Unit J

Biomedical Research

Definition

BIOMEDICAL RESEARCH:

The study of the processes of life;

the prevention and treatment of disease ;

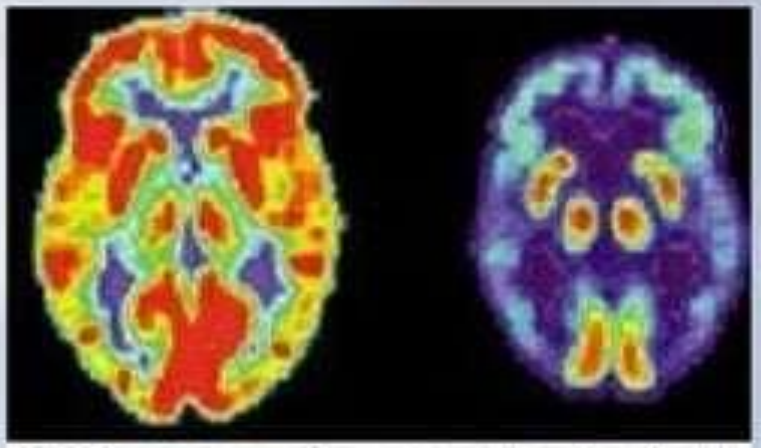
genetic, lifestyle and environmental factors related to disease and health

Basic Research

- Research conducted to increase fundamental knowledge.
- Provides building blocks for all other types of research.
- Not directed toward solving any particular problem.

Examples of Basic Research

A teacher assigning her students to write a research paper on Alzheimer's disease.



PET scans of normal brain (left) and an Alzheimer's brain. Photo: U.S. National Institute on Aging

- Mice being deprived of sleep as part of a research study.

- A new disease in Africa would prompt

Basic = gathering information

Applied Research

- Directed toward specific objectives – for example, development of a new drug, treatment, or surgical procedure.
- Conducted MOSTLY with animals.
- Can be non-animal methods (computer models or tissue cultures).

Clinical Research

1. Used when other forms of research have taken place.

2. Used to test potential drugs & treatments in humans. Mostly involves human subjects.

3. Builds on what is done in basic & applied stages.

Broad variety of activities in clinical research & areas of study.

- **Human clinical trials**-leukemia, cancers, AIDS & many other diseases. Some people are paid if willing to participate
- **Psychosocial & behavioral research**
- **Disease control research**

Humans are mainly used when test

Medical Research

Clinical Research occurs in the last stage of medical research.

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Objective 10.02

Biomedical Research Methods

Biomedical Research Methods

Chemical, mechanical, mathematical, and computer simulations.

Strengths of models

Computer simulations increases speed & efficiency of existing data. It provides a method of not using animals.

Strengths of Chemical, mechanical, mathematical, and computer simulations

- **Increases speed & efficiency with which data is use and processed**
- Pattern recognition programs enable scientists to compare characteristics of one compound to another
- Can extrapolate data from high dose experimental exposure to low dose and also from animals to humans
- **Reduces the number of animals needed for research**

Limitations of chemical, mechanical, mathematical, and computer models

- **Can not replace laboratory testing**
- Computers do not generate data; they just process existing data
- Computer equipment and software is expensive

In vitro tests "In glass" – takes place in an artificial environment. (Laboratory)

Strengths of in vitro studies

*Allows scientists to study a single effect in isolation

*Less expensive, less time, more accurate, and easier to control than in vivo (whole animal) systems

*More precise results due to the ability to control temperature, acidity, oxygen levels, and environmental conditions

*Limited to the study of a microorganism which can only survive in a living

Limitations of in vitro studies

- The time from chemical exposure to toxic effects is too complex to be duplicated
- Cells grown in cultures are not exposed to other functions taking place in a living organism
- Cells don't metabolize toxins in a culture the same way in the whole body
- Difficult to maintain differentiated cells in a culture
- **Cultures cannot tell us how a substance affects a complex animal system.**

Animal (non human) models

Animals provide the best known surrogate for humans in the lab.

Similarities between animals and humans outweigh differences.

Strengths of Animal Models

- **Share the same structures (cells, tissues and organs) as humans**
- Ethical alternative to using humans
- Animals provide a whole, integrated complex biological system
- Scientists can design experiments where they can control far more variables than with humans

Limitations of Animal Models

- Animals are NOT humans so results must be extrapolated
- Research animals are expensive to purchase, house, feed, and provide veterinary care
- The use of animals is governed by FEDERAL regulations

HUMAN MODELS

Most often used in developing prescription drugs

Is the drug biologically active in humans?

Is the drug safe in humans?

Clinical Trials
PHASE I

First stage of human testing, typically involves a small amount of healthy volunteers.

Primarily concerned with assessing risks and side effects associated with a drug

Takes about one year

Clinical Trials Phase II

- Involves 100-300 volunteers with the condition the drug is designed to treat.
- Focus is on determining the best dose of a drug
- Controlled tests to determine the drug's effectiveness
- Simultaneous animal and human testing to assess safety
- Takes about two years

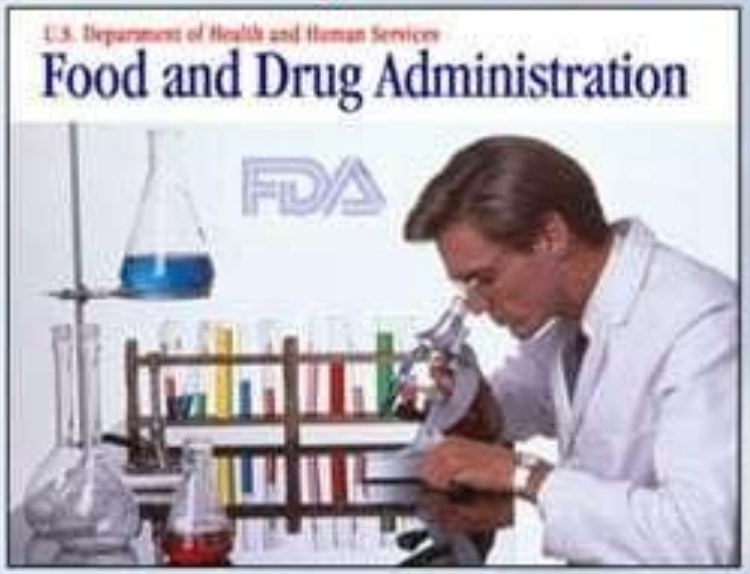
CLINICAL TRIALS
Phase III

- Involves 1,000-3,000 volunteers at multiple study sites nationwide
- Results will provide the evidence for safety and effectiveness that the FDA will consider in deciding whether to approve a drug
- Takes about three years

After Clinical Trials

- The company files a New Drug Application (NDA) with the FDA

- Takes two and a half years to complete



Development of New Drug

Strengths of Clinical Trials

Actual human data

Limitations of Clinical Trials

Ethical and moral considerations of using human volunteers as test subjects

Numerous variables, which may affect test data, are introduced when humans are used

Epidemiological Studies

The study of health in populations to understand the causes and patterns of health and illness

EXPERIMENTAL EPIDEMIOLOGY

- Providing or withholding a substance to determine its effects
- Limited by ethical and legal considerations

DESCRIPTIVE EPIDEMIOLOGY

- Analyzes data on the distribution and extent of health problems
- Tries to find correlations among characteristics (diet, air quality, occupation)
- Comparisons often made between countries and small geographic regions

OBSERVATIONAL EPIDEMIOLOGY

- Data is derived from individuals or small groups
- Data evaluated statistically to determine the strength of association between a particular variable and disease

Strengths of Epidemiology Studies

- Direct opportunity to study the effects in humans exposed to chemicals and disease-causing organisms
- Useful in identifying patterns in disease or injury distribution

Limitations of Epidemiology Studies

- Human exposure can take place before a toxic effect is detectable
- Difficult to demonstrate a direct cause-and-effect relationship
- Limited methods to measure individual's prior exposure, route of exposure, or extent of exposure
- Difficulty identifying control group (unexposed populations)
- Privacy issues
- Expensive to conduct

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Objective 10.03

Benefits of Biomedical Research

Benefits of Biomedical Research

Contributions to human health

1.) Treatment for heart disease — heart-lung machine

2.) Treatment for cancer

3.) Treatment for diabetes

4.) Bone marrow transplants

5.) Early vaccines

6.) Polio vaccine

7.) Chicken pox (Varicella)

8.) Hepatitis

9.) Fluoride

10.) Penicillin & other antibiotics

Some examples of the benefits of Biomedical Research...

Treatment for heart disease
Heart-Lung Machine

- Revolutionized cardiac surgery **40 years ago**.

Smallpox

- In 1967, the World Health Organization launched a global campaign to eradicate Smallpox.

- Edward Jenner discovered vaccine

Heart Disease

- **The reduction of CIGARETTE SMOKING has decreased HEART disease by 40%.**
- An experimental drug for heart disease is currently in Phase I clinical trails. How long before it will be approved for public use? (2,4,8, or 11 years)

CANCER

- Cancer is the most studied in biomedical research efforts.
- Gene therapy for treatment is currently being researched!

Insulin

- **1ST extracted from a cow's** pancreas & used to treat a 14 year old boy in 1922.
- **Today we genetically engineer insulin. Bacteria is used to produce human insulin.**
- Insulin Pumps
- Blood Sugar Monitoring Equipment (Glucometer) which uses less blood
- Transplantation of pig pancreas cells

Chicken pox (Varicella)

- A highly contagious illness caused by infection with **varicella** zoster.
- Vaccine became available in 1995

Availability of Vaccines

- **Why are children under 2 still not vaccinated with the recommended vaccines?**

Fear of side effects and lack of education about diseases vaccines prevent!

Parents are not familiar with infectious diseases and have therefore become complacent about vaccinations….problem!

Polio Vaccine

- The first was developed by Jonas Salk in 1949 and first tested in 1952, and announced to the world by Salk on April 12, 1955.

- Vaccine was made from killed polio virus

Dr. Albert Sabin

- Worked on a polio vaccine that could be administered orally in 1954.

- It was made from live virus that was **attenuated** (weakened) but not killed. Administered on a sugar cube finally available in 1961

Dr. Salkin at the National Institutes of Health, Ca. mid-1960's

Biomedical Research

- Has had a profound impact on childhood cancer (leukemia) that, in the 1950's, killed every child diagnosed with it within 6 months. Survival rate is 75% now

Biomedical Research

- Most commonly studied is cancer and genetic diseases

- Research on tooth decay lead to fluoride being added to the drinking water

Louis Pasteur

- French chemist and microbiologist
- Developed vaccines
  - Cholera 1879
  - Anthrax 1881
  - Rabies 1885

Alexander Fleming

Discovered Penicillin

- Penicillin is one of the earliest discovered and widely used antibiotic agents, derived from the Penicillium mold.

Penicillin Mold Fungus

- AIDS research continues (Acquired Immunodeficiency Syndrome)

1.) Began in early 1980s

2.) Caused by a virus

3.) HIV infection progresses to AIDS when immune system is impaired & individual becomes susceptible to

ic infections.

AIDS RESEARCH

- Animals important part of research
- Number of possible vaccines have been developed and are being tested in humans
- Anti-HIV drugs available
  - Lots of pills at different times of the day
  - Expensive and not always covered by insurance
  - Lots of side effects

Common sense preventive measures best way to prevent AIDS.

- Avoid contact with Bodily fluids, infected blood, and breast milk
- Abstaining from sex
- Being aware if one's partner is infected
- Using condoms
- Sterilized needles or not sharing needles
- Health workers should wash hands and use protective barriers, such as, gloves and goggles when handling bodily fluids and infected blood
- Mothers infected with HIV should not breastfeed their child.

The Use of Animals in Biomedical Research

Less than 0.5%

Less than 0.5%

Less than 0.5%

Less than 3.3%

More than 90%

Research Animals Used to Make Major Medical Advances

Discovery of Insulin for Diabetes
Major antibiotics
Chemotherapy for cancer
Organ transplantation
Heart disease treatment

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Prevention of Polio
Chemotherapy for cancer
AIDS research
Drug abuse research

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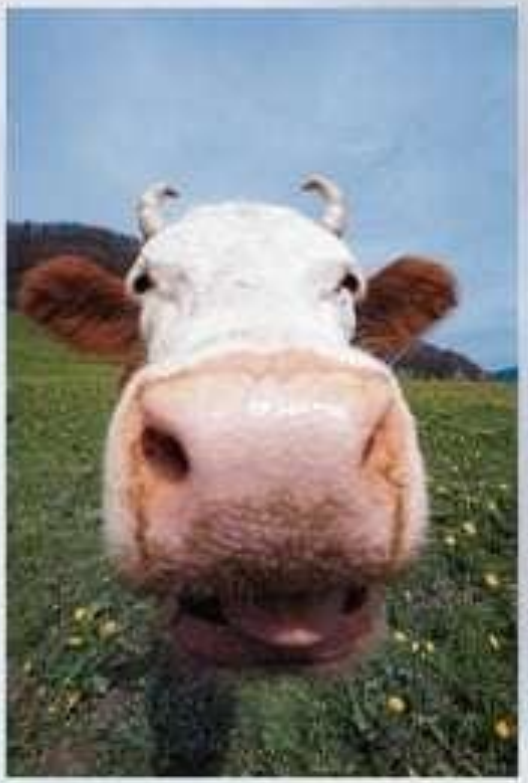

Who takes care of animals in research?

Technicians

- -check on animal's health
- -control animal's environment
- -take blood samples and x-rays
- -give medicines
- -assist with surgery
- -provide care after surgery

What are the Animal facilities like?

- Facilities kept clean and safe
- Technicians wear lab coats, surgical masks, and gloves when necessary

How are animals treated?

- Caretakers do everything possible to make animals feel comfortable and happy
- Treated with compassion

What about pain?

- Researchers make every effort to make sure animals don't feel pain (except when pain killing drugs or anesthesia will interfere with study results)
- Quantity and duration of pain strictly monitored to be kept to a minimum

Laws, Regulations and Guidelines Governing Animal Research

FEDERAL REQUIREMENTS FOR ANIMAL TESTING

Food and Drug Administration (FDA)

-requires laboratory animal tests be conducted for prescription and over-the-counter drugs BEFORE being tested in humans

Environmental Protection Agency (EPA)

-uses data from animal tests to identify and regulate substances in the environment that might be hazardous to humans and animals

Consumer Product Safety Commission (CPSC)

-relies on animal data to identify and regulate risks to consumers from household and other products

Occupational Safety and Health Administration (OSHA)

-uses data from animal tests to set regulations that protect workers in the workplace

Federal laws, Regulations and Guidelines Governing Biomedical Research Using Animals

- U.S. Government Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research and Training
- Animal Welfare Act
- United States Department of Agriculture (USDA) Animal Welfare Regulations
- Health Research Extension Act
- Institutional Animal Care and Use Committee (must be present at each facility using animals in research)
- American Association for Accreditation of Laboratory Animal Care (AAALAC)- voluntary

??? Did You Know ???

- 95% of all animals used in medical research are rats, mice or other rodents specifically bred for research
- Valid and useful scientific findings are obtainable only when research animals are healthy & protected from undue stress
- Federal regulations prohibit both animal abuse and the use of sick, injured or distressed animals as research subjects
- Majority of animal studies use medical techniques similar to those used on humans. They involve little or no pain for the animals
- Research animals are carefully selected to ensure that only the number and species essential to each research project is used
- Most research animals are bred specifically for the purpose of research

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