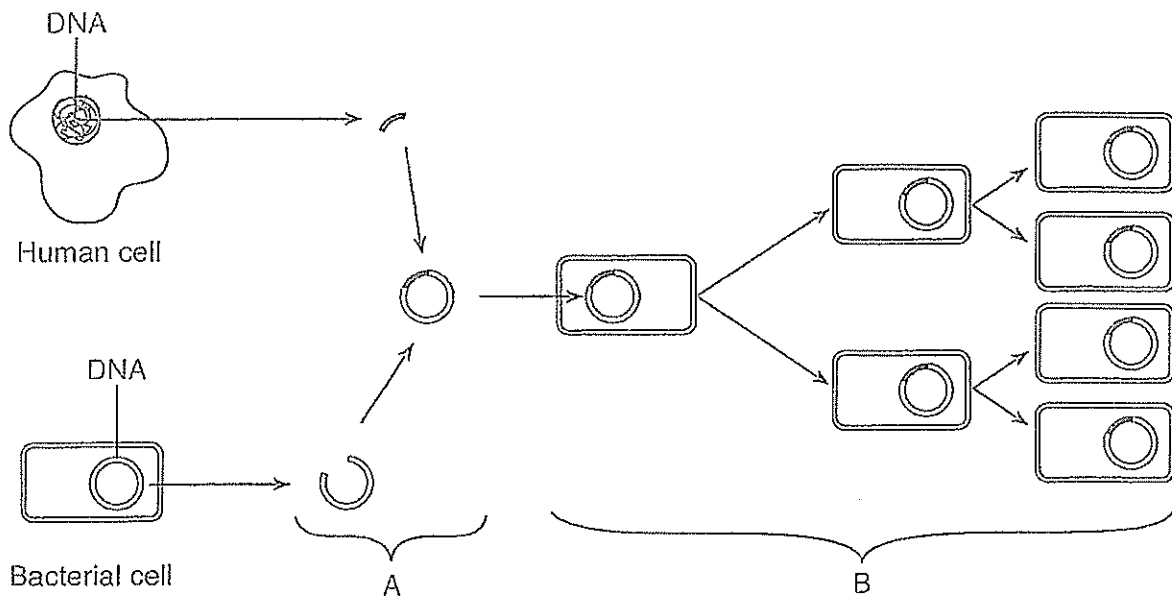
27. Base your answer to the following question on the information below.

Some geneticists are suggesting the possibility of transferring some of the genes that influence photosynthesis from an efficient variety of crop plant to a less efficient crop plant to produce a new variety with improved productivity.

Which technique would most likely be used to produce large numbers of genetically identical offspring from this new variety of plant?

- 1) cloning
- 2) karyotyping
- 3) cross-pollination
- 4) chromatography

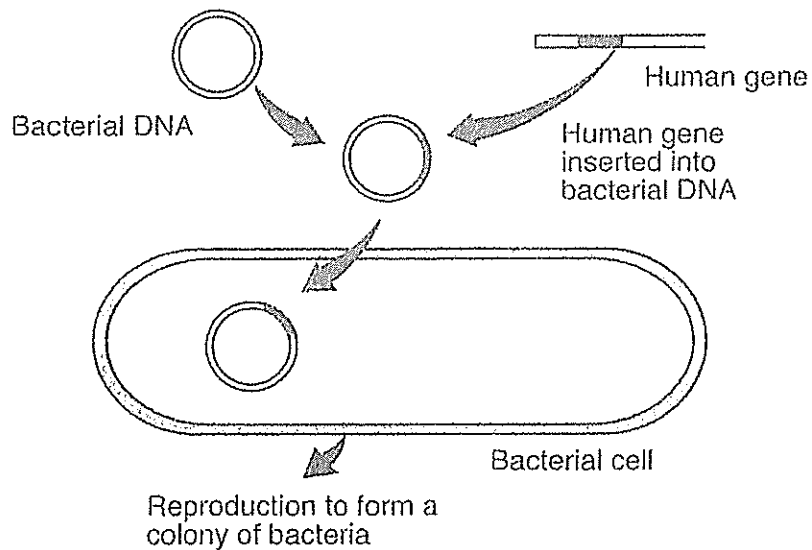
28. Base your answer to the following question on the diagram below and on your knowledge of biology.



Which process is indicated by letter B?

- 1) natural selection 2) asexual reproduction 3) sexual reproduction 4) gene deletion

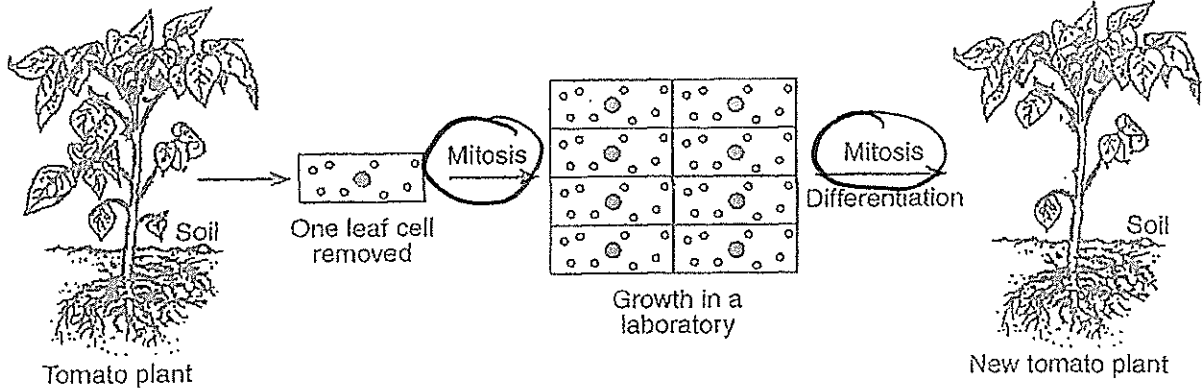
29. The diagram below represents a genetic procedure.



Which statement best describes the outcome of this procedure?

- 1) Bacterial cells will destroy defective human genetic material.
 2) Bacterial cells may form a multicellular embryo.
 3) The inserted human DNA will change harmful bacteria to harmless ones.
 4) The inserted human DNA may direct the synthesis of human proteins.

30. A process used in agriculture is represented in the diagram below.



The diagram illustrates a process known as

- 1) amniocentesis 2) translocation 3) cloning 4) nondisjunction

31. A small amount of DNA was taken from a fossil of a mammoth found frozen in glacial ice. Genetic technology can be used to produce a large quantity of identical DNA from this mammoth's DNA. In this technology, the original DNA sample is used to

- 1) stimulate differentiation in other mammoth cells
- 2) provide fragments to replace certain human body chemicals
- 3) act as a template for repeated replication
- 4) trigger mitosis to obtain new base sequences

32. Scientists have cloned sheep but have not yet cloned a human. The best explanation for this situation is that

- 1) the technology to clone humans has not been explored
- 2) human reproduction is very different from that of other mammals
- 3) there are many ethical problems involved in cloning humans
- 4) cloning humans would take too long

33. "Dolly" was a sheep developed from an egg cell of her mother that had its nucleus replaced by a nucleus from a body cell of her mother. As a result of this technique, Dolly was

- 1) no longer able to reproduce
- 2) genetically identical to her mother
- 3) able to have a longer lifespan
- 4) unable to mate

34. Steps in a reproductive process used to produce a sheep with certain traits are listed below.

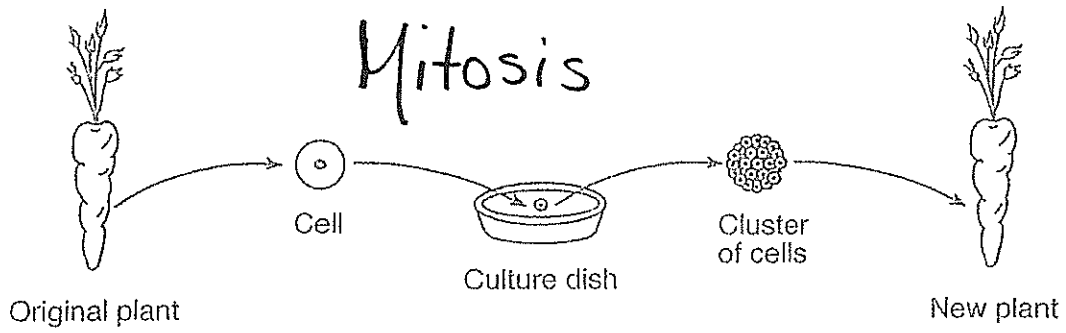
- Step 1 — The nucleus was removed from an unfertilized egg taken from sheep *A*.
- Step 2 — The nucleus of a body cell taken from sheep *B* was then inserted into this unfertilized egg from sheep *A*.
- Step 3 — The resulting cell was then implanted into the uterus of sheep *C*.
- Step 4 — Sheep *C* gave birth to sheep *D*.

Which sheep would be most genetically similar to sheep *D*?

- 1) sheep *A*, only
- 2) sheep *B*, only
- 3) both sheep *A* and *B*
- 4) both sheep *A* and *C*

35. The diagram below represents the cloning of a carrot plant.

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Compared to each cell of the original carrot plant, each cell of the new plant will have

- 1) the same number of chromosomes and the same types of genes
- 2) the same number of chromosomes, but different types of genes
- 3) half the number of chromosomes and the same types of genes
- 4) half the number of chromosomes, but different types of genes

Ibuprofen Helps Patients with Cystic Fibrosis

A faulty version of the CFTR gene causes the disease cystic fibrosis (CF). This gene is found in 1 in 25 Caucasians in the United States. A person who inherits a copy of this gene from each parent develops CF. Thick mucus builds up in the lungs of CF patients, leaving them vulnerable to infections. Over time, this repeated cycle of illness and inflammation causes structural damage to the lungs of the patient.

In a recent study, the common pain reliever ibuprofen significantly reduced lung damage caused by cystic fibrosis. This study included 85 CF patients between the ages of 5 and 39. Half of those participating in the study were given a tablet containing ibuprofen, and the other half were given a placebo (a tablet containing no ibuprofen). Ibuprofen, taken along with other treatments, most benefited CF patients between the ages of 5 and 13. Patients taking ibuprofen suffered less inflammation of the bronchial tubes. Lung deterioration in the children taking ibuprofen was nearly 90% slower than expected. Among those patients taking ibuprofen, lung capacity declined by only 2%, while those taking the placebo experienced a decline of 16%.

Researchers recommend that doctors begin the new therapy with their cystic fibrosis patients. However, the treatment involves taking large doses of ibuprofen, which can cause serious side effects, including stomach and kidney damage. The researchers warn people with cystic fibrosis not to take ibuprofen without talking with their doctors first.

Thirty years ago, most CF patients died before the age of 5. Today, many CF patients live into their 30's. A new drug for CF, DNase, was approved in 1994. Trials are also being done using gene therapy to correct the faulty gene found in cystic fibrosis patients. Since ibuprofen therapy delays the progression of the disease, it is hoped that more patients will be able to benefit from gene therapy when it becomes available for general use.

36. Which statement regarding the use of ibuprofen in the treatment of cystic fibrosis is correct?
- 1) Lung deterioration in individuals taking ibuprofen was about 16% slower than in those taking the placebo.
 - 2) Although initially promising, problems with stomach and kidney damage have made most doctors unwilling to prescribe ibuprofen for the treatment of cystic fibrosis.
 - 3) Large doses of ibuprofen can be dangerous, but under the care of a doctor the benefits of ibuprofen for individuals with cystic fibrosis can be significant.
 - 4) The most significant reduction in the swelling of the bronchi due to ibuprofen therapy occurred in individuals 15 to 35 years of age.
37. A valid conclusion that can be drawn from this information is that
- 1) ibuprofen is now considered the drug of choice, replacing DNase in treating cystic fibrosis
 - 2) because of ibuprofen, gene therapy and the use of DNase are no longer considered effective ways to treat cystic fibrosis
 - 3) ibuprofen, with its serious side effects, is too dangerous to use in the treatment of cystic fibrosis
 - 4) in combination with other drugs, ibuprofen reduces lung damage and slows the progress of cystic fibrosis
38. Cystic fibrosis results when an individual is
- | | |
|---|--|
| <input checked="" type="radio"/> 1) homozygous for the faulty CFTR gene | 3) given an overdose of ibuprofen |
| 2) heterozygous for the faulty CFTR gene | 4) exposed to a person with this disease |
39. Using one or more complete sentences, state one possible result of the buildup of mucus in the lungs of individuals with cystic fibrosis.

Build up mucus in the lungs of individuals with cystic fibrosis makes them vulnerable to infections.

Base your answers to questions 40 and 41 on the passage below and on your knowledge of biology.

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Plastics Produced by Plants

Plastics are generally thought of as materials made exclusively by human technology. However, some plants and bacteria naturally make small amounts of plastics. Furthermore, unlike synthetic plastics, plastics produced by plants and bacteria break down easily in the environment. Synthetic plastics, which are produced from petroleum, are the fastest growing type of waste in the United States. Researchers are learning how to greatly increase the amount of plastic made by plants. One day farmers may grow crops of plastic-producing plants in addition to wheat and corn crops.

A researcher at the Carnegie Institution of Washington was one of the first to attempt to use plants to make plastics. He knew that a common bacterium, known as *Alcaligenes eutrophus*, naturally produced a plastic called polyhydroxybutyrate (PHB), which resembles the type of plastic used to make garbage bags. However, growing bacteria to produce plastic can be expensive. In order to determine if genetically engineered plants could make plastic, genes were isolated from *A. eutrophus* and inserted into plants. After a few tries, the researchers were able to produce healthy plastic-producing plants.

40. By what process were the plastic-producing plants developed?

Bacterial genes were inserted into the plants (Genetically Engineered Plants)

41. Explain why the use of the plastic produced by these plants is better for the environment than plastic produced by human technology, and explain why this plastic would be a benefit to future generations.

Plant plastics are biodegradable.

Base your answers to questions 42 and 43 on the passage below.

The Human Genome Project

For a number of years, scientists at Cold Spring Harbor Laboratory have been attempting to map every known human gene. By mapping, scientists mean that they are trying to find out on which of the 46 chromosomes each gene is located and exactly where on the chromosome the gene is located. By locating the exact positions of defective genes, scientists hope to cure diseases by replacing defective genes with normal ones, a technique known as gene therapy. Scientists can use specific enzymes to cut out the defective genes and insert the normal genes. They must be careful to use the enzyme that will splice out only the target gene, since different enzymes will cut DNA at different locations.

While the human genome project should eventually improve the health of humans, many people are skeptical and apprehensive, believing that gene therapy would be working against nature and would have religious, moral, legal, and ethical implications.

42. Using one specific example, explain why the human genome project is considered important.

Knowing the location of genes will help in finding cures for diseases.

43. Explain why scientists must use only certain enzymes when inserting or removing a defective gene from a cell.

Specific restriction enzymes cut the DNA so that only the target gene is isolated.

44. For many years, humans have used a variety of techniques that have influenced the genetic makeup of organisms. These techniques have led to the production of new varieties of organisms that possess characteristics that are useful to humans. Identify one technique presently being used to alter the genetic makeup of an organism, and explain how humans can benefit from this change. Your answer must include at least:

- the name of the technique used to alter the genetic makeup
- a brief description of what is involved in this technique
- one specific example of how this technique has been used
- a statement of how humans have benefited from the production of this new variety of organism

- Gene cloning
- Foreign DNA is inserted into a plasmid. Plasmid (rplasmid) is inserted into the bacteria.

Human insulin is produced this way. The bacteria clone the gene through binary fission.

45. <1column>

Give three examples of how the technology of genetic engineering allows humans to alter the genetic makeup of organisms.

- Gene cloning to produce human proteins
- Animal cloning to produce desirable meats
- Gene therapy - replacing defective genes with normal genes to cure diseases.