Gene Activity Can Be Turned On or Off

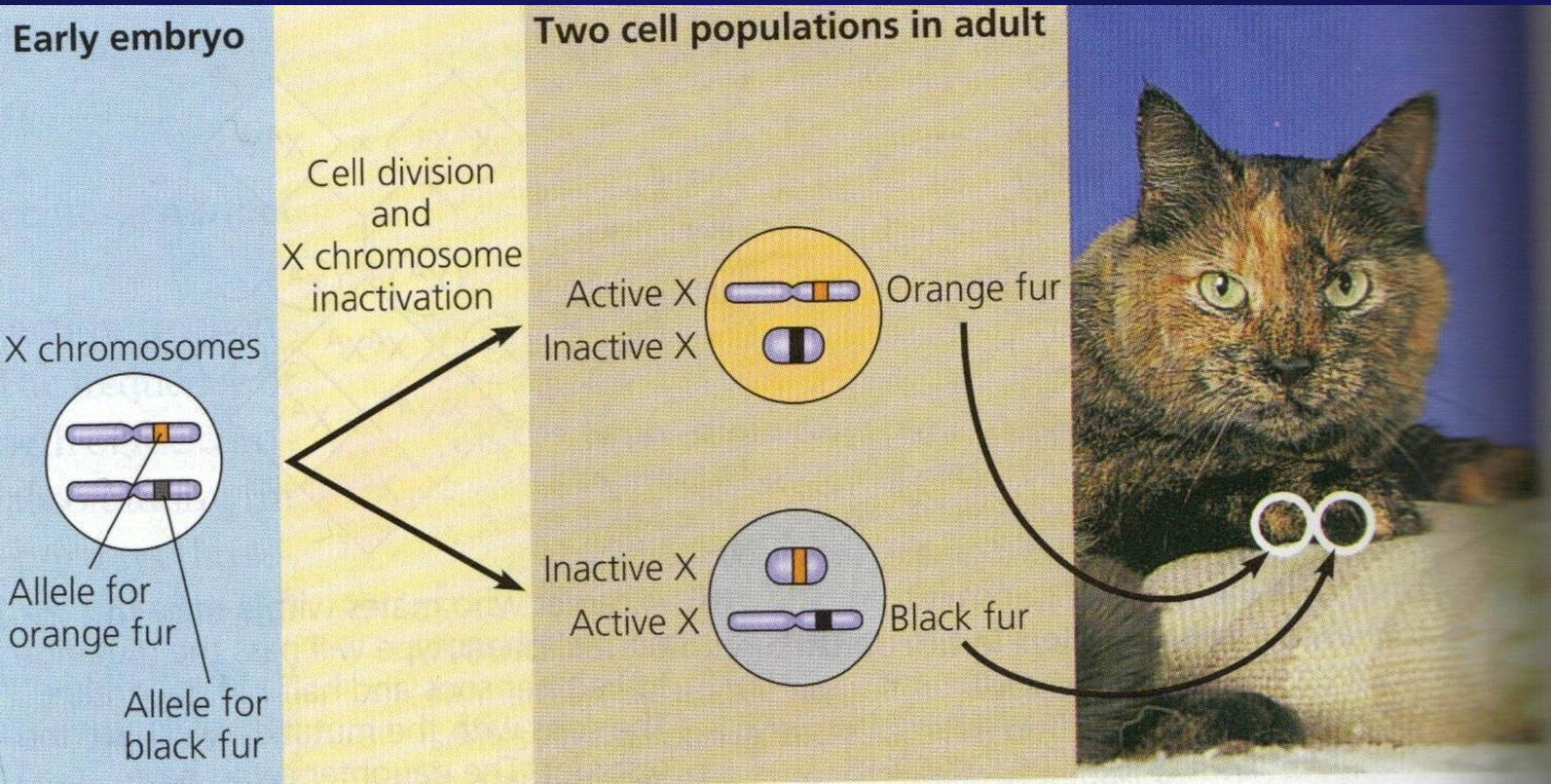
- Coiling and uncoiling of chromosomes regulate gene activity at the chromosome level:
  - Example: X chromosome inactivation in females
  - Only one of (the two) X chromosomes is active in females
  - Because male cells have only one X chromosome, it is always active

X-Chromosome Inactivation

X-Chromosome Inactivation

Random X Chrom. Inactivation

Reason for calico markings in cats



Which is true regarding gene actiivty?

A. All genes are active in all cell at all times
B. Only one of the two X chromosomes is inactive in cells of females
C. One X chromosome is active in some cells but the other X chromosome is active in other cells

Genetic Engineering Is the Manipulation of DNA for Human Purposes

- Recombinant DNA is made of DNA from different sources

Uses of Recombinant DNA Technology

- DNA Fingerprinting (crime scene)
- Clone genes
- Clone Organisms
- Transgenic Plants and Animals
- Gene Therapy
- Medical Research (knockout organisms)

Genetic Engineering: Producing Transgenic Organisms

- Transgenic Bacterial Uses
  - Insulin
  - Human Growth Hormone
  - Erythropoeitin (EPO) for anemia
  - Factor VIII (blood clotting factor) for hemophilia
  - Tissue Plasminogen Activator (tPA) anti-clotting
  - Vaccines

Figure 21-13 Biology of Humans, 2/e

Genetic engineering is used to produce large quantities of a desired protein or to create an organism with a desired trait. This girl has an underactive pituitary gland. Its undersecretion of growth hormone would have caused her to be very short, even as an adult. However, growth hormone from genetically engineered bacteria has helped her grow to almost a normal height.

Genetic Engineering

- In gene ***pharming*** transgenic animals are created that produce a protein with medicinal value in their milk, eggs or blood

Genetic Engineering: Transgenic Organisms

- Transgenic Plants
  - Increased resistance to freezing
  - Longer shelf life
  - Increased Vitamin A
  - Increased Omega 3 fatty acids
  - Human Proteins, e.g., albumin, vaccines, etc.

Producing Transgenic Animals

- Bigger challenges
  - More difficult in animals
    - Microinjection into fertilized eggs
- Successes
  - Bovine growth hormone for faster animal growth
  - Creation of “Alzheimer's Disease” mice
  - Producing pharmaceuticals in milk (a.k.a., gene farming)

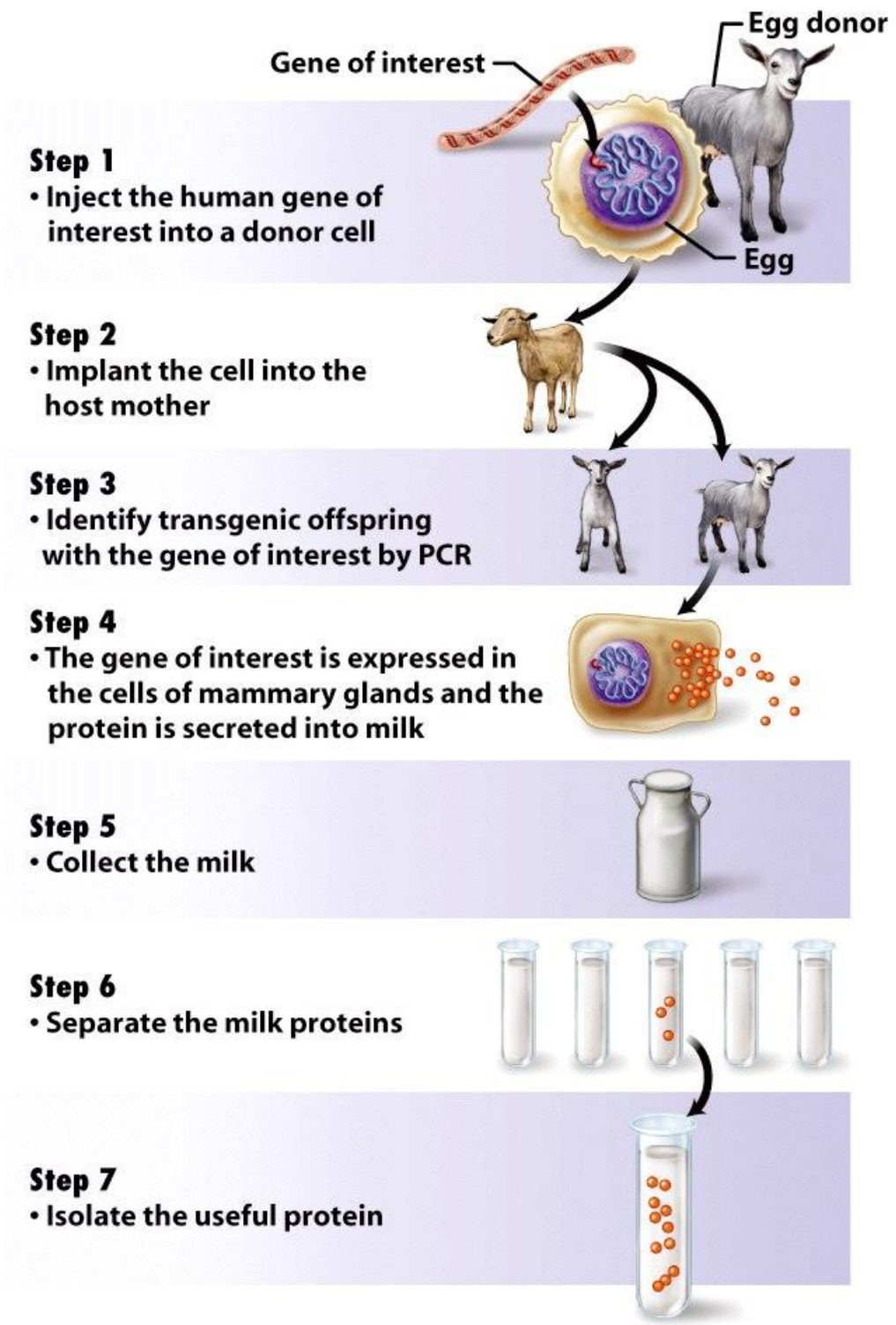


Figure 21-14 Biology of Humans, 2/e

This transgenic goat has the gene for making spider silk, one of the strongest substances known. The spider silk protein can be extracted from the goat's milk and spun into threads that can be used for products in which strength and light weight are important qualities.

Figure 21-15 Biology of Humans, 2/e

Gene Therapy: Hope of the Future

- Gene therapy replaces faulty genes with functional genes
- May be used to cure inherited diseases

Gene Therapy Targets

- Severe Combined Immunodeficiency (SCID)
  - Limited success treating for lack of ADA enzyme
- Cystic Fibrosis (work in progress)
- Hemophilia (work in progress)
- Cancer Research (work in progress)

Rhys Evans is the first person to be cured of X-linked severe combined immunodeficiency disease (X-SCID) by gene therapy.

The immune system of a person with X-SCID is nonfunctional. Rhys Evans' immune system was strengthened, and he can now go to public places without fearing contact with people who might carry germs.

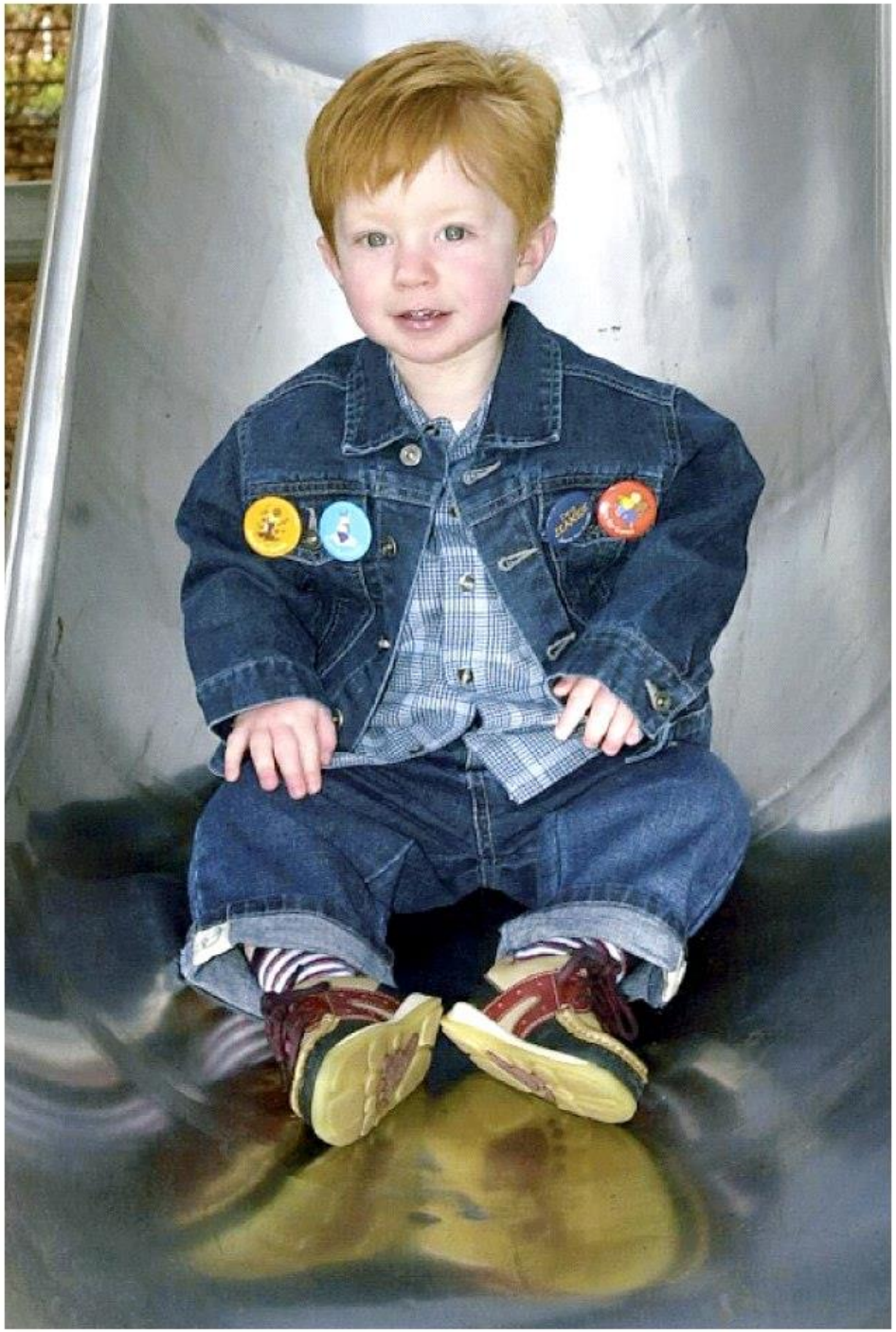


Figure 21-17 Biology of Humans, 2/e

Gene Therapy: Hope of the Future

- Obstacles
  - How to insert the recombinant gene into appropriate cells
  - What is the appropriate “vector”; Virus? Other?
  - Should we insert recombinant genes into reproductive cells? Can we avoid it?