Zebrafish

Danio rerio (animal, fish)

Uses: For regeneration studies (processes of renewal and growth of cells and organs), the study of embryonic development and gene-environment interaction studies. Also used for research on developmental defects in adult diseases and age-related abnormalities, such as cardiovascular disease, Alzheimer's disease, and diabetes.

Advantages: Vertebrates. Easy and inexpensive to maintain and breed. Sequenced genome. Some transgenic zebrafish (where a gene has been added into a living organism) are available. Embryos (fertilized eggs) are transparent and develop outside of the parent's body, allowing for observation of the developing embryo.

Disadvantages: Zebrafish have many differences from humans, including many organ systems. Any drug studies on zebrafish need additional testing on mammals before human use.

Ethical Considerations: The creation of transgenic zebrafish is controversial.

Worms

Caenorhabditis elegans (animal, roundworm)

Uses: For research on the development of nerve cells and genetic screening. Worms are used as models of basic cellular communication.

Advantages: Instead of a brain, worms have a primitive nerve ring, making them ideal for studying the development of nerve cells. Easy and inexpensive to maintain and breed in large numbers. Sequenced genome.

Disadvantages: Invertebrates. Limited in scope. Worms are very different from humans. Any drug studied on worms needs additional testing on mammals before human use.

Ethical Considerations: Ethical issues with worms may differ from those with "higher" organisms like mammals.

Humans

Homo sapiens (animal, mammal)

Uses: For studying the safety and effectiveness of drugs and other treatments that are at the final stages of development (before they are allowed to be manufactured and sold).

Advantages: Results are strongest, since the testing is done on actual humans.

Disadvantages: Low participation by human volunteers. Costly and takes time. Ethical considerations limit most studies.

Ethical Considerations: Researchers must obtain informed consent from volunteers (volunteer must be capable of understanding the facts and risks of the study). Researchers must protect vulnerable populations (such as children, pregnant women, prisoners, and others). The study must maximize benefits and reduce harm for the volunteers.

Computer-Based Modeling

Uses: For predicting the best dosage (a prescribed amount of a drug), potential toxicity (from damaging and poisonous substances), and side effects from drugs.

Advantages: No animals needed; can be used to refine animal studies.

Disadvantages: Only able to make predictions which must then be tested on animals.

Ethical Considerations: Animal studies are still needed to validate results (to be sure that the results of the modeling are accurate).

Mice

Mus musculus (animal, mammal)

Uses: For surgical technique studies, transplantation studies, drug safety studies, toxicity studies, behavioral studies, gene-environment interaction studies, and the study of diseases and disorders, including: cardiovascular disease, psychiatric disorders (mental illness), spinal injuries, stroke, diabetes, autoimmune disorders, Alzheimer's Disease, cancer, bone healing, and many more.

Advantages: Small mammals. Easy to breed and inexpensive to house and feed. 80% of human genes are the same as in mice, allowing for the study of human genetic disorders and diseases. Genes can be added or removed in embryos to produce transgenic mice (where a gene has been added into a living organism) with genes that are similiar to human disorders. Currently, most animal research is conducted on mice and rats.

Disadvantages: Mice are different from humans, so not all results transfer directly to human responses.

Ethical Considerations: The creation of transgenic mice is controversial and might ultimately increase the number of animals used in research because many mice must be bred in order to produce a few with the genes of interest.

Fruit Flies

Drosophila melanogaster (animal, insect)

Uses: Essential for research of genetics, developmental biology, and drug development. Also used for research on the effects of drugs on the progression of Alzheimer's disease. Although flies have very simple brains, they have highly developed muscles and nerves.

Advantages: Easy and inexpensive to maintain and breed. Easy to observe embryonic development (fertilized eggs). Large chromosomes. Can easily produce mutants.

Disadvantages: Invertebrates. Flies are very different from humans. Any drug studied on flies needs additional testing on mammals before human use.

Ethical Considerations: Ethical issues with flies may differ from those with "higher" organisms like mammals.

Yeast

Saccaromyces cerevisiae (fungi, ascomycetes, Baker's yeast)

Uses: For studies of basic cell biology, drug development, and the effects of virus infection on cell function.

Advantages: Yeasts have similar basic cellular functions as humans. Easy to grow and maintain on a large scale.

Disadvantages: Yeasts are different from multicellular organisms.

Ethical Considerations: Less concern over care and welfare.

Cell Culture Systems

Uses: For basic cell biology research to determine how cells work and respond to changes in their environment. Used to measure toxic (damaging or poisonous) effects on specific cell types and to encourage cell growth and specialization. Cell culture lines exist for prostate and breast cancers, neural tissue, heart tissue, bone marrow, skin and many other cell types.

Advantages: Can be strictly controlled. Cells are easy to work with and provide results quickly.

Disadvantages: Cells are grown in artificial environments (grown in culture, such as a Petri dish, instead of inside an organism). Cells maintained for a long time in culture are different than those growing naturally inside an organism.

Ethical Considerations: Cells must be obtained from animals or humans.

Computer-Based Modeling
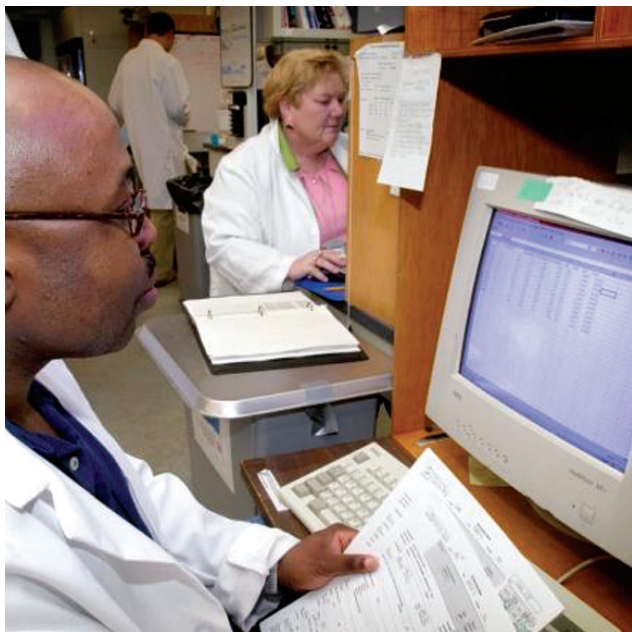
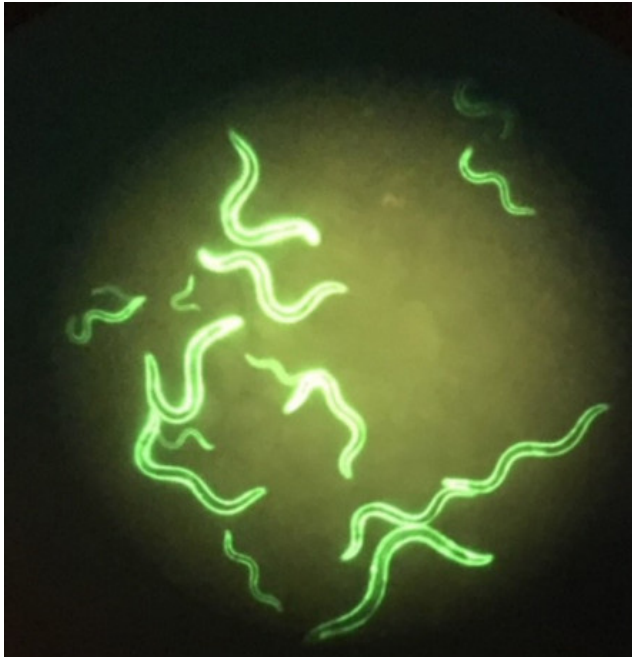Credit: Centers for Disease Control and Prevention/James Gathany, 2003.

Humans

Homo sapiens (animal, mammal)

Credit: Centers for Disease Control and Prevention/James Gathany, 2006.

Worms

Caenorhabditis elegans (animal, roundworm)
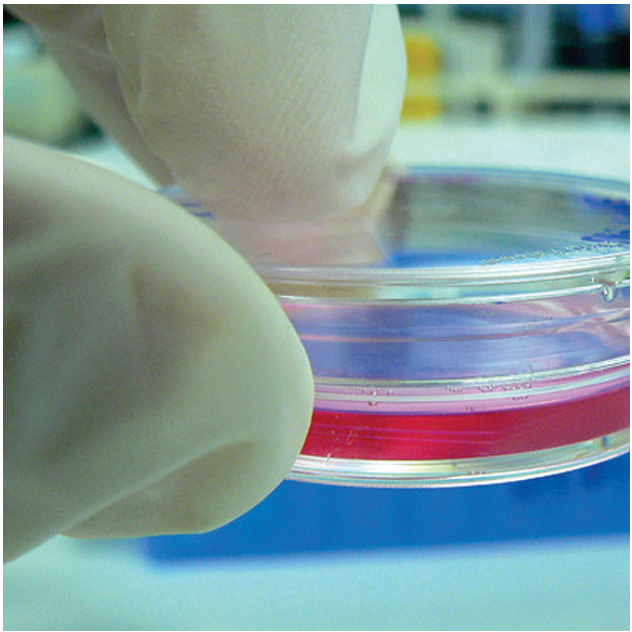

Zebrafish

Danio rerio (animal, fish)

Credit: Wikimedia, 2007.
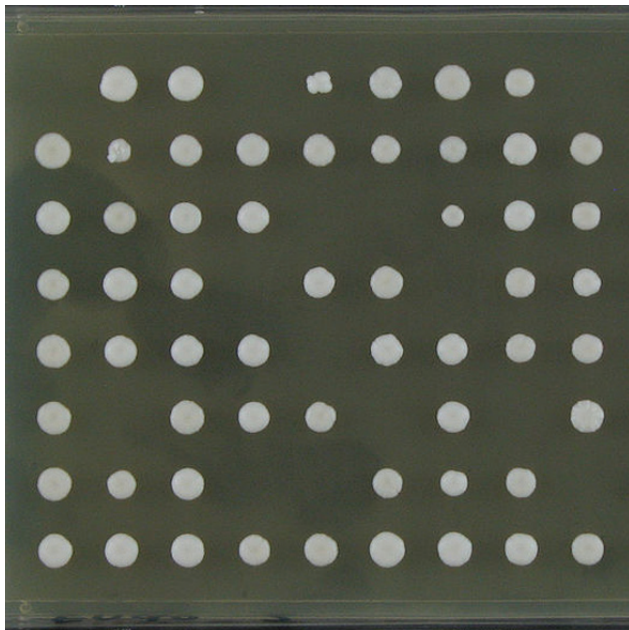http://commons.wikimedia.org/wiki/File:Danio_rerio_port.jpg.

Cell Culture Systems

Credit: Wikimedia, 2008. Umberto Salvagnin,
http://www.flickr.com/photos/kaibara/3075268200/.

Yeast

Saccaromyces cerevisiae (fungi, ascomycetes, Baker's yeast)

Credit: Wikimedia, 2009, Masur.
http://commons.wikimedia.org/wiki/File:Yeast_colonies_array_96_format.jpg.

Fruit Flies

Drosophila melanogaster (animal, insect)

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http://commons.wikimedia.org/wiki/File:Drosophila_melanogaster.jpg.

Mice

Mus musculus (animal, mammal)

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