

# Concept 1.3: Scientists use two main forms of inquiry in their study of nature

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- The word *Science* is derived from Latin and means “to know”
- **Inquiry** is the search for information and explanation
- There are two main types of scientific inquiry: discovery science and hypothesis-based science

# Discovery Science

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- **Discovery science** describes natural structures and processes
- This approach is based on observation and the analysis of data

# *Types of Data*

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- **Data** are recorded observations or items of information
- Data fall into two categories
  - *Qualitative*, or descriptions rather than measurements
  - *Quantitative*, or recorded measurements, which are sometimes organized into tables and graphs

Fig. 1-23



# *Induction in Discovery Science*

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- **Inductive reasoning** draws conclusions through the logical process of induction
- Repeated specific observations can lead to important generalizations
  - For example, “the sun always rises in the east”

# Hypothesis-Based Science

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- Observations can lead us to ask questions and propose hypothetical explanations called **hypotheses**

# *The Role of Hypotheses in Inquiry*

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- A **hypothesis** is a tentative answer to a well-framed question
- A scientific hypothesis leads to predictions that can be tested by observation or experimentation

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- For example,
    - Observation: Your flashlight doesn't work
    - Question: Why doesn't your flashlight work?
    - Hypothesis 1: The batteries are dead
    - Hypothesis 2: The bulb is burnt out
  - Both these hypotheses are testable



Fig. 1-24

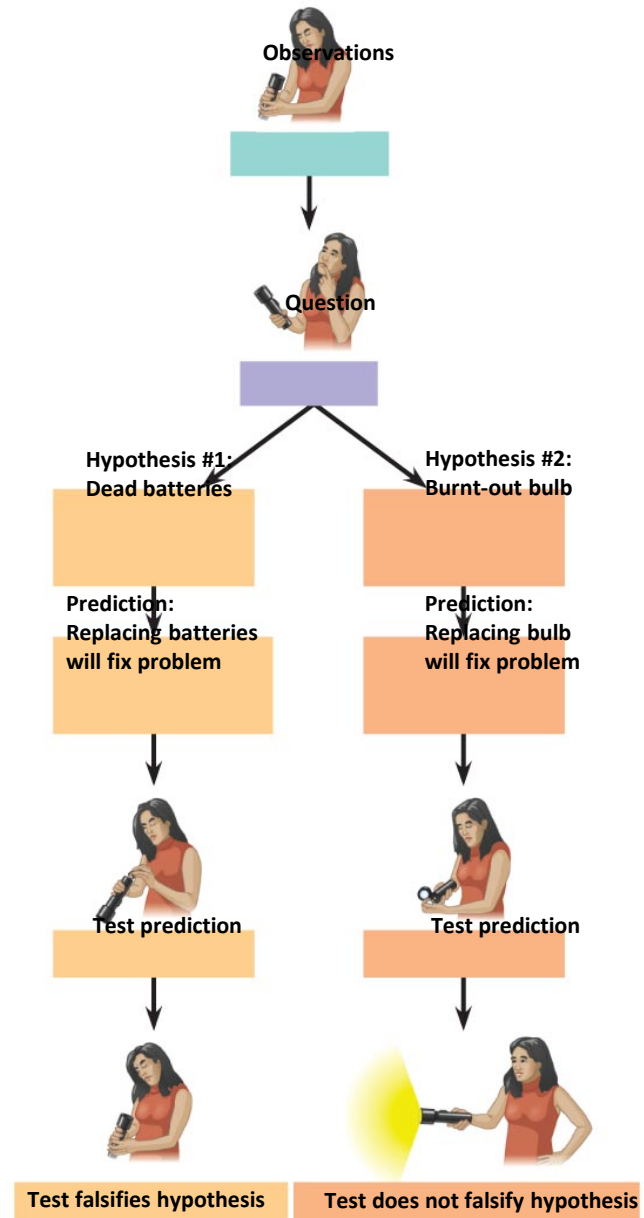


Fig. 1-24a

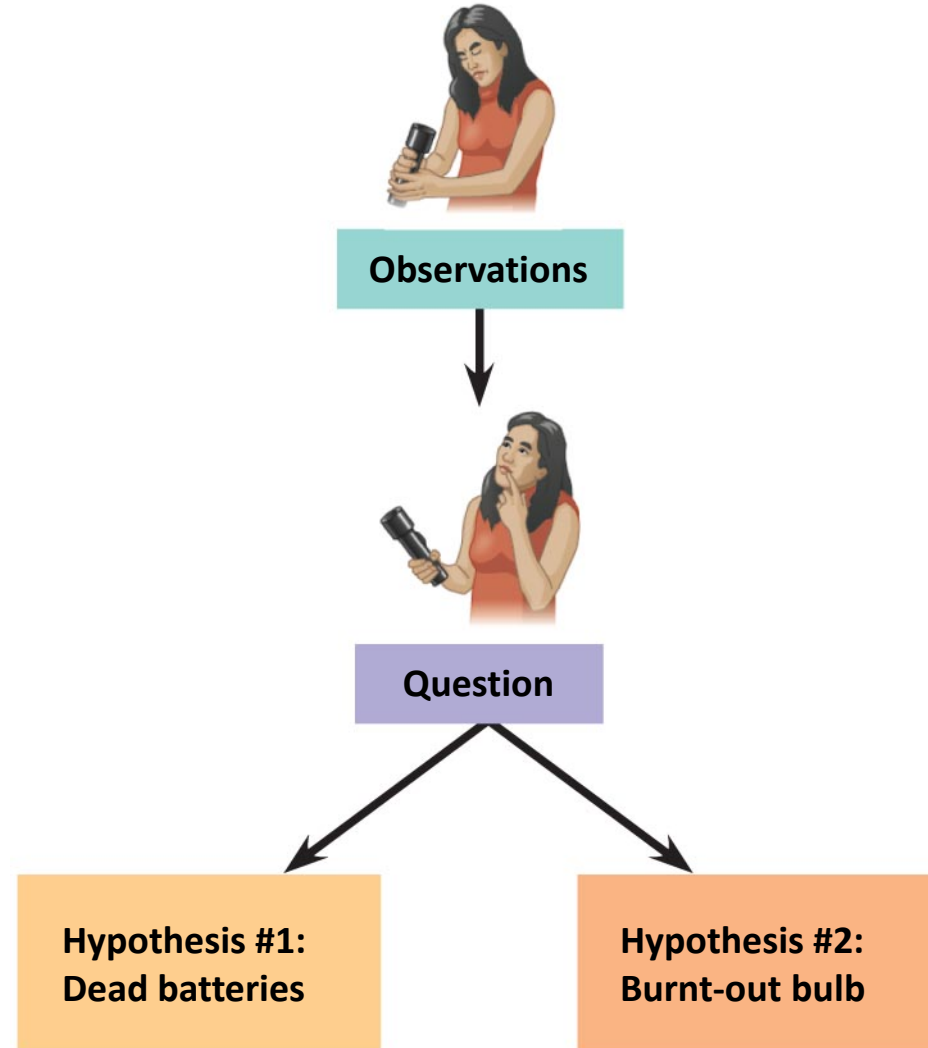
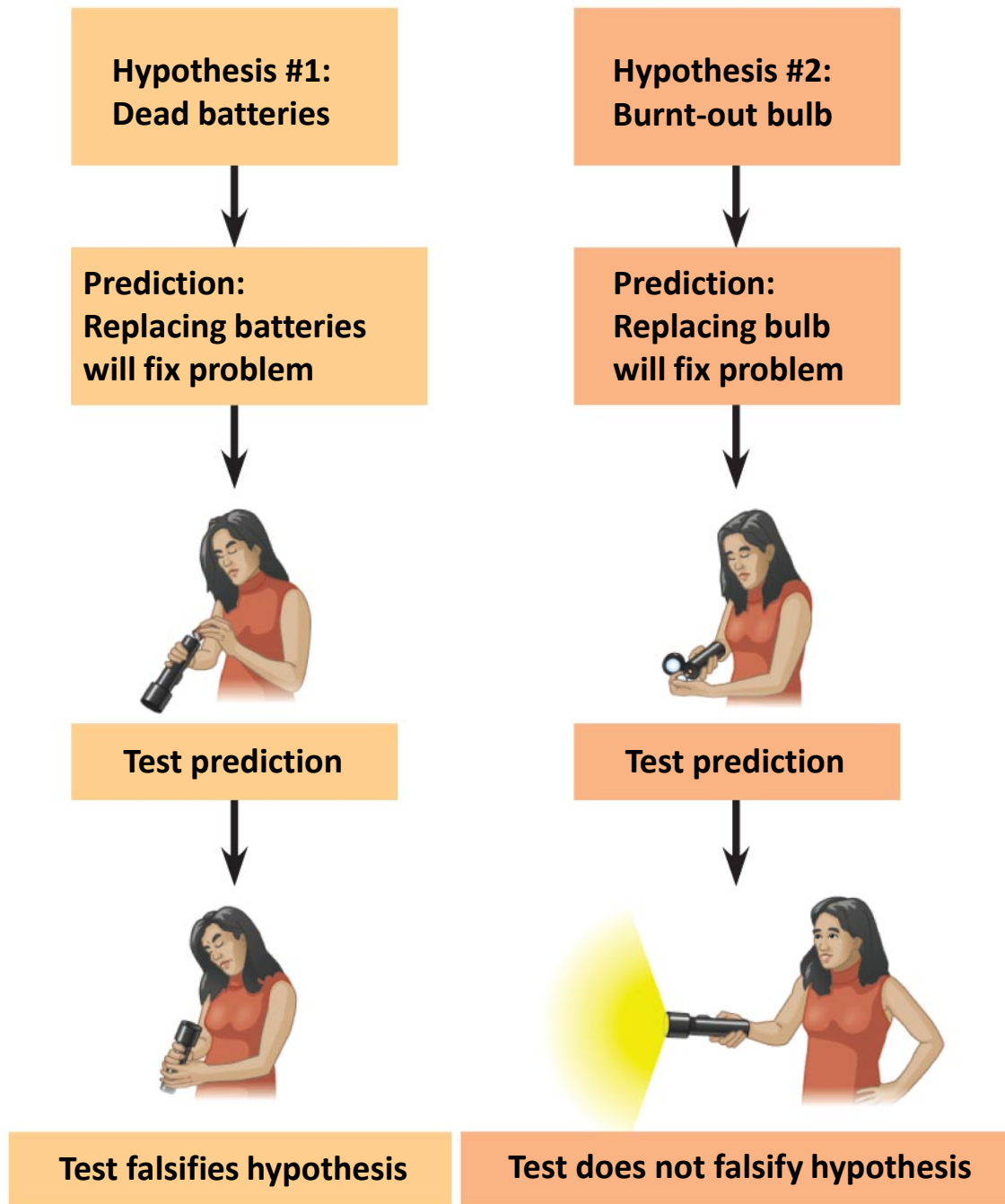


Fig. 1-24b



# *Deduction: The “If...Then” Logic of Hypothesis Based Science*

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- **Deductive reasoning** uses general premises to make specific predictions
- For example, *if* organisms are made of cells (premise 1), and humans are organisms (premise 2), *then* humans are composed of cells (deductive prediction)

# *A Closer Look at Hypotheses in Scientific Inquiry*

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- A hypothesis must be *testable* and *falsifiable*
- Hypothesis-based science often makes use of two or more alternative hypotheses
- Failure to falsify a hypothesis does not *prove* that hypothesis
  - For example, you replace your flashlight bulb, and it now works; this supports the hypothesis that your bulb was burnt out, but does not prove it (perhaps the first bulb was inserted incorrectly)

# *The Myth of the Scientific Method*

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- The *scientific method* is an idealized process of inquiry
- Hypothesis-based science is based on the “textbook” scientific method but rarely follows all the ordered steps
- Discovery science has made important contributions with very little dependence on the so-called scientific method

# *Designing Controlled Experiments*

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- A **controlled experiment** compares an experimental group with a control group
- Ideally, only the variable of interest differs between the control and experimental groups
- A controlled experiment means that control groups are used to cancel the effects of unwanted variables
- A controlled experiment does *not* mean that all unwanted variables are kept constant

# Limitations of Science

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- In science, observations and experimental results must be repeatable
- Science cannot support or falsify supernatural explanations, which are outside the bounds of science



# Theories in Science

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- In the context of science, a **theory** is:
  - Broader in scope than a hypothesis
  - General, and can lead to new testable hypotheses
  - Supported by a large body of evidence in comparison to a hypothesis

# Model Building in Science

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- **Models** are representations of natural phenomena and can take the form of:
  - Diagrams
  - Three-dimensional objects
  - Computer programs
  - Mathematical equations

# Science, Technology, and Society

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- The goal of science is to understand natural phenomena
- The goal of **technology** is to *apply* scientific knowledge for some specific purpose
- Science and technology are interdependent
- Biology is marked by “discoveries,” while technology is marked by “inventions”

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- The combination of science and technology has dramatic effects on society
    - For example, the discovery of DNA by James Watson and Francis Crick allowed for advances in DNA technology such as testing for hereditary diseases
  - Ethical issues can arise from new technology, but have as much to do with politics, economics, and cultural values as with science and technology