Notes

Biology 102
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Chapter 13, plus pp 202-204, p 843

Topic: Genetic technologies

Main concepts:

- Recombinant gene technology takes advantage of gene transformation as it occurs in nature. Geneticists can take engineer similar processes to isolate genes, analyze them, and even insert genes into organisms.
- Viruses are already natural gene vectors, inserting their genetic material into cells to reproduce themselves. Viruses are often used by researchers as a vector for inserting desired genes into cells in processes such as gene therapy and creating transgenic organisms.
- The Polymerase Chain Reaction (PCR) is a technology for taking a small sample of DNA and turning it into a large one. Using warm-cool cycles, DNA polymerase, and free nucleotides, a researcher can make millions of copies of the DNA from a small sample, so that a larger sample is available for analysis.
- DNA fingerprinting is a technology for analyzing segments of DNA by running DNA fragments through a gel by means of an electric current. It may be used to diagnose genetic disorders by determining if someone has a certain allele, or more often it is used to analyze highly variable "junk" DNA so that two samples of DNA can be compared. In forensics, it can be used to determine if a suspect was at a crime scene. It can also reunite children with parents they were separated from at a young age, or determine paternity of a child. DNA fingerprinting is giving way to microarrays that can test for tens of thousands of genes at once (see Useful Websites below).
- Transgenic crops are made by inserting genes into plants using viral or bacterial vectors, or a device called a "gene gun" (see Useful Websites below). The desired gene may make a crop more nutritious, make it resistant to pests, or make it resistant to pesticides. A gene may be inserted into a virus, or inserted into a bacterial plasmid that a bacteria can insert into a cell. The virus or the bacteria is the **vector** used to insert the gene into a cell. A culture of undifferentiated plant cells is treated with the vector. Hormones are used to make the cells divide so that each grows into a new plant. A small number of them will show expression of the new gene.
- Transgenes can also be used in the pharmaceutical industry. The human insulin gene was successfully inserted into a bacteria in the early 1980's, so that the bacteria produced pure human insulin. This is the source of insulin today. Milk-producing livestock such as goats produce a protein in their milk called casein; if a gene for a medically useful protein is inserted into goat embryo cells, the female goats will produce that protein in their milk, from which the protein can be purified and used as medicine. Some crop plants are being developed to grow useful medicines as well. Some people refer to this as "bio-pharming."
- The technologies used in transgenics are being used to treat people with genetic diseases. A few single-gene diseases can be treated with gene therapy, where a virus is used to insert a good copy of an allele, thus curing the genetic disease. This technology is still very new, and has had limited success, because it's one thing to get a gene into a cell — it's another to get it to function.
- Cloning is a means of producing two genetically identical organisms. Plants to it naturally (a cutting from a houseplant is a clone), as do some simple animals. Your book calls this "asexual reproduction." Identical twins are natural clones produced when a fertilized egg divides completely, and the two resulting cells grow into separate embryos. Frogs can be artificially cloned by teasing apart the cells of an 8-cell embryo. Artificial cloning was more recently accomplished by nuclear transfer: taking the nucleus of an adult's cell and inserting it into an egg cell. This produces the cell doner's twin, delayed in time. The technology is imperfect, and produces an offspring that is already aged, because somehow cells know how old they are.
- Stem cells are those that are undifferentiated. An embryo in its earliest stages is composed entirely of stem cells. Adults have patches of more specialized stem cells, such as those in the bone marrow that produce the blood cells. Stem cells can be used to grow tissues that can replace tissues damaged by disease. Parkinson's disease is one disorder that has been successfully treated with stem cells. Using embryonic stem cells is highly controversial, but some promising advances have been made with adult stem cells.

Common misconceptions:

- The idea of "frankenfoods" raises fears in everyone. Many people believe that changing the genes of any organism renders it poisonous, or that somehow the transgenic organisms will cause mutations in the people who eat them. There is no evidence that bioengineered crops cause these types of problems

humans. Problems of allergic responses to transgenic proteins is a small but potentially important risk. However, there are enormous environmental, social, economic, and political issues that have arisen over the production and cultivation of genetically modified crops.

- Many people have misconceptions about cloning that they get from movies and televison programs. Clones are not instant copies of a person, so you'll never be able to walk into a futuristic Kinkos and walk out with a clone of yourself. Clones are not mindless zombies that can be made and stored for organ harvest later. If you cloned yourself, what you would get is an infant who is your identical twin delayed in time, and that infant would have all the human rights that you have. It's also unlikely that cloning will replace the natural methods of reproduction, since nature's method works very well and costs nothing, while cloning is imperfect, extremely expensive, and no fun at all.

Reading notes:

Chapter 13

- Define: genetic engineering, recombinant DNA, transgenic, transformation, plasmid.
- Describe how viruses naturally insert their genes into cells.
- Define and describe the polymerase chain reaction. Describe how scientists choose which segments of DNA to amplify.
- List the steps of DNA fingerprinting. State the role of the labeled DNA probes that are used.
- Look at figure 13-6. Notice on the fingerprint that some individuals have two bands, while others have one, and the single bands fluoresce twice as bright as the others. Why?
- Describe some of the benefits farmers and scientists seek from biotechnology in agriculture.
- Describe the steps of creating a transgenic crop. (Note that the *Agrobacterium* is only one way to get a gene into a cell). List some of the ways transgenic crops and animals may be useful in medicine ("bio-pharming").
- Describe how DNA technology can diagnose hereditary disorders. Describe the role of RFLPs in this process.
- Describe how DNA technology can be used to treat disease, including gene therapy.
- Describe some of the ethical issues raised by genetic engineering, and possible or perceived risks to the food supply, environment, and human health.

Pages 202-204

- Define "clone." List some ways that nature clones. Why are seedless naval oranges all clones?
- Describe the steps in nuclear transfer cloning (shown in the pictures).
- Explain why cloning is an inefficient and expensive way to produce livestock.
- Thinking question: Why does no one object to cloning naval oranges, but many people do object to cloning sheep? In what ways are these different?

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- Define "embryonic stem cell."
- Describe the steps of producing a cell culture from stem cells.
- Describe the uses of embryonic stem cells in research.
- Are there other places we can get stem cells besides embryos?

Useful websites:

- "Microarray virtual lab" http://learn.genetics.utah.edu/units/biotech/microarray/ is an fun, interactive activity explaining what microarrays are and how they are used.
- "How to make transgenic plants" http://cls.casa.colostate.edu/TransgenicCrops/animation.html is an animation of the process of transferring genes to cloned plant tissue callus.
- "Gene Gun" http://www.hort.purdue.edu/hort/courses/HORT250/animations/Gene%20Gun%20Animation/Genegun1.html is an animation showing one method of gene insertion. Viruses and bacteria are also used as vectors. The choice of vectors depends on which is most effective with the organism that one is working with.
- "Space Doctor" http://learn.genetics.utah.edu/units/genetherapy/spacedoctor/ is a fun yet educational look at gene therapy. Perform gene therapy on three space aliens and see whether you chose the right vectors and methods.
- "Cloning in Focus" http://learn.genetics.utah.edu/units/cloning/index.cfm is a series of articles explaining the science behind cloning, some of the myths, and some of the ethical questions.

- "Stem Cells in the Spotlight: http://learn.genetics.utah.edu/units/stemcells/index.cfm is a series of helpful articles explaining current stem cell technology and why these technologies create ethical dilemmas.