Animal Biotechnology

Introduction to Animal Biotechnology

- Genetically engineered animals can be used to
  - Develop new medical treatments
  - Improve our food supply
  - Enhance our understanding of all animals, including humans
- Presents tough scientific and ethical challenges

Animals in Research

- Animal Models
  - Many genetic and physiological similarities exist between animals and humans
  - Research using animals has been the key to most medical breakthroughs in the past century
    - Polio vaccine was developed using animals as test systems
    - Cataract surgical procedures were developed with animals
    - Dialysis was tested first in animals before being applied to human conditions

Side-effects of new drugs discovered in animal models

- Example
  - Propecia
    - Used to encourage hair growth
    - Animal studies indicated that serious birth defects occurred in male offspring when pregnant animals were given large doses of drug
    - As a result of animal tests, warnings were put on containers of Propecia to avoid birth defects in humans using drug.

Animals in Research

- Animals most often used are
  - Purebred mice and rats
- Other species used include
  - Zebrafish, fruit flies, nematodes
- Dogs, monkeys, chimpanzees, cats make up less than 1% of total number of research animals

How do you select appropriate animal as a model for the human system?

- Look for genetic homology between animal and human systems.
- In addition, identify animal that
  - Has short time between generations
  - Can produce lots of offspring in each generation
  - Can be easily maintained and manipulated in the laboratory

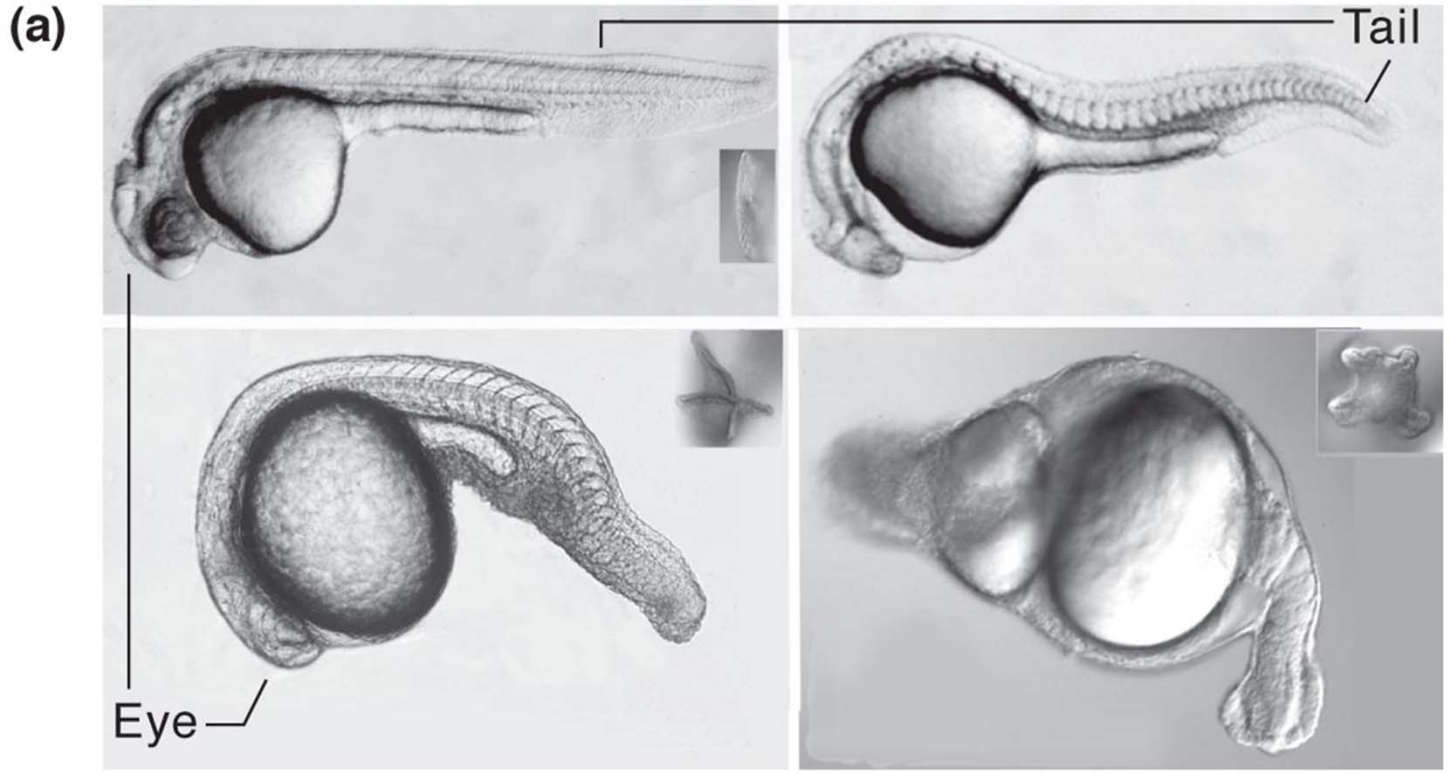
Matching animal systems as models for the human system

System	Best animal model for human
• Lung and cardiovascular	• Dog
• Immune system	• Mice
• HIV and AIDS research	• Monkey and chimpanzee
• Drug toxicity tests surgical experimentation	• Rats

Zebrafish as a model organism

- Popular hardy aquarium fish
- Size of a paperclip
- Can live in small spaces
- Spawn continuously
- 3 months between generations
- 200 progeny/week/female
- Complete organ development within 120 hours of birth
- Because the embryos inside a female are easily visible to naked eye, they are ideal animal systems for evaluating the effect of a new drug on development

Easy to follow drug effect on embryo development under microscope, since egg can mature outside female.



Zebrafish

- Lots of genetic similarity to humans
- Egg lends itself to genetic transfer
  - no need to implant an egg inside a donor mother for gestation.
- Embryos are transparent, making it possible to study cell division under microscope from first hour of creation.
  - transplant gene into embryo
- Because the genetics of zebrafish and humans are similar, they are ideal animal systems for determining whether a new drug induces genetic mutations

Animals in Research

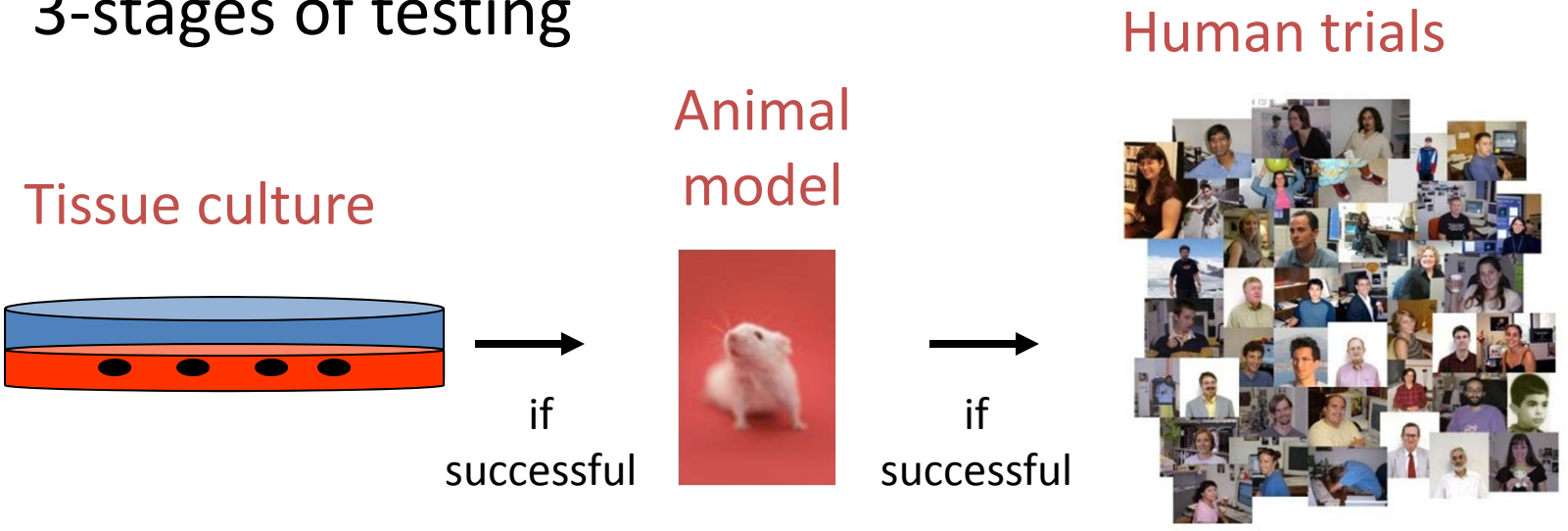
- FDA regulations state that new drugs, medical procedures, and cosmetic products must pass safety tests
  - Involves phase testing
    - Conduct a significant number of trials on cell cultures, in live animals, and on human research participants
    - Only in vitro testing is not sufficient

Regulation of animal research

- Animal Welfare Act
  - Sets specific regulations regarding, housing, feeding, cleanliness and medical care of animals
  - Researchers must first develop a plan describing
    - Appropriateness of species to be used
    - Minimum number of animals needed for test
  - Oversight committee reviews and approves plan
  - Government agencies monitor welfare of the test animals

Phase Testing

- Testing a new product for safety in humans involves vigorously following scientific methodology developed for animal systems
  - Involves collecting data from a statistically significant number of trials (experiments) in lab cell tissue cultures, in live animals and in human subjects.
- 3-stages of testing



Testing

- If test results using cell cultures indicates toxicity of product, then product will never be tested on live animals.
- Testing on live animals requires evaluation of more than one species, since different species may respond differently.

Phase Testing

- Animal models can provide the following information on a new product
  - Absorption of chemical by body
  - Body metabolism of chemical
  - Time require for chemical or product to be excreted

- If significant problems are encountered with product in live animals, then product is never tested in humans.

Animals in Research

- Alternatives to Animal Models
  - Cell culture and computer-generated models
- Cell Culture
  - Preliminary screen to check the toxicity of substances
  - Can answer fundamental questions about biology
  - Cannot provide information about potential impacts on entire living organism

Animals in Research

- Computer Models
  - Simulate specific molecular and chemical structures and their interactions
  - Limited by programming and knowledge of how the physiological system works

Animals in Research

- Regulation of Animal Research
  - **Federal Animal Welfare Act** set standards regarding the housing, feeding, cleanliness, and medical care of research animals
  - **Institutional Review Boards** are present at each institution; researcher must prove the need to use animals, select the most appropriate species, and devise a plan for using as few animals as possible

Animals in Research

- Regulation of Animal Research
  - The “Three Rs”
    - Reduce the number of higher species (cats, dogs, primates) used
    - Replace animals with alternative models whenever possible
    - Refine tests and experiments to ensure the most humane conditions possible

Animals in Research

- Veterinary Medicine as Clinical Trials
  - Veterinarians also participate in research
  - Information gleaned from one species may be applied to another
    - BRCA1 gene in humans is similar to BRCA1 gene in dogs
    - Cancer treatments cross between species