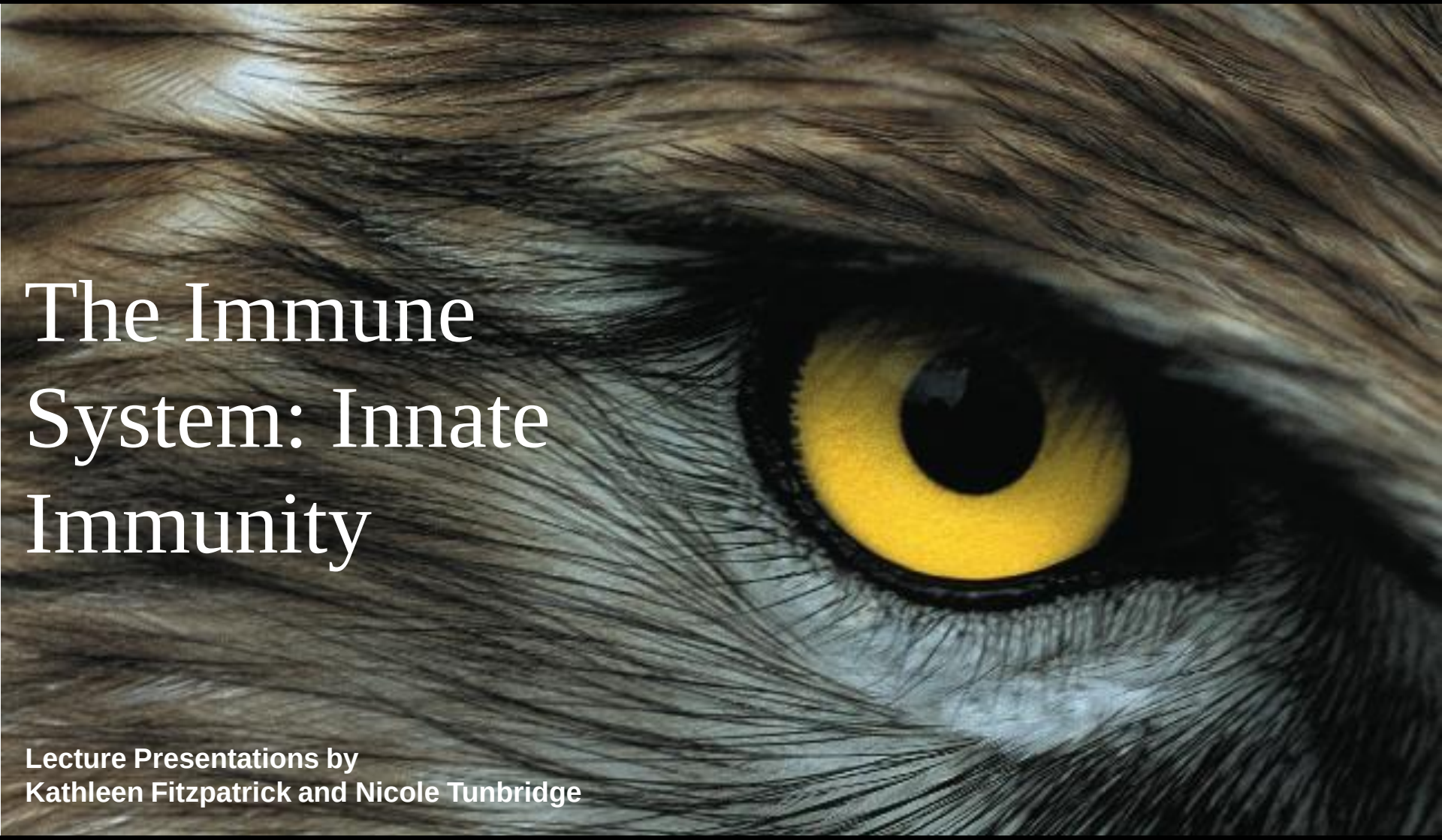
CAMPBELL **BIOLOGY IN FOCUS**

Urry • Cain • Wasserman • Minorsky • Jackson • Reece



The Immune System: Innate Immunity

Lecture Presentations by
Kathleen Fitzpatrick and Nicole Tunbridge

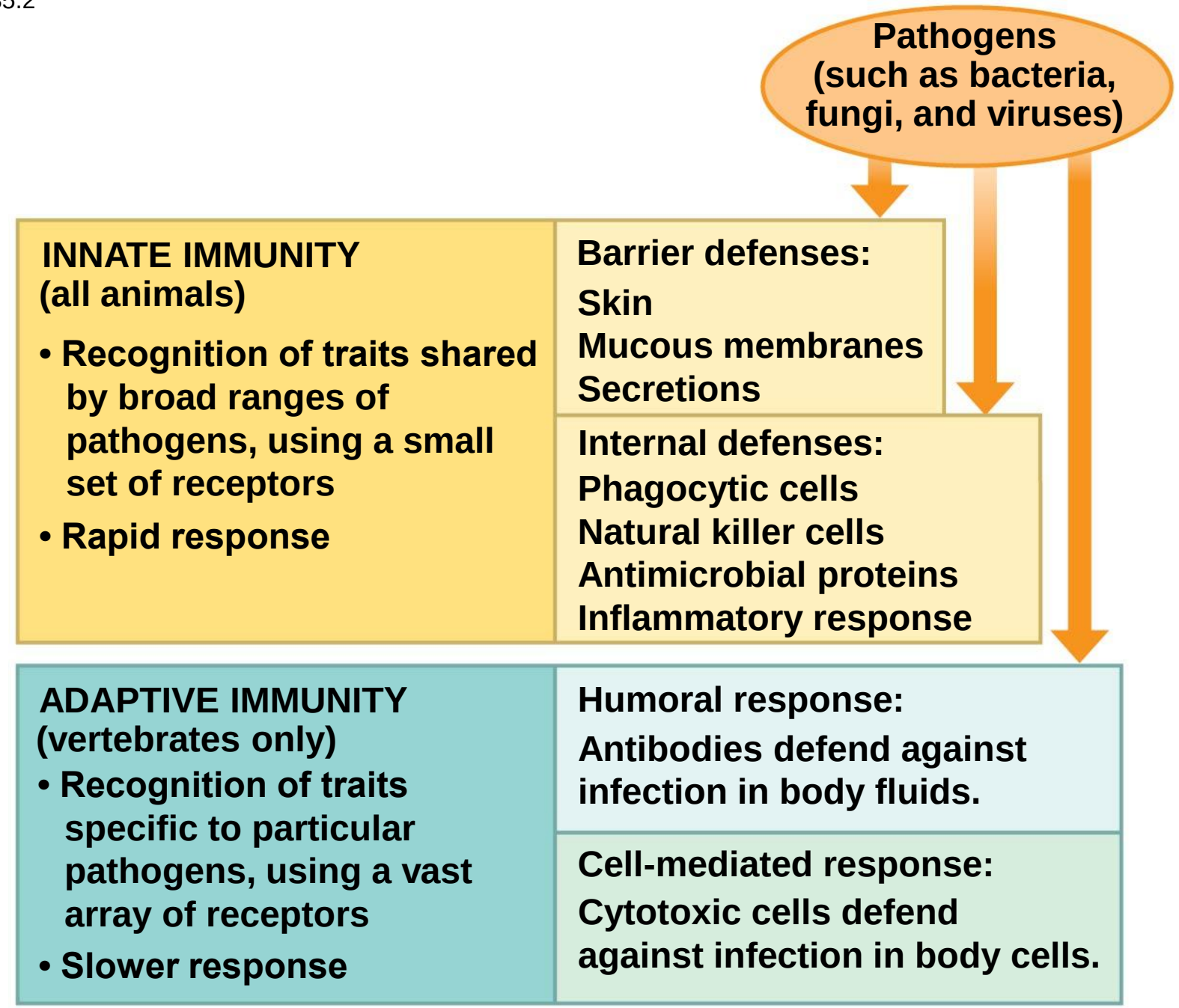
- Innate immunity is present before any exposure to pathogens and is effective from the time of birth
- It involves nonspecific responses to pathogens
- Innate immunity consists of external barriers plus internal cellular and chemical defenses

Overview: Recognition and Response

- **Pathogens**, agents that cause disease, infect a wide range of animals, including humans
- The **immune system** enables an animal to avoid or limit many infections
- All animals have **innate immunity**, a defense that is active immediately upon infection
- Vertebrates also have **adaptive immunity**

- Adaptive immunity, or acquired immunity, develops after exposure to agents such as microbes, toxins, or other foreign substances
- It involves a very specific response to pathogens

Figure 35.2



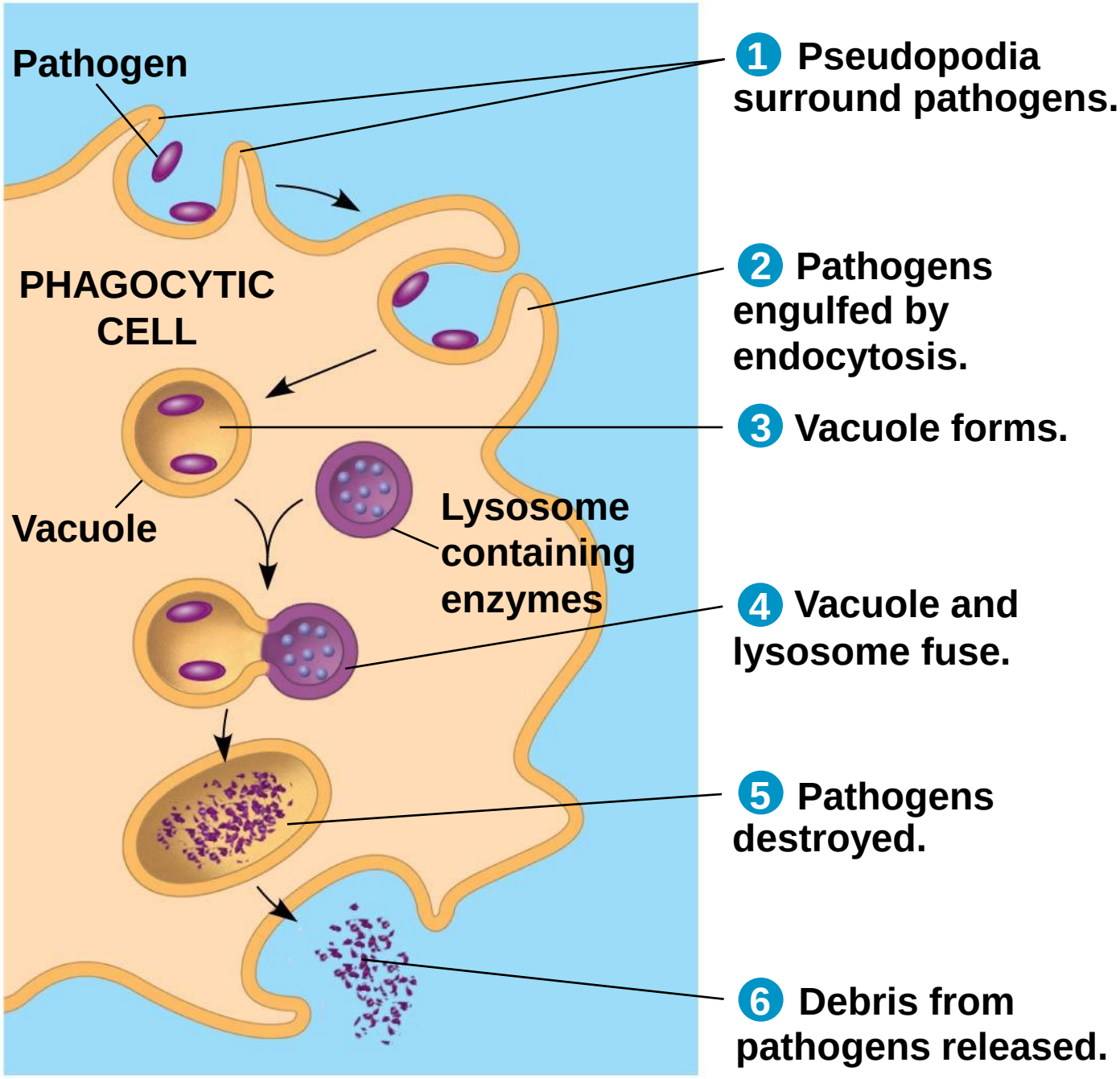
Concept 35.1: In innate immunity, recognition and response rely on traits common to groups of pathogens

- Innate immunity is found in all animals and plants
- In vertebrates, innate immunity is a first response to infections and serves as the foundation of adaptive immunity

Innate Immunity of Invertebrates

- Insects rely on their exoskeleton as a first line of defense against infection
- In the digestive system, the enzyme **lysozyme** breaks down bacterial cell walls, protecting against pathogens ingested along with food
- Hemocytes circulate within hemolymph and carry out **phagocytosis**, the ingestion and breakdown of foreign substances including bacteria

Figure 35.3



- Hemocytes also release antimicrobial peptides that disrupt the plasma membranes of fungi and bacteria
- The immune system recognizes bacteria and fungi by structures on their cell walls
- An immune response is specific for each class of pathogen

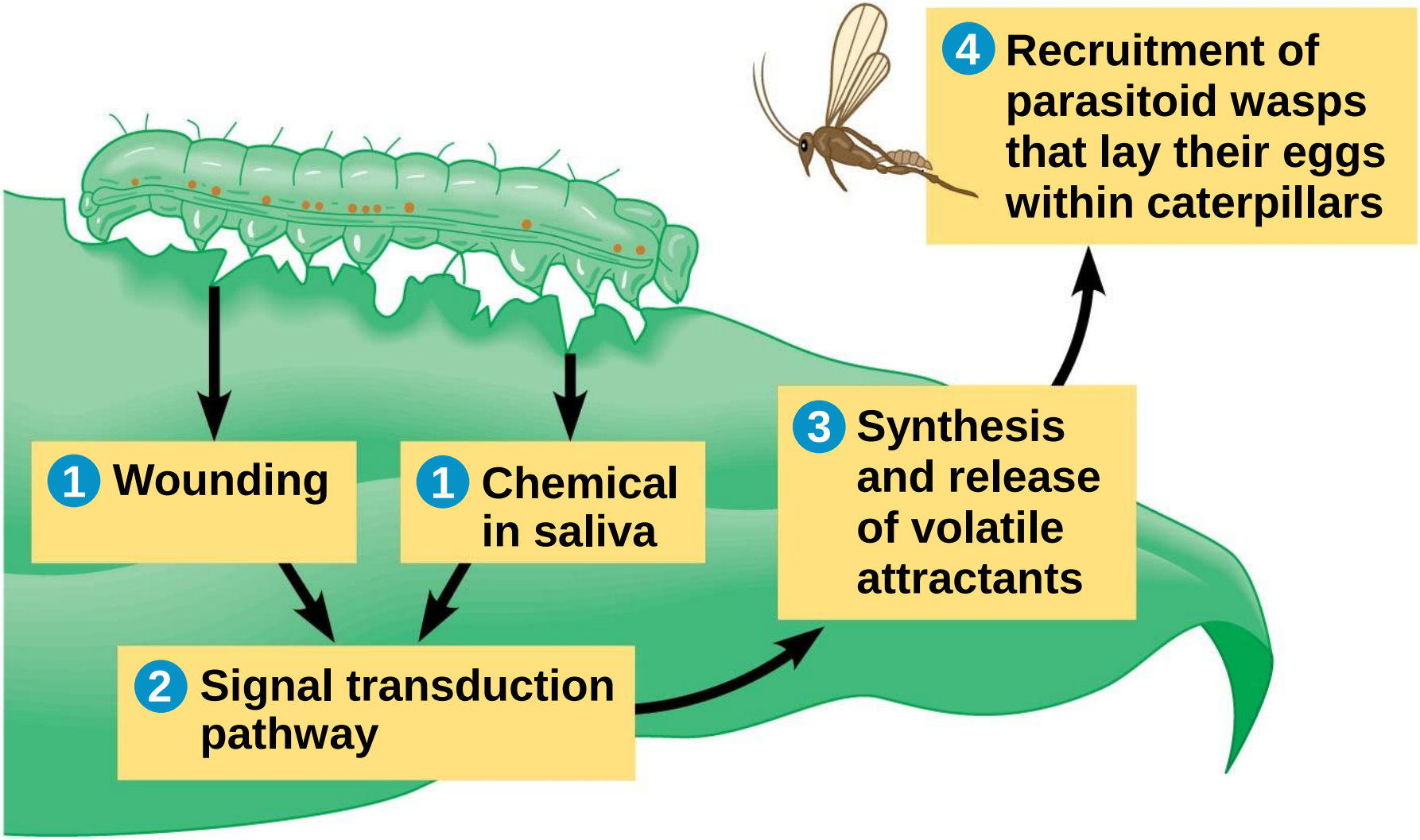
Concept 31.4: Plants respond to attacks by herbivores and pathogens

- Through natural selection, plants have evolved defense systems to deter herbivory, prevent infection, and combat pathogens

Defenses Against Herbivores

- Herbivory, animals eating plants, is a stress that plants face in any ecosystem
- Plants counter excessive herbivory with physical defenses, such as thorns and trichomes, and chemical defenses, such as distasteful or toxic compounds
- Some plants even “recruit” predatory animals that help defend against specific herbivores

Figure 31.23



- Plants damaged by insects can release volatile chemicals to warn other plants of the same species
- *Arabidopsis* can be genetically engineered to produce volatile components that attract predatory mites

Defenses Against Pathogens

- A plant's first line of defense against infection is the barrier presented by the epidermis and periderm
- If a pathogen penetrates the dermal tissue, the second line of defense is a chemical attack that kills the pathogen and prevents its spread
- This second defense system is enhanced by the plant's ability to recognize certain pathogens

Host-Pathogen Coevolution

- A **virulent** pathogen is one that a plant has little specific defense against
- An **avirulent** pathogen is one that may harm but does not kill the host plant

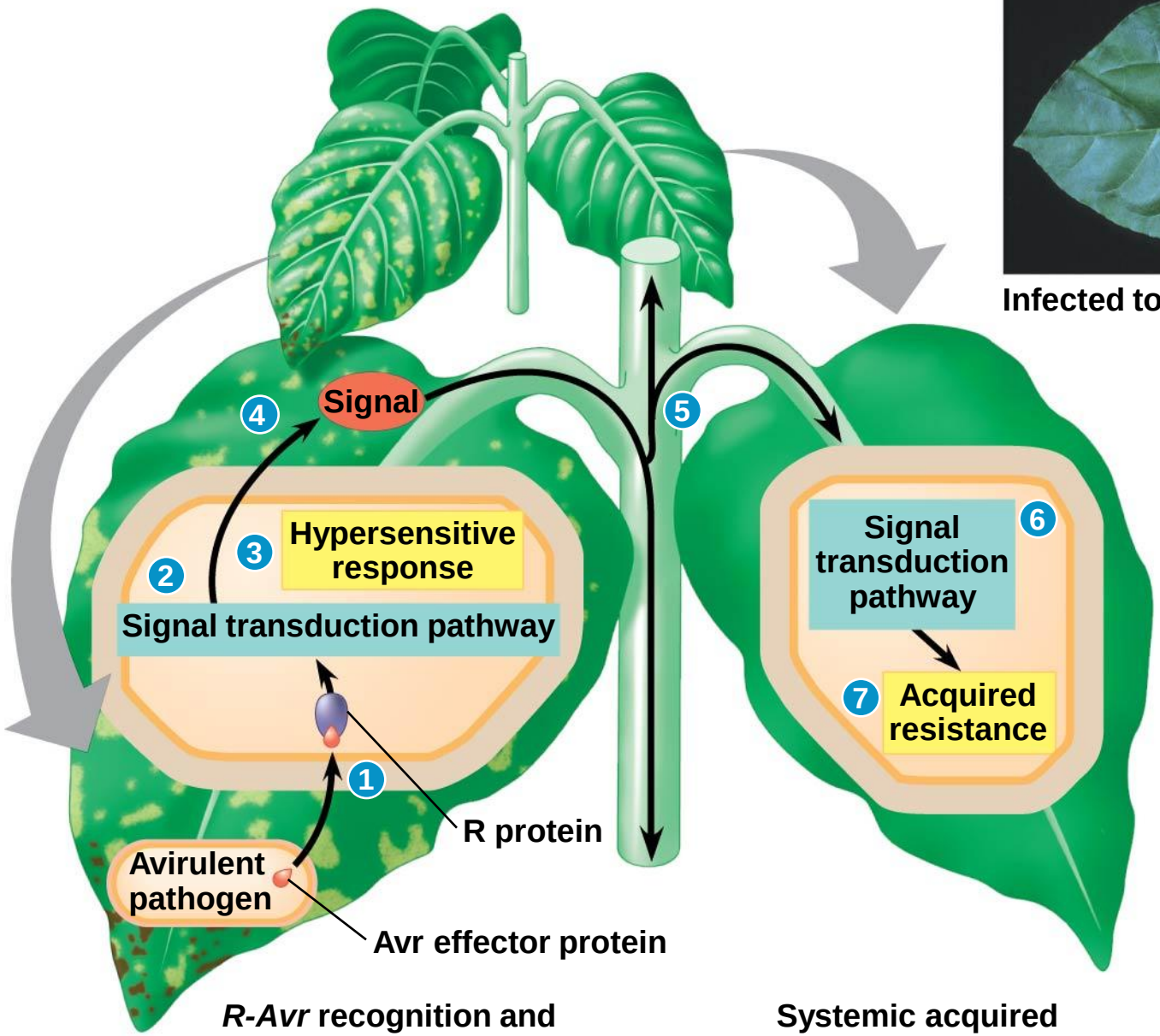
- **Gene-for-gene recognition** involves recognition of effector molecules by the protein products of specific plant disease resistance (*R*) genes
- An R protein recognizes a corresponding molecule made by the pathogen's *Avr* gene
- R proteins activate plant defenses by triggering signal transduction pathways
- These defenses include the hypersensitive response and systemic acquired resistance

The Hypersensitive Response

- The **hypersensitive response**
  - Causes localized cell and tissue death near the infection site
  - Induces production of phytoalexins and PR proteins, which attack the specific pathogen
  - Stimulates changes in the cell wall that confine the pathogen

Figure 31.24

Infected tobacco leaf with lesions



R-Avr recognition and hypersensitive response

Systemic acquired resistance

Figure 31.24a

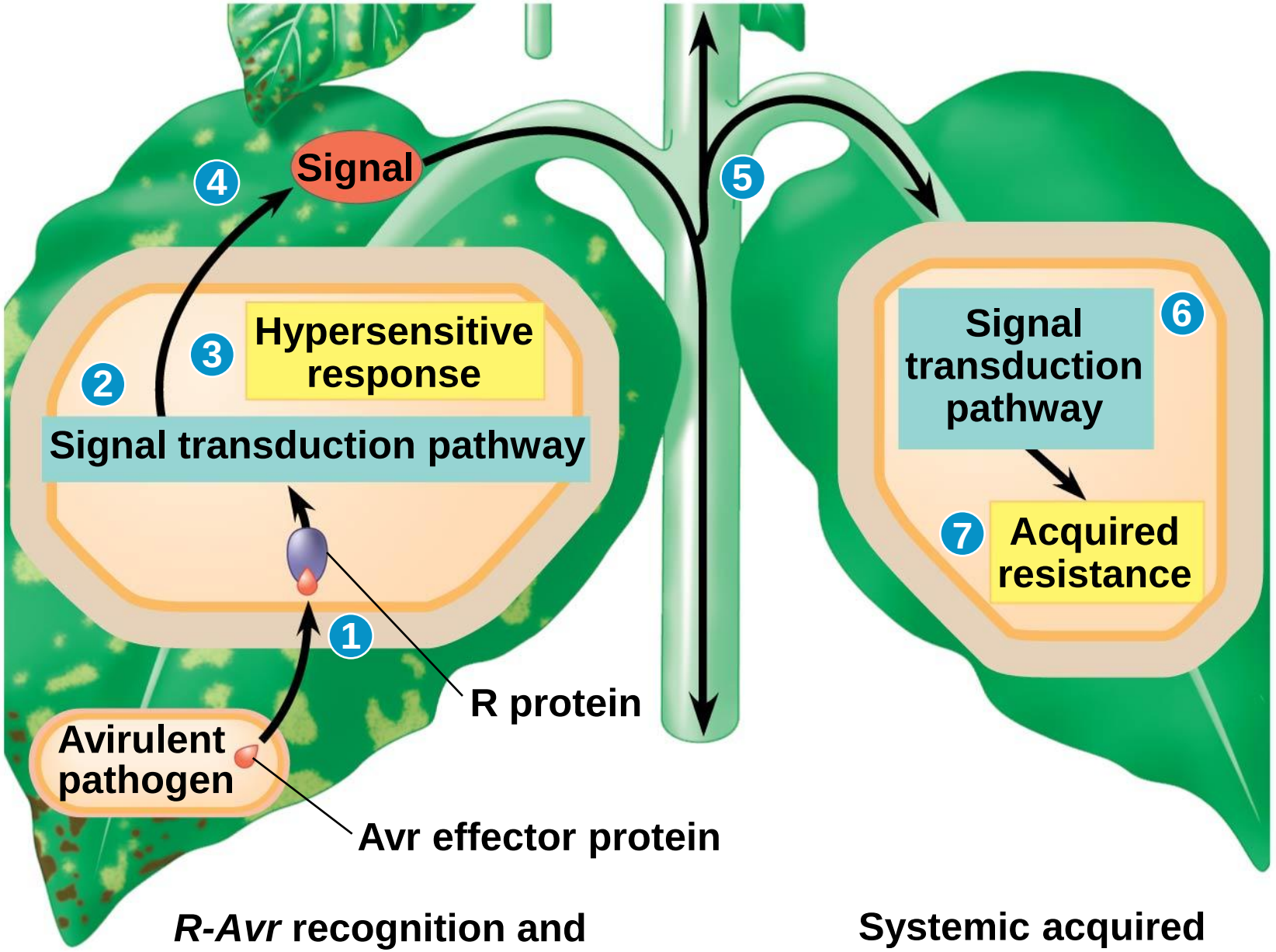


Figure 31.24b

Infected tobacco leaf with lesions

Systemic Acquired Resistance

- **Systemic acquired resistance**
  - Causes plant-wide expression of defense genes
  - Protects against a diversity of pathogens
  - Provides a long-lasting response
- Methylsalicylic acid travels from an infection site to remote areas of the plant where it is converted to **salicylic acid**, which initiates pathogen resistance