Biomedical research methods
What are biomedical research methods?

- An integrated approach using chemical, mathematical and computer simulations, in vitro tests, whole animal models, and human epidemiological studies and clinical trials is currently the best approach to advance science, develop new products and drugs, and treat, cure and prevent disease.
Chemical, mechanical, mathematical and computer simulations prove most useful in the preliminary stages of research where they can stimulate ideas about new research directions.

These are effective research models but they cannot replace laboratory testing.

Computer simulations are an effective research tool because they increase speed and efficiency of existing data.
In vitro tests (meaning “in glass”***are experiments performed in laboratory*** containers using tissues or cells. These tests are most useful during the early and intermediate research stages to study a single effect of a substance in isolation.

An example of a limitation to in vitro studies would be that cultures cannot tell us how a substance affects a complex animal system.

In vitro studies are critical to the study of viruses that can only grow in living cells. ***
Nonhuman animal models provide the most reliable and complete data on the functioning of a living system, and they offer the best indicator of how humans will react to a new drug or medical procedure.

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

Animals share the same structures (cells, tissues organs) as humans. ***

People with concerns about animals in research should be aware that the use of animals is governed by federal regulations ***
Human studies involve taking laboratory data on the safety and effectiveness of new vaccines or medicines and evaluating them in carefully staged clinical trials using informed human volunteers.

When humans are used in biomedical research studies, drugs are usually what is being tested.***
3 main phases of human clinical trials:

- In *Phase I* clinical trials, researchers determine a drug’s interaction with the human system, including how it is absorbed, distributed, metabolized and excreted, and the likely duration of its therapeutic effect. **This phase involves a small number of healthy volunteers*** and takes approximately one year.
Phase II trials use controlled tests that help determine a drug’s effectiveness. These studies involve 100 to 300 volunteer patients. Simultaneous animal and human tests are also conducted at this stage as researchers continue to assess the safety of the drug. This phase takes approximately two years.
Phases (cont).

- *Phase III* trials are conducted to confirm the results of earlier efficacy tests and further identify any adverse reactions. Clinical testing at this point is extensive, involving 1,000 to 3,000 volunteer patients in medical clinics and hospitals. This phase takes approximately three years.
After human clinical trials are completed, firms file a New Drug Application (NDA) with the FDA. The NDA is a comprehensive statement of the information on: drug structure, the scientific rationale and purpose of the drug therapy, pre-clinical animal and other laboratory study results, all human clinical testing results, drug formulation and production details and the company’s proposed labeling. This takes approximately 2.5 years to complete.

Currently, it takes approximately 12 years from initiation of animal and other laboratory studies through all phases of clinical trials and submission of data to the FDA for approval. For each new medicine approved, the cost is hundreds of millions of dollars.
Example

- If an experimental drug is currently in phase I of clinical trials, it will be 11 years before it is made available to the public.***
Epidemiological studies are another type of human study. These studies look at occurrence and distribution of disease in a population.

May be divided into three general types: experimental, descriptive and observational.
Experimental epidemiology

- Experimental epidemiology is the human equivalent of animal testing — providing or withholding a substance to determine its toxic or beneficial effects.

- Such studies are greatly limited by ethical and legal considerations as well as the difficulties involved in securing the cooperation of a large number of people.
Descriptive epidemiology

Descriptive epidemiology analyzes data on the distribution and extent of health problems or other conditions in various populations, trying to find correlations among characteristics such as diet, air quality and occupation.
Observational epidemiology

- Observational epidemiology uses data derived from individuals or small groups. Data are evaluated statistically to determine the strength of association between a particular variable and disease.
Strengths and limitations

- **Strengths:** Epidemiological studies offer scientists a direct opportunity to study the effects in humans exposed to chemicals and disease-causing organisms.

  These studies are also useful in identifying patterns in disease or injury distribution. These patterns may be traced to causative factors.

- **Limitations:** A major disadvantage of epidemiological studies is that considerable human exposure can take place before a toxic effect is detectable, particularly in the case of diseases like cancer that take many years to develop.