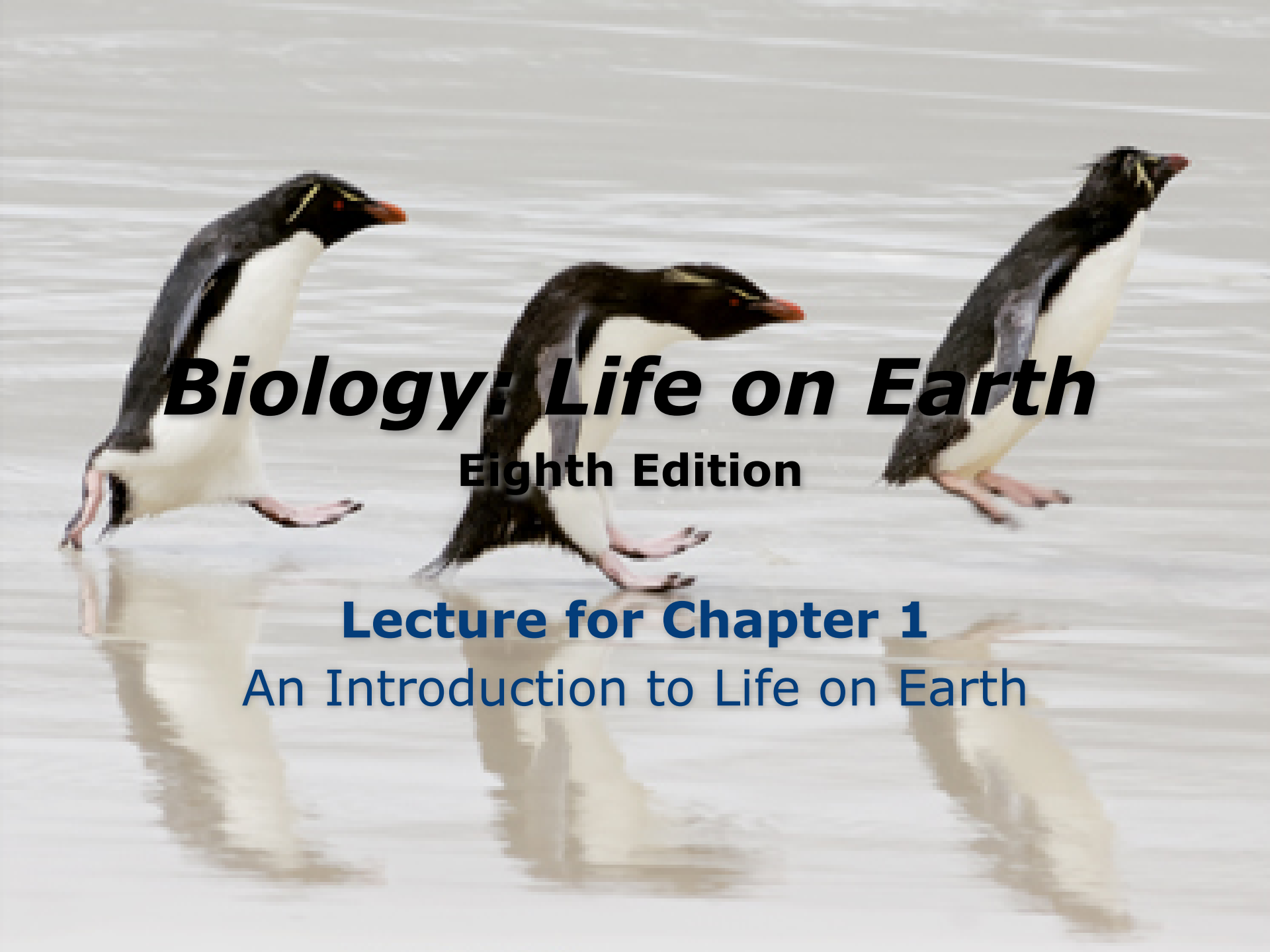


Biology: Life on Earth

Eighth Edition

Lecture for Chapter 1

An Introduction to Life on Earth

The Scientific Method

- Scientific inquiry is a rigorous method for making observations
- The Scientific Method for inquiry follows 4 steps…

The Scientific Method

1. **Observation of a phenomenon**
   - Subsequent development of **questions**
2. **Formulation of a hypothesis**
   - A supposition that explains an observed phenomenon, leading to testable **predictions**

The Scientific Method

3. **Testing through experimentation**
   - Additional controlled observations
4. **Development of a conclusion**
   - Evaluation of hypothesis in light of experimental data

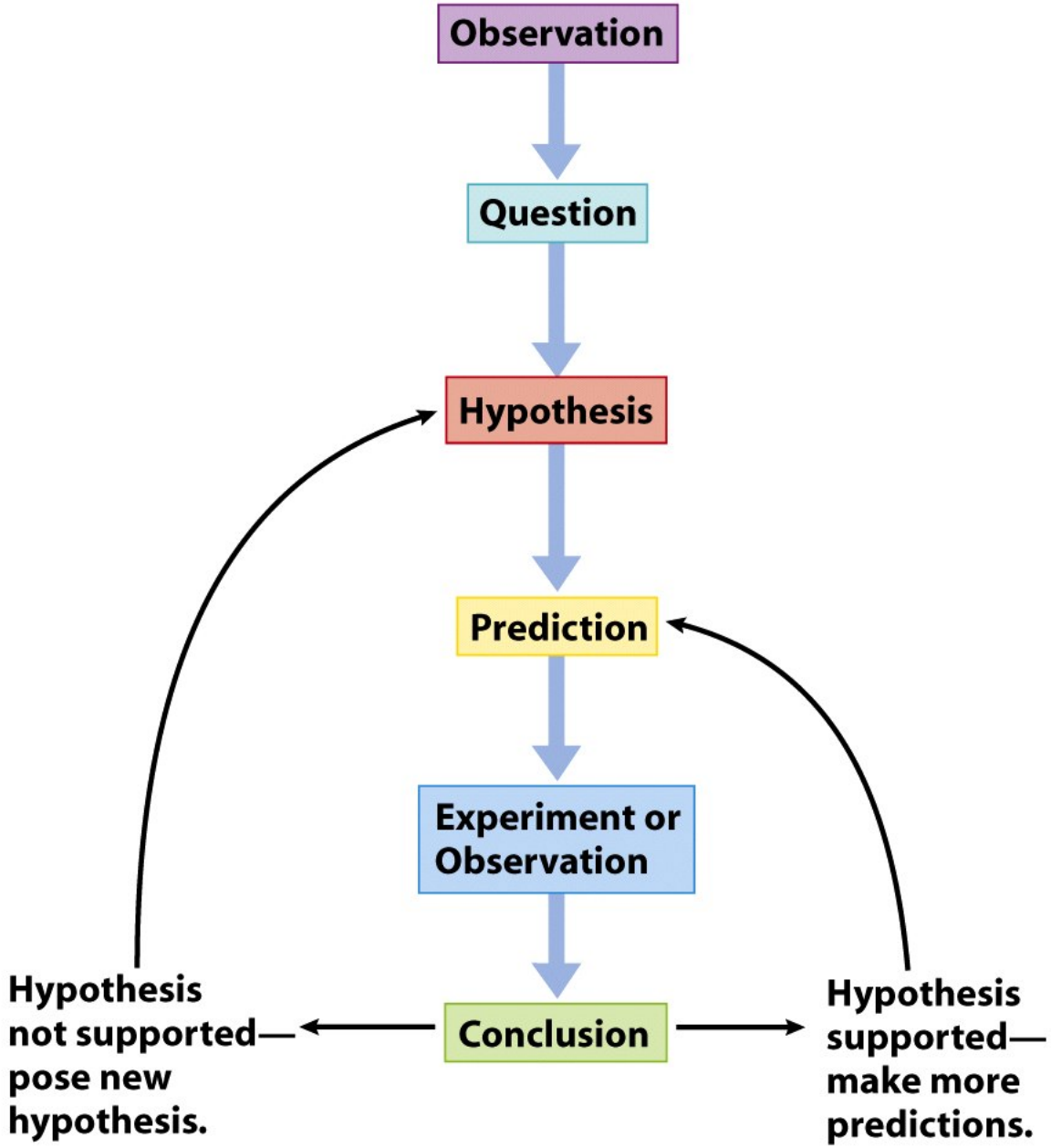


Figure 1-4a Biology: Life on Earth, 8/e

The Scientific Method

- Scientific experimentation tests the assertion that a *single* ***variable*** causes a particular observation
- The experiment must rule out the influence of other possible variables on the recorded observations

The Scientific Method

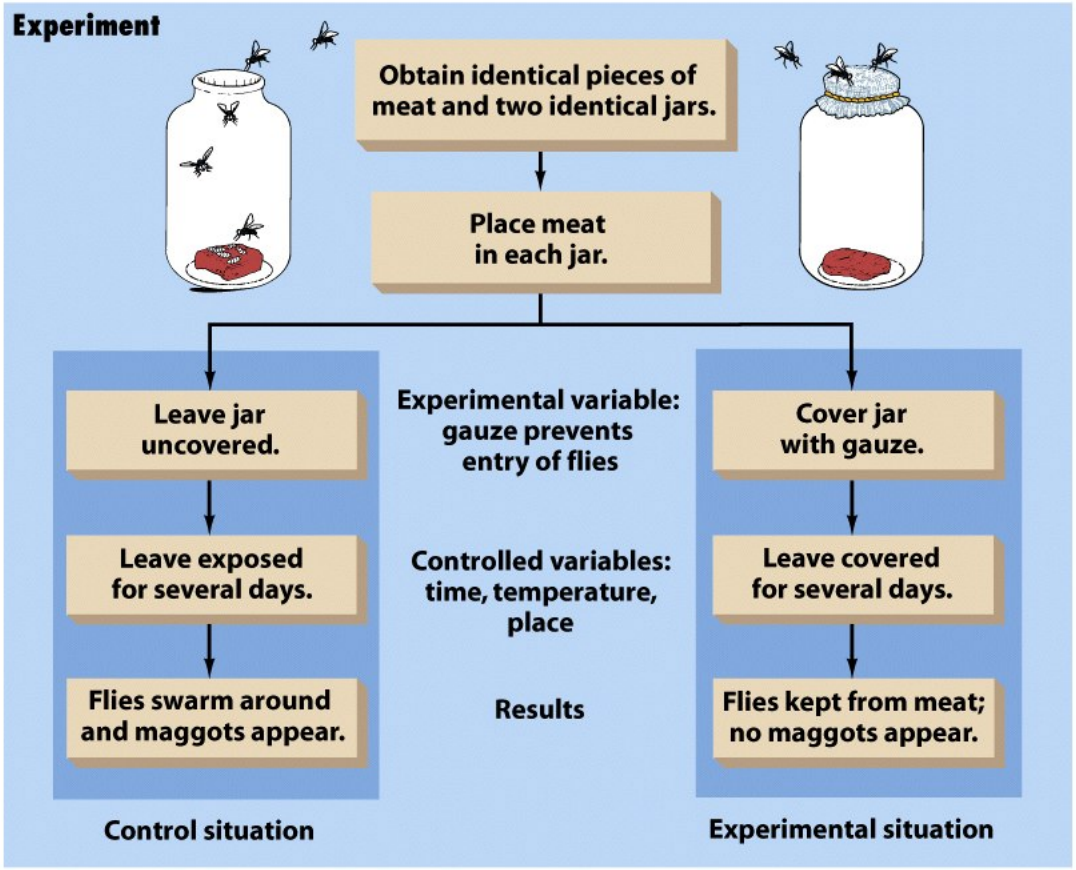
- **Controls** are incorporated into experiments
- Controls keep untested variables constant
- Scientific method is illustrated by Francesco Redi's experiment

Observation: Flies swarm around meat left in the open; maggots appear on meat.

Question: Where do maggots on meat come from?

Hypothesis: Flies produce the maggots.

Prediction: IF the hypothesis is correct, THEN keeping the flies away from the meat will prevent the appearance of maggots.



Conclusion: The experiment supports the hypothesis that files are the source of maggots and that spontaneous generation of maggots does not occur.

Figure E1-1 Biology: Life on Earth, 8/e

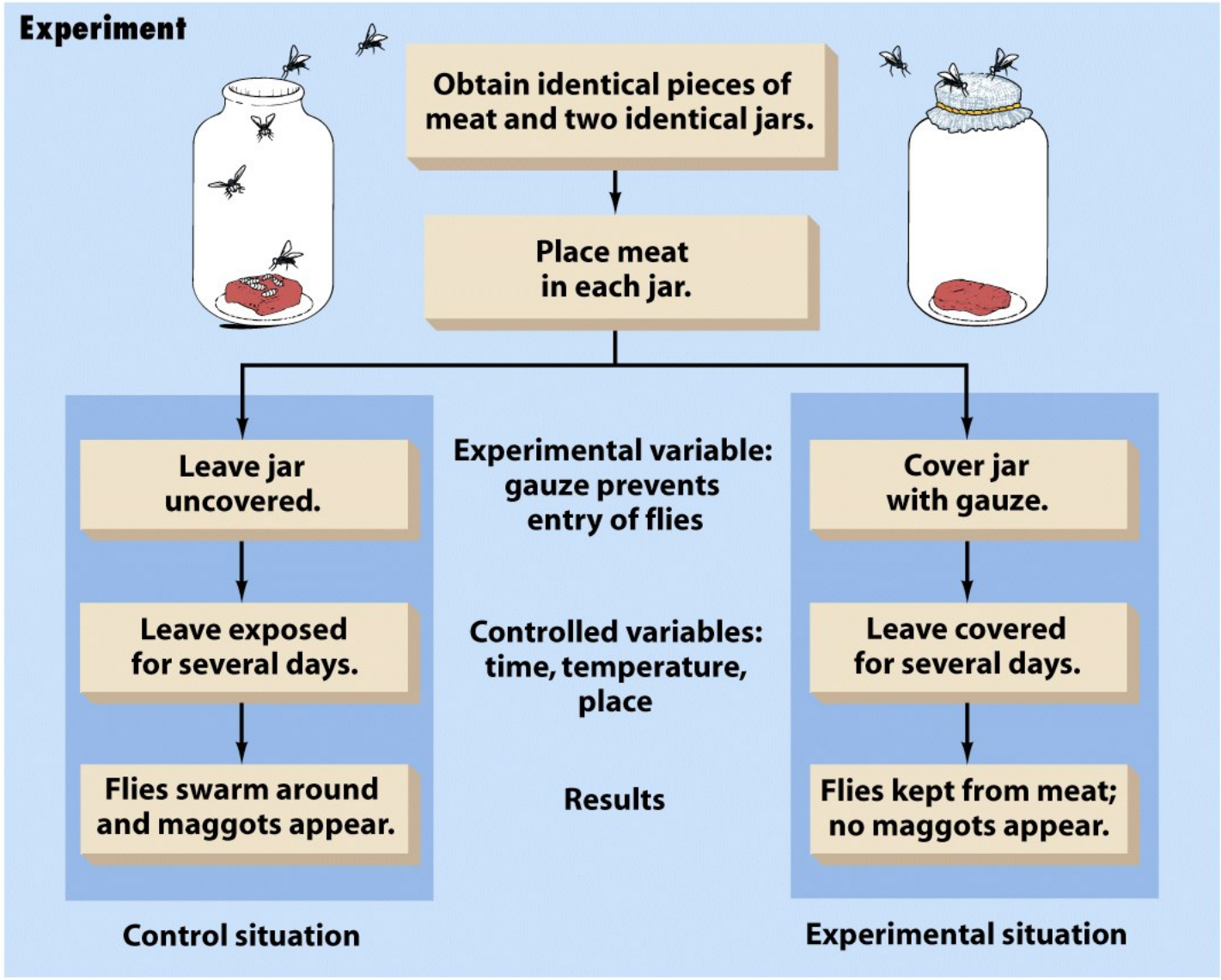
Observation: Flies swarm around meat left in the open; maggots appear on meat.

Question: Where do maggots on meat come from?

Hypothesis: Flies produce the maggots.

Prediction: IF the hypothesis is correct, THEN keeping the flies away from the meat will prevent the appearance of maggots.

Figure E1-1 part 1 Biology: Life on Earth, 8/e



Conclusion: The experiment supports the hypothesis that files are the source of maggots and that spontaneous generation of maggots does not occur.

Figure E1-1 part 2 Biology: Life on Earth, 8/e

Observation

Car won't start.

Question

Why won't the car start?

Hypothesis

The car won't start because the battery is dead.

Prediction

IF the hypothesis is correct, THEN the car will start if the battery is replaced.

Experiment or Observation

Replace the battery.

Conclusion

The dead battery hypothesis is supported.

Figure 1-4b Biology: Life on Earth, 8/e

Limitations of the Scientific Method

- Can never be sure *all* untested variables are controlled
- Conclusions based on the experimental data must remain tentative

Limitations of the Scientific Method

- Results of experimentation must be communicated thoroughly and accurately to other scientists for repetition
- Repetition by other scientists add verification that findings can be used as the basis for further studies

Science Is a Human Endeavor

- Human personality traits are part of “real science”
- Scientists, like other people may be driven by pride, ambition, or fear
- Scientists sometimes make mistakes
- Accidents, lucky guesses, intellectual powers, and controversies with others contribute strongly to scientific advances

Science Is a Human Endeavor

1. In the 1920s, bacteriologist Alexander Fleming grew bacteria in cultures
2. One of the bacterial cultures became contaminated with a mold
3. Fleming nearly destroyed the culture when he noticed the mold (*Penicillium*) inhibited bacterial growth in the culture

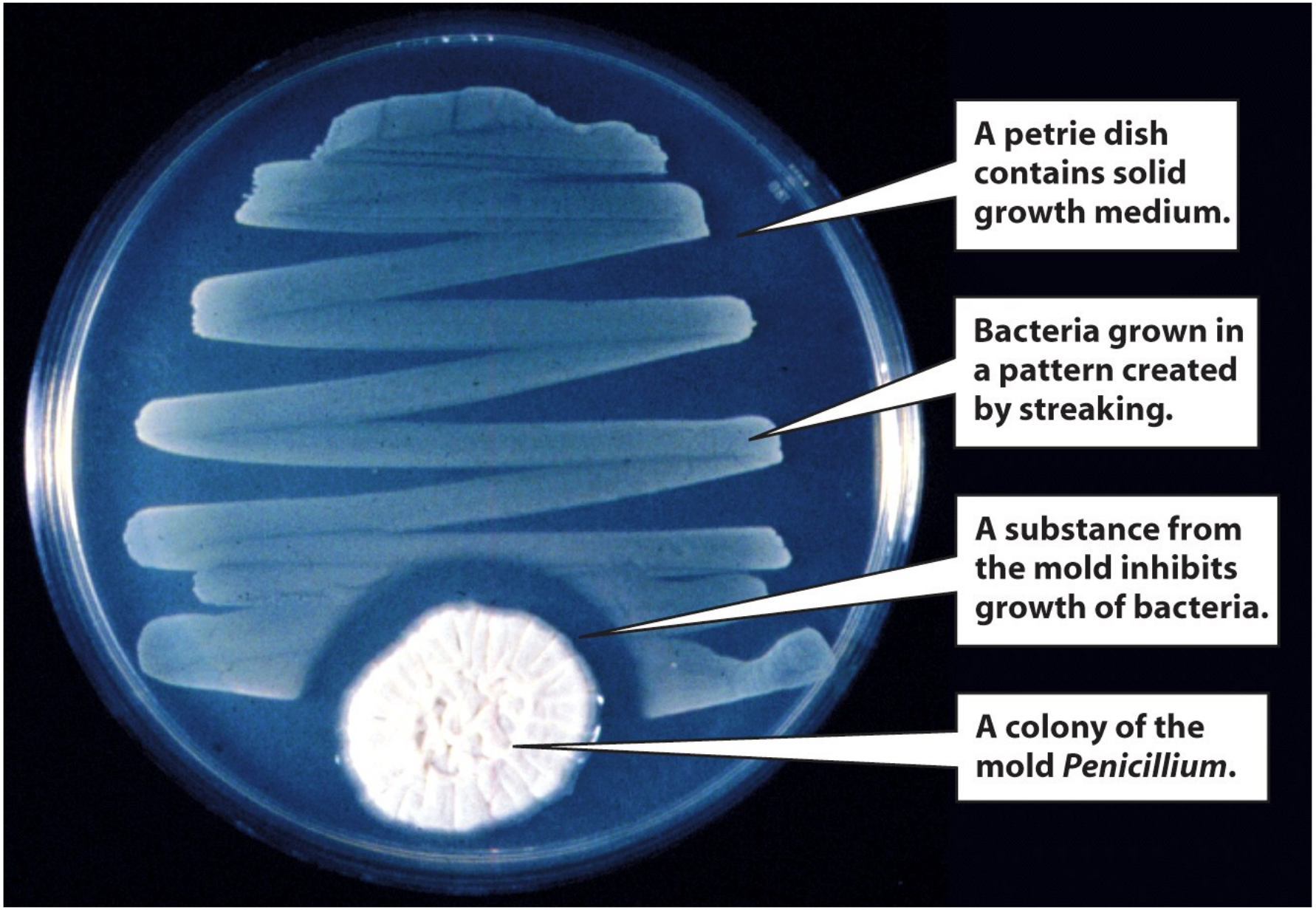


Figure 1-5 Biology: Life on Earth, 8/e

Science is a Human Endeavor

4. Fleming hypothesized that the mold produced an antibacterial substance
5. Further tests using broth from pure *Penicillium* cultures lead to the discovery of the first antibiotic, penicillin

Science is a Human Endeavor

6. Fleming continued beyond a lucky "accident" with further scientific investigation to a great discovery
7. "Chance favors the prepared mind" (Louis Pasteur)

Scientific Theory

- A **scientific *theory*** differs in definition from that of everyday usage
  - Many people use the word *theory* to mean *hypothesis*, and “educated guess”

Scientific Theory

- A scientific theory is a general explanation for important natural phenomena
  - It is extensively and reproducibly tested
  - It is more like a principle or natural law (e.g. the atomic, gravitational, and cell theories)
  - If compelling evidence arises, a theory may be modified

Scientific Theory

- New scientific evidence may prompt radical revision of existing theory
- Example: the discovery of *prions…*

Scientific Theory

- Before 1980, all known infectious diseases contained DNA or RNA
- In 1982, Stanley Prusiner showed that the infectious sheep disease *scrapie* is caused by a protein (a “protein infectious particle” or *prion*)

Scientific Theory

- Prions have since been shown to cause “mad cow disease” and diseases in humans
- The willingness of scientists to *revise accepted belief in light of new data* was critical to understanding and expanding the study of prions

Science Is Based on Reasoning

- Inductive Reasoning
  - Used in the development of scientific theories
  - A *generalization* is created from many observations
  - e.g., the cell theory (all living things are made of one or more cells) arises from many observations that all indicate a cellular basis for life

Science Is Based on Reasoning

- Deductive Reasoning
  - Generating *hypotheses* based on a well-supported generalization (such as a theory)
  - e.g., based on the cell theory, any newly discovered organism would be expected to be composed of cells