

# TEACHER RESOURCE 2.4

## Master Copy for Research Model Cards

Copy these pages back-to-back and then cut out each card. Each student group will need one complete set of cards.

### 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).

### 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.

### 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.

### Macaques

*Macaca mulatta* (animal, mammal, non-human primate)

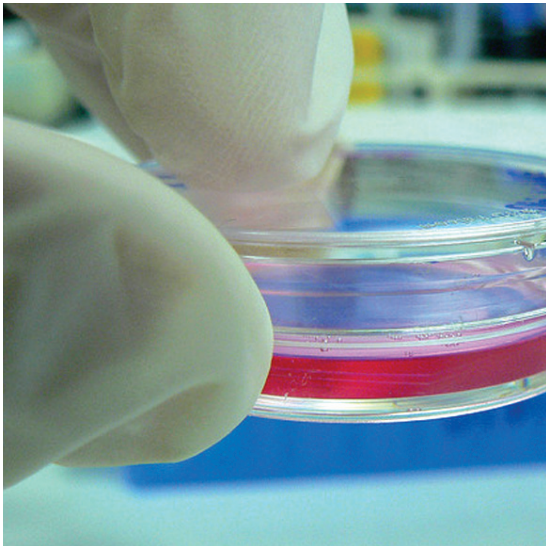
**Uses:** For behavioral studies, brain function and development studies, surgical development, vaccine and infectious disease studies, and drug safety studies. HIV research relies on primates such as macaques.

**Advantages:** Primates are humans' closest relatives. They provide a strong model for both behavioral (study of behavior) and physiological (study of organisms, organs, and cells) studies.

**Disadvantages:** Primates are expensive to house and feed, slow to breed, useful only for a limited number of studies, and genetically diverse.

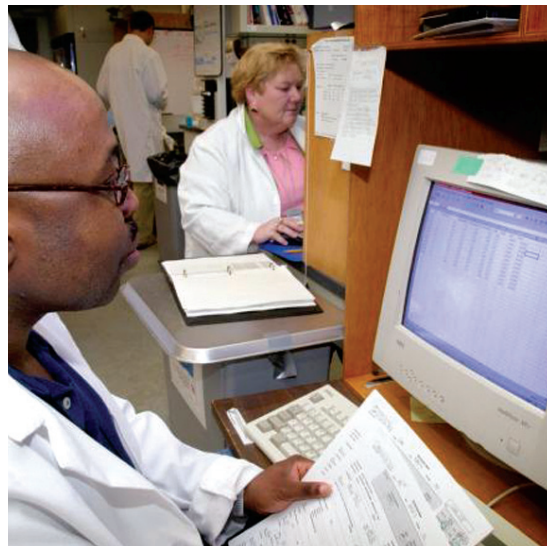
**Ethical Considerations:** Because of their intelligence and social nature, macaques require intensive care and social interaction to maintain their health.

## Cell Culture Systems



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

## Computer-Based Modeling



Credit: Centers for Disease Control and Prevention/James Gathany, 2003.

## Macaques

*Macaca mulatta* (animal, mammal, non-human primate)



Credit: Copyright 2007 Understanding Animal Research.

## Humans

*Homo sapiens* (animal, mammal)



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

## Pigs

*Sus scrofa* (animal, mammal)

**Uses:** For transplantation, cardiac, skin and prosthetic device studies, surgical technique studies, gene-environment interaction studies, and studies of brain disorders like Alzheimer's disease.

**Advantages:** Mammals. Pigs have large organ systems that are similar to humans.

**Disadvantages:** Pigs are large, expensive to house and feed, and genetically diverse.

**Ethical Considerations:** Because of their intelligence and social nature, pigs require some social interaction to keep them healthy.

## Dogs

*Canis lupus familiaris* (animal, mammal)

**Uses:** For behavioral studies and the development of surgical techniques for both veterinary and human applications. Dogs are also important for heart research, as well as transplantation and prosthetic device studies.

**Advantages:** Mammals. Dogs have large organ systems that are similar to humans. They are able to interact with researchers. Research on dogs benefits veterinary practice as well as humans.

**Disadvantages:** Dogs are expensive to house and feed as compared to smaller mammals.

**Ethical Considerations:** Because of their intelligence and social nature, dogs require some social interaction to keep them healthy. Historically, there has been public concern about the use of dogs in research.

## Rabbits

*Oryctolagus cuniculus* (animal, mammal)

**Uses:** For antibody (an immune system protein) production studies, product safety testing, gene-environment interaction studies, transplantation and prosthetic device studies, surgical technique studies, and studies of respiratory diseases such as asthma and cystic fibrosis.

**Advantages:** Small mammals. Easy to breed and inexpensive to house and feed. Can be bred specifically for research to obtain genetically similar animals.

**Disadvantages:** Rabbits are larger and more expensive to house and feed than mice or rats.

**Ethical Considerations:** Historically, there has been public concern about the use of rabbits in research, especially the use of the Draize test on rabbits. In this test for cosmetics safety, substances are applied to the eyes or skin of conscious rabbits.

## 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 similar 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.



## Dogs

*Canis lupus familiaris* (animal, mammal)



Credit: Copyright 2007 Understanding Animal Research.

## Pigs

*Sus scrofa* (animal, mammal)



Credit: Copyright 2000 Understanding Animal Research/Wellcome Images.

## Mice

*Mus musculus* (animal, mammal)



Credit: Copyright 2007 Understanding Animal Research.

## Rabbits

*Oryctolagus cuniculus* (animal, mammal)



Credit: Copyright 2000 Understanding Animal Research/Wellcome Images.

## 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.

## Chickens

*Gallus gallus* (animal, bird)

**Uses:** For embryonic development studies (after an egg is fertilized). In particular, this includes craniofacial development studies (face and skull development), brain development studies, environmental factors studies, and toxicity (damaging or poisonous substances) studies.

**Advantages:** Vertebrates. Warm blooded. Easy and inexpensive to maintain and breed. Embryos (fertilized eggs) develop outside of the parent's body, allowing for observation of the developing embryo.

**Disadvantages:** Chickens have many differences from humans. Any drug studied on chickens needs additional testing on mammals before human use.

**Ethical Considerations:** The creation of transgenic chickens (where a gene has been added into a living organism) is controversial.

## Frogs

*Xenopus tropicalis* (animal, amphibian)

**Uses:** For embryonic development studies (after an egg is fertilized). In cell biology and biochemistry studies, frogs are used for studying chromosome replication, control of the cell cycle, and various signaling pathways between cells.

**Advantages:** Vertebrates. Easy and inexpensive to maintain and breed. Large, transparent embryos (fertilized eggs) develop outside of the parent's body, allowing for observation of the developing embryo. Organ systems are complex. Genetic material can be easily manipulated to produce genetically similar organisms.

**Disadvantages:** The frog life cycle is very different from that of mammals.

**Ethical Considerations:** The creation of transgenic frogs (where a gene has been added into a living organism) is controversial. Ethical issues with frogs may differ from those with "higher" organisms like mammals.

## 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.

## Chickens

*Gallus gallus* (animal, bird)



Credit: Copyright 2007 Understanding Animal Research.

## Zebrafish

*Danio rerio* (animal, fish)



Credit: Wikimedia, 2007.  
[http://commons.wikimedia.org/wiki/File:Danio\\_rerio\\_port.jpg](http://commons.wikimedia.org/wiki/File:Danio_rerio_port.jpg)

## Fruit Flies

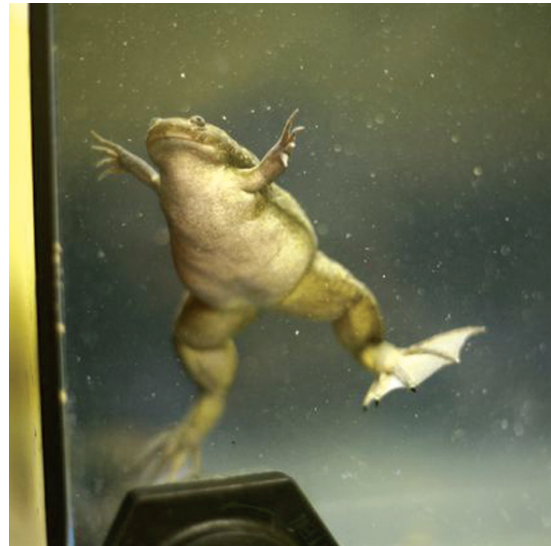
*Drosophila melanogaster* (animal, insect)



Credit: Wikimedia, Mr. Checker, 2009.  
[http://commons.wikimedia.org/wiki/File:Drosophila\\_melanogaster.jpg](http://commons.wikimedia.org/wiki/File:Drosophila_melanogaster.jpg)

## Frogs

*Xenopus tropicalis* (animal, amphibian)



Credit: Copyright 2007 Understanding Animal Research.



## 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.

## Plants

*Zea mays* (land plant, corn)

**Uses:** For studies of plant diseases that affect crop production. Compounds found in plants can be used for drug development. Also used for genetic studies of transgenic organisms (where a gene has been added into a living organism), and gene-environment studies.

**Advantages:** Easy and inexpensive to maintain and breed. Less concern over care and welfare than animals.

**Disadvantages:** Plant. Require room to grow. Much of the cellular processes in plants are different than those in animals.

**Ethical Considerations:** Ethical issues surrounding genetic modification and the loss of genetic diversity in crop species.

## Yeast

*Saccharomyces 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.

## Bacteria

*Escherichia coli* (bacteria, gammaproteobacteria)

**Uses:** For studies of basic cell biology, drug development, and the effects of virus infection on cell function. Also used for studying how toxins (damaging or poisonous substances) affect cell growth and function.

**Advantages:** Bacteria can be used to synthesize medical compounds.

**Disadvantages:** Bacteria are very different from eukaryotic cells (cells that have a nucleus contained inside a membrane).

**Ethical Considerations:** Less concern over care and welfare. Much concern over the development of “super bugs” that are resistant to antibiotics.

## Plants

*Zea mays* (land plant, corn)



Credit: Wikimedia, 2009, Ashlyak at ml.wikipedia.  
[http://commons.wikimedia.org/wiki/File:Cor\\_n\\_01.JPG](http://commons.wikimedia.org/wiki/File:Cor_n_01.JPG)

## Worms

*Caenorhabditis elegans* (animal, roundworm)



Credit: Centers for Disease Control and Prevention/Dr. Mae Melvin, 1974.

## Bacteria

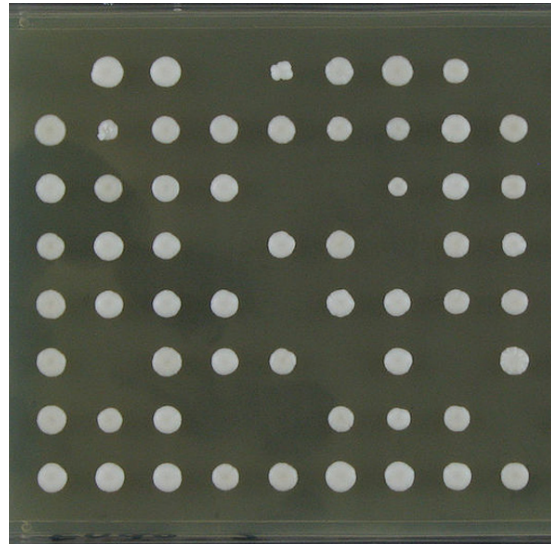
*Escherichia coli* (bacteria, gammaproteobacteria)



Credit: Centers for Disease Control and Prevention/Pete Seidel, 2010.

## Yeast

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



Credit: Wikimedia, 2009, Masur.  
[http://commons.wikimedia.org/wiki/File:Yeast\\_colonies\\_array\\_96\\_format.jpg](http://commons.wikimedia.org/wiki/File:Yeast_colonies_array_96_format.jpg)