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MICROBIOLOGY

WITH DISEASES BY TAXONOMY, THIRD EDITION

Chapter 17 Immunization and Immune Testing

預防接種與免疫測試

學習目標

- Understand the general characteristics of immunization.
- Understand the procedure of antibody-antigen testing.

Immunization

- Two Artificial Methods of Immunity
  - Active immunization
    - Administration of antigens so patient actively mounts a protective immune response
  - Passive immunization
    - Individual acquires immunity through the transfer of antibodies formed by immune individual or animal

Immunization

- Brief History of Immunization
  - Chinese noticed children who recovered from smallpox did not contract the disease again
  - They infected children with material from a smallpox scab to induce immunity
    - This process known as variolation
  - Variolation spread to England and America but was stopped due to risk of death

Immunization

- Brief History of Immunization
  - 1796 – Edward Jenner discovered process of vaccination
  - 1879 – Louis Pasteur developed a vaccine against *Pasteurella multocida*
  - Antibody transfer developed when it was discovered vaccines protected through the action of antibodies

Effect of immunization in reducing prevalence of disease

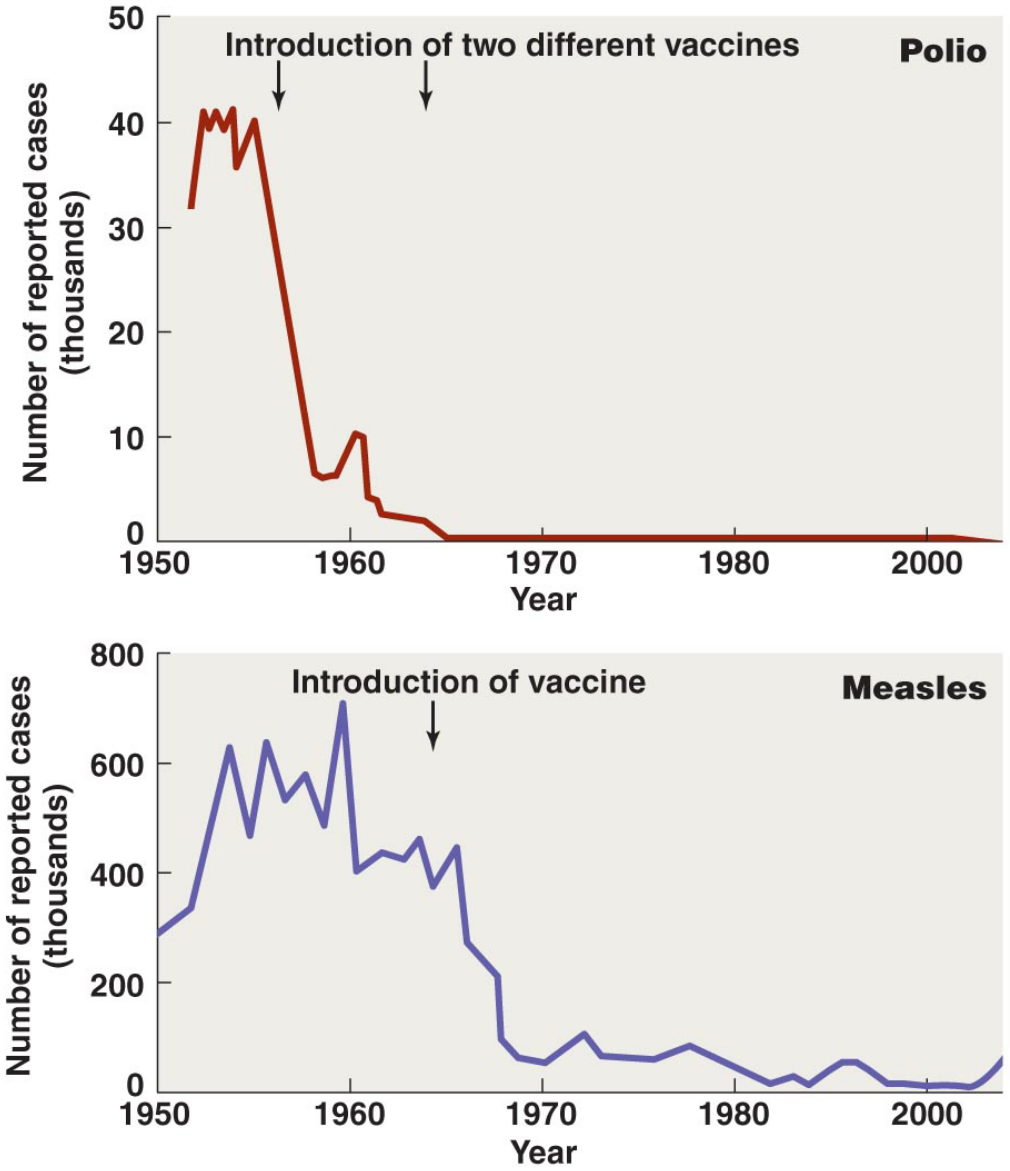


Figure 17.1

Immunization

- Brief History of Immunization
  - Many developing nations do not receive vaccines
  - Effective vaccines not developed for some pathogens
  - Vaccine-associated risks discourage investment in developing new vaccines

Immunization

- Active Immunization
  - Vaccine types
    - Attenuated (live) vaccines 减毒疫苗
      - Use pathogens with reduced virulence
      - Can result in mild infections
      - Active microbes stimulate a strong immune response
      - Modified microbes may retain enough residual virulence to cause disease

Immunization

- Active Immunization
  - Vaccine types
    - Inactivated (killed) vaccines
      - Whole agent vaccines
      - Subunit vaccines
        - Both safer than live vaccines
      - Antigenically weak because microbes don't provide many antigenic molecules to stimulate the immune response
      - Often contain adjuvants
        - Chemicals added to increase effective antigenicity

Immunization

- Active Immunization
  - Vaccine types
    - Toxoid vaccines 類毒素
      - Chemically or thermally modified toxins used to stimulate active immunity
      - Useful for some bacterial diseases
      - Stimulate antibody-mediated immunity
      - Require multiple doses because they possess few antigenic determinants

Immunization

- Active Immunization
  - Vaccine types
    - Combination vaccines
      - Simultaneous administration of antigens from several pathogens
    - Vaccines using recombinant gene technology
      - Research attempts to make vaccines more effective, cheaper, and safer
      - Variety of recombinant DNA techniques used to improve vaccines

Uses of recombinant DNA technology in making vaccines

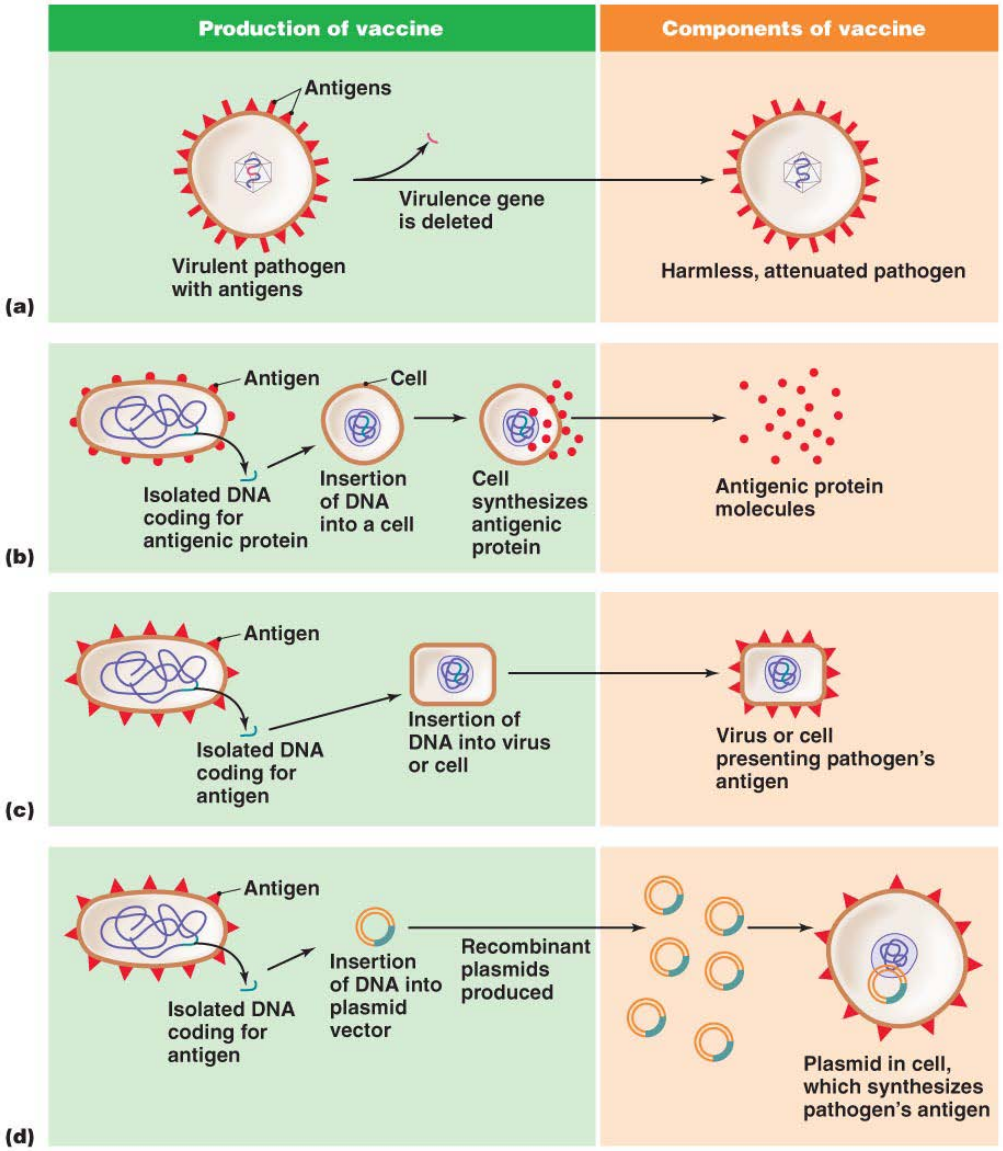


Figure 17.2

Immunization

- Active Immunization
  - Vaccine manufacture
    - Mass-produce many vaccines by growing microbes in culture vessels
    - Viruses are cultured inside chicken eggs
    - Individuals with egg allergies must avoid some vaccines

CDC's recommended immunization schedule

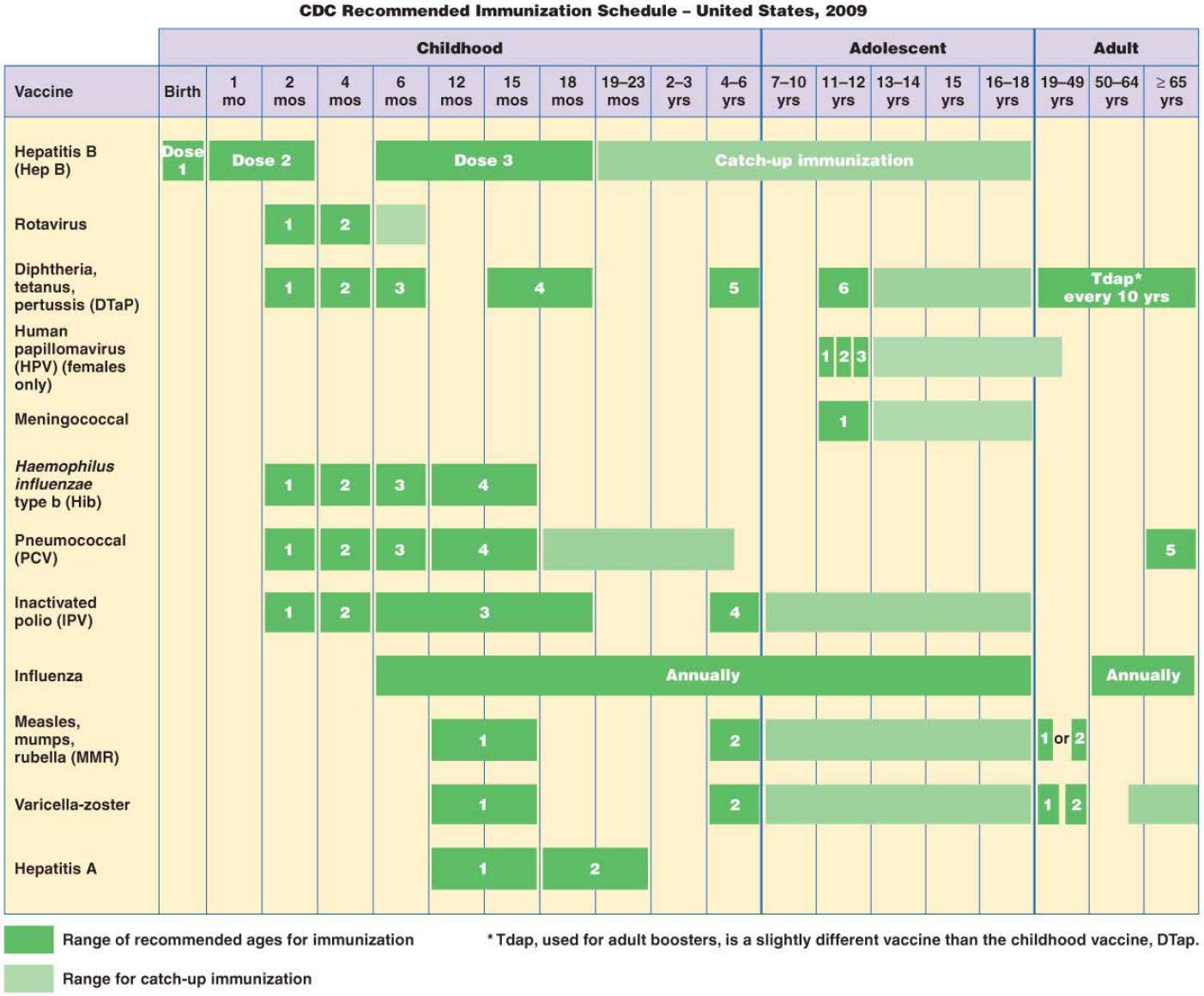


Figure 17.3

Immunization

- Active Immunization
  - Vaccine safety
    - Problems associated with immunization
      - Mild toxicity most common
      - Risk of anaphylactic shock
      - Residual virulence from attenuated viruses
      - Allegations certain vaccines cause autism, diabetes, and asthma
        - Research has not substantiated these allegations

Immunization

- Passive Immunotherapy
  - Administration of antiserum containing preformed antibodies
  - Provides immediate protection against a recent infection or an ongoing disease
  - Antisera have several limitations
    - Contain antibodies against many antigens
    - Can trigger allergic reactions called serum sickness
    - Viral pathogens may contaminate antisera
    - Antibodies of antisera are degraded relatively quickly
  - Limitations are overcome through development of hybridomas

The production of hybridomas

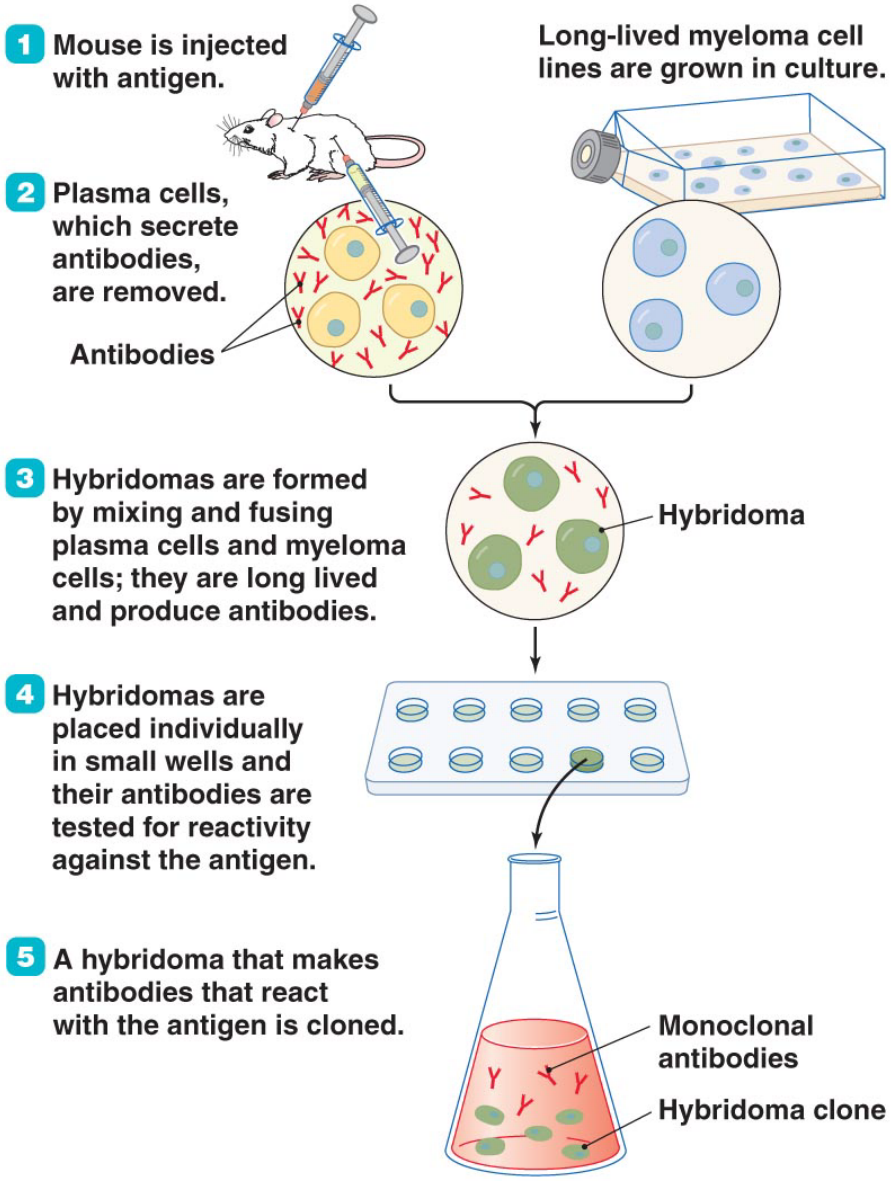


Figure 17.4

Immunity by active immunization and passive immunotherapy

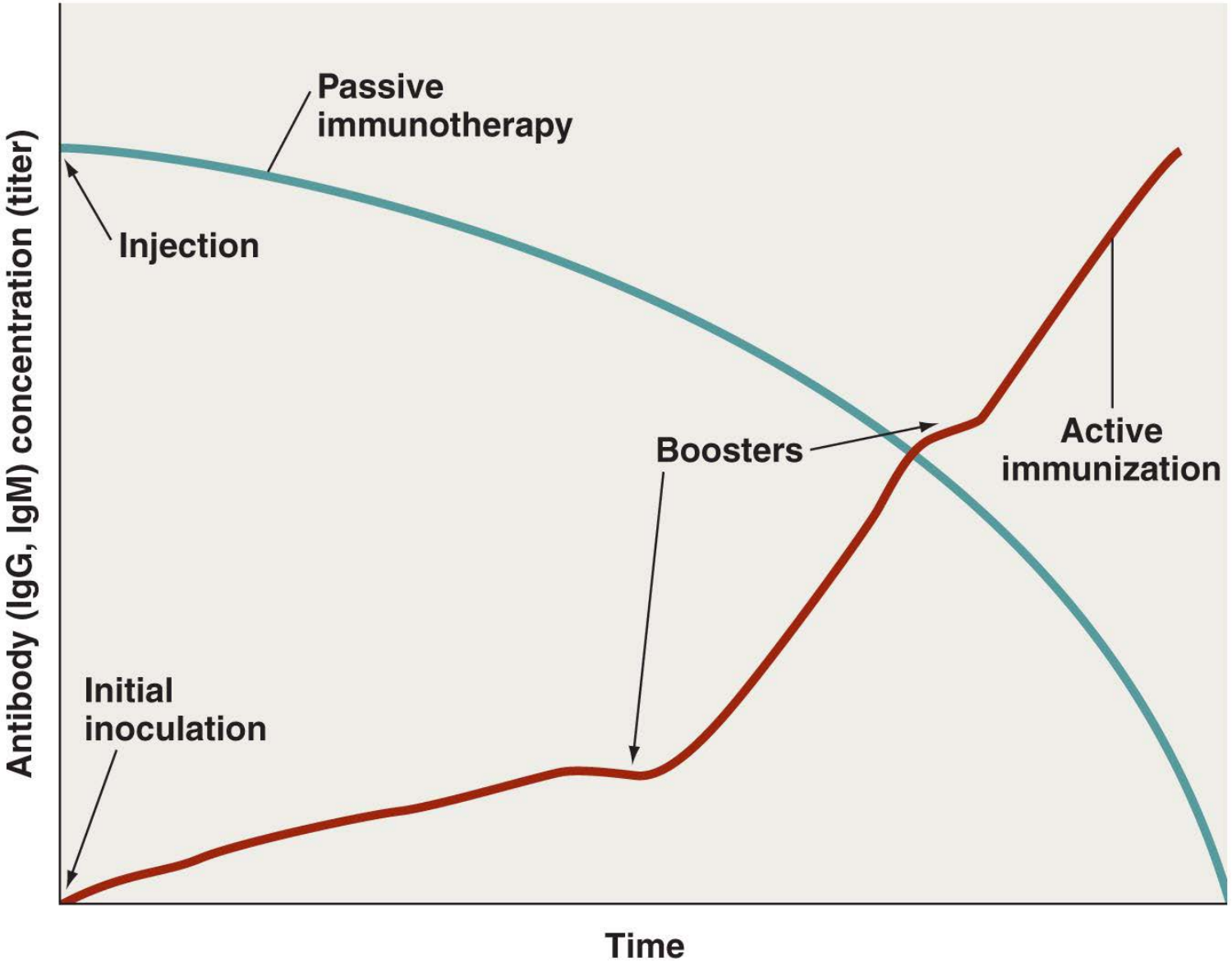


Figure 17.5

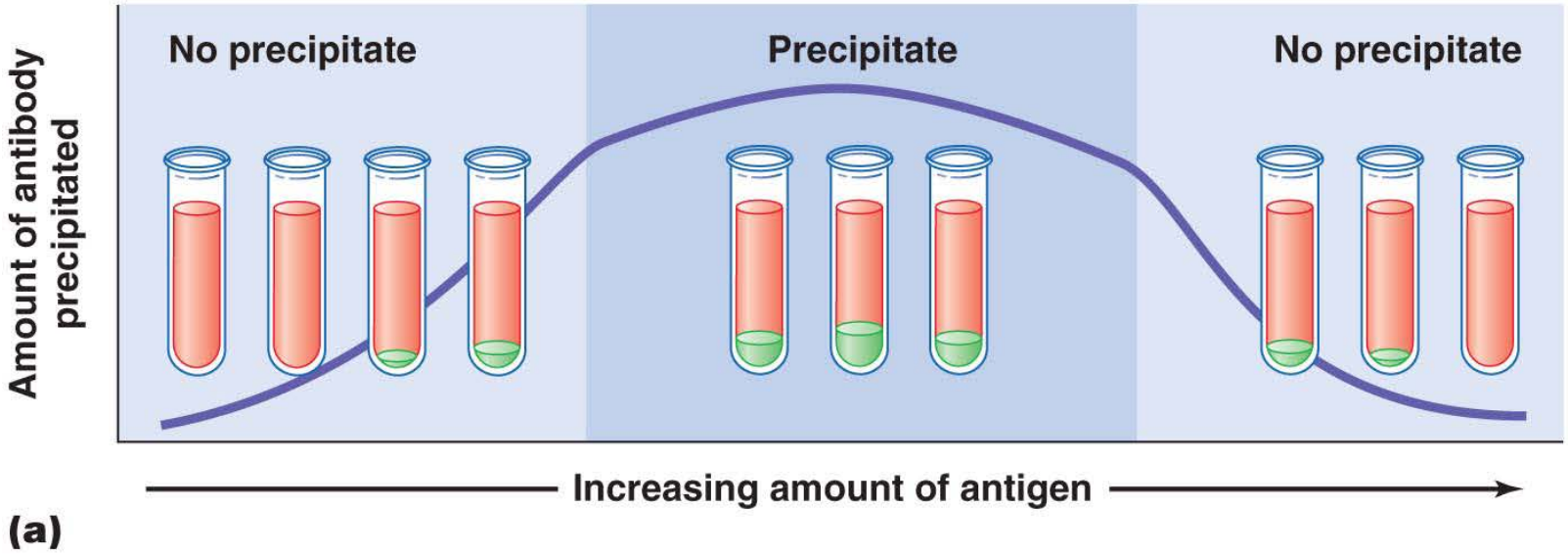
Immune Testing

- Uses serology
  - Study and diagnostic use of antigen-antibody interactions in blood serum
- Two categories of immune testing
  - Direct testing
    - Looking for presence of antigens
  - Indirect testing
    - Look for antibodies in blood that have formed against antigens
- Test chosen based on the suspected diagnosis, cost, and speed with which a result can be obtained

Immune Testing

- Precipitation Tests 沈澱測試
  - One of the easiest of serological tests
  - Antigens and antibody mixed in the proper proportion form large complexes called precipitates
  - Immunodiffusion
    - Determines optimal antibody and antigen concentrations

Characteristics of precipitation reactions



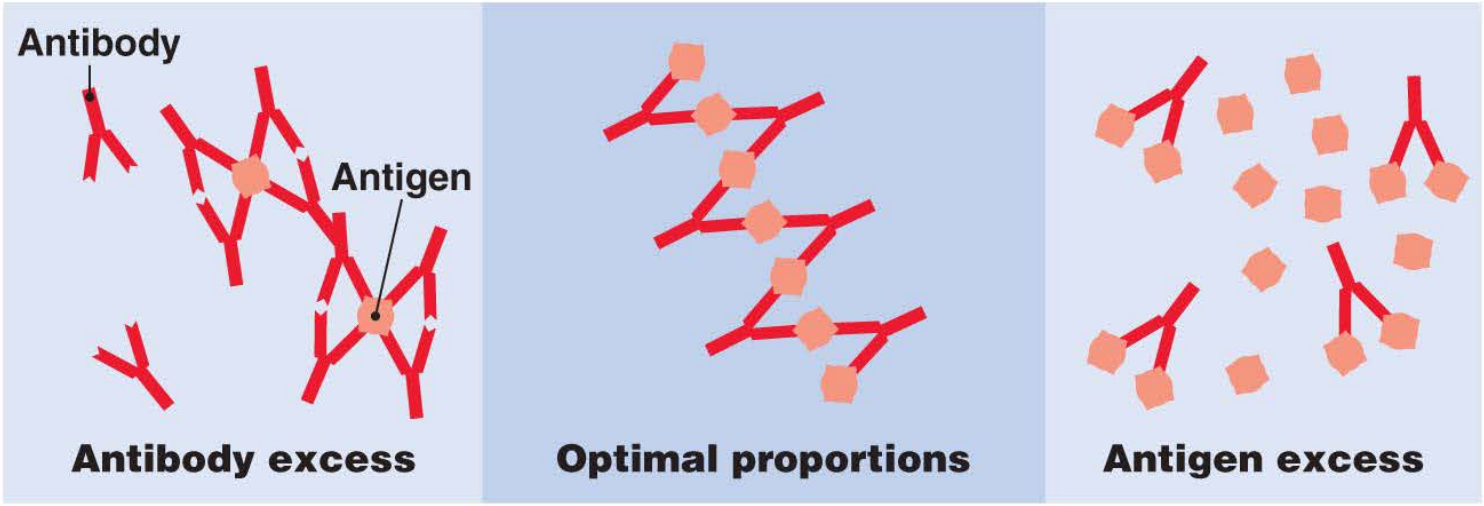
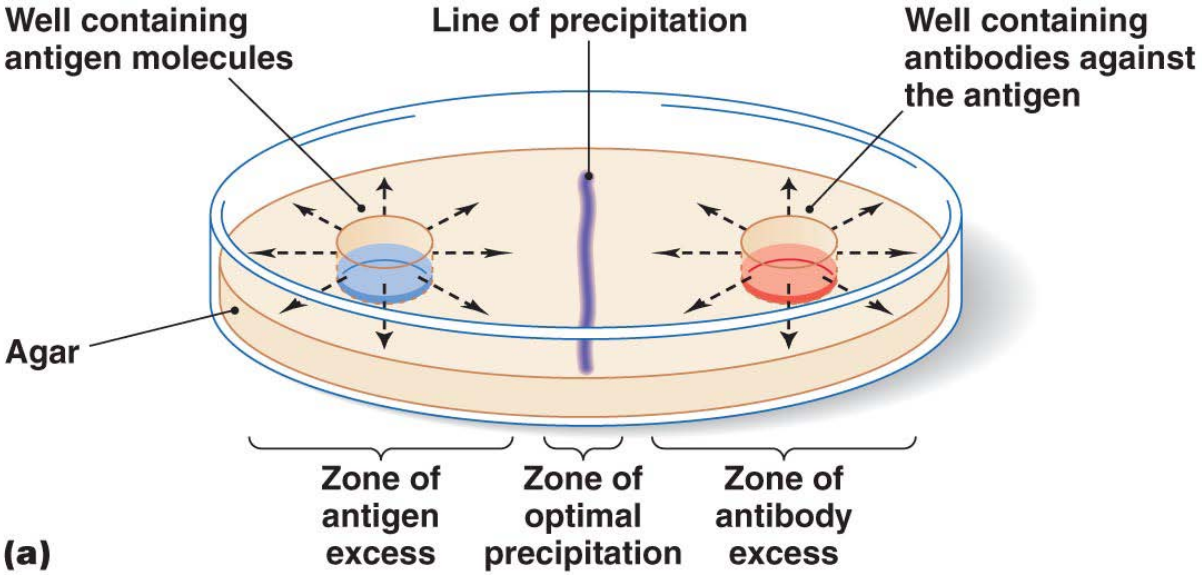


Figure 17.6

Immunodiffusion, a type of precipitation reaction



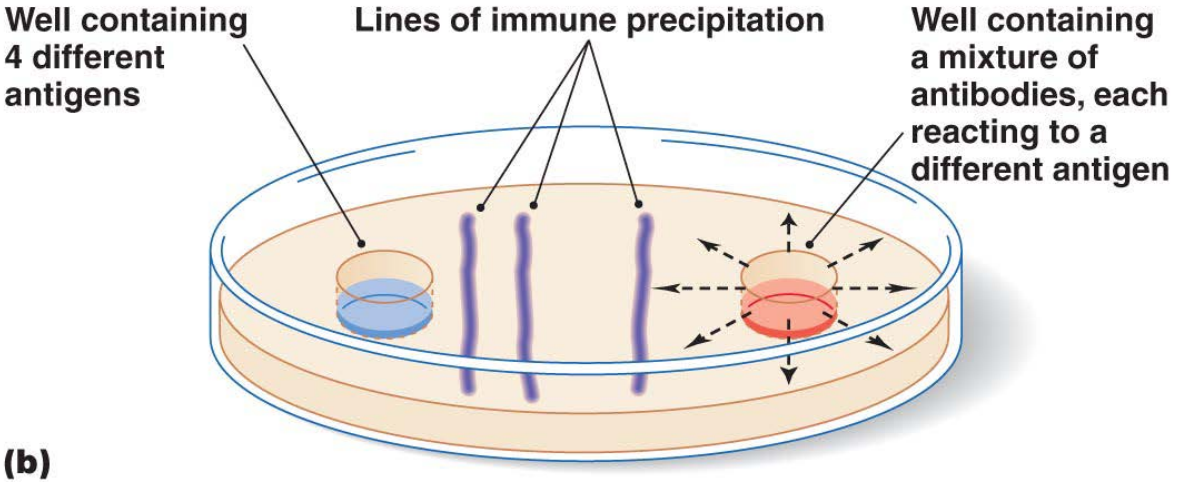
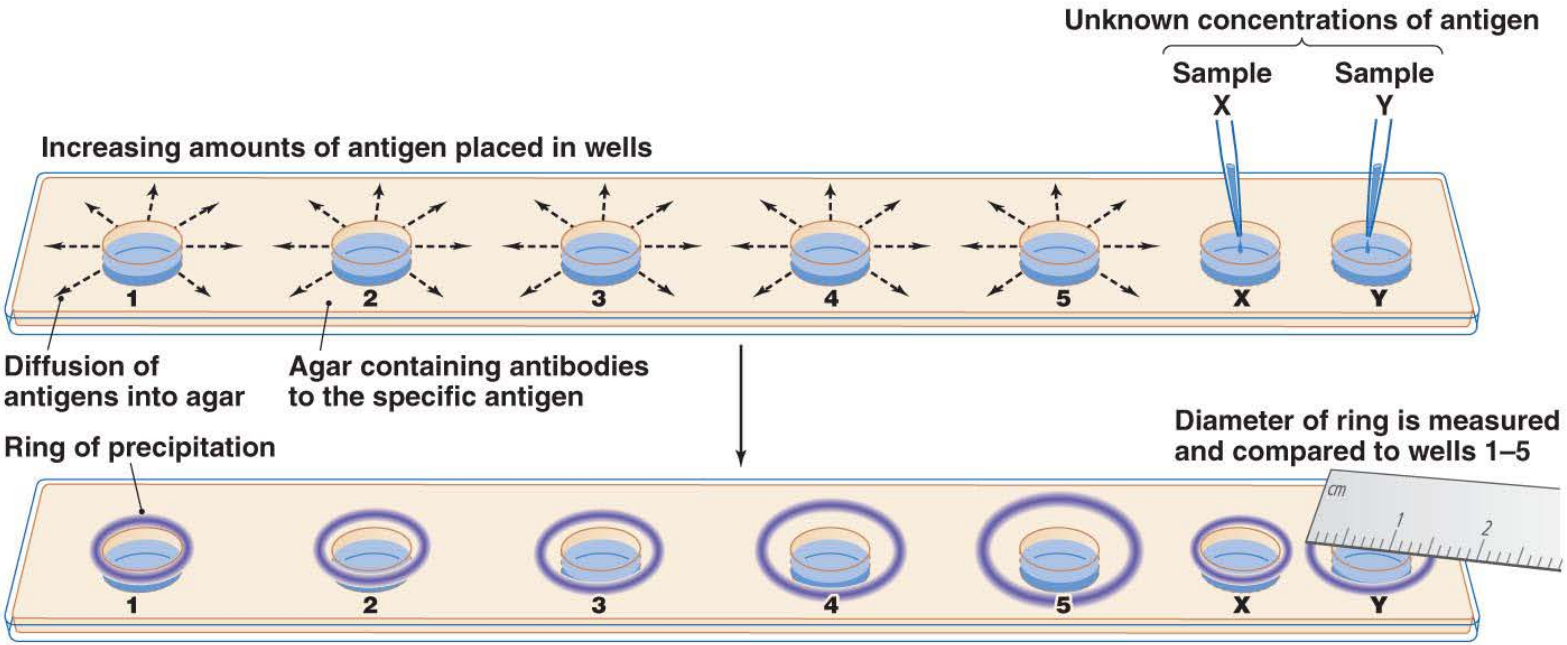


Figure 17.7

Radial immunodiffusion



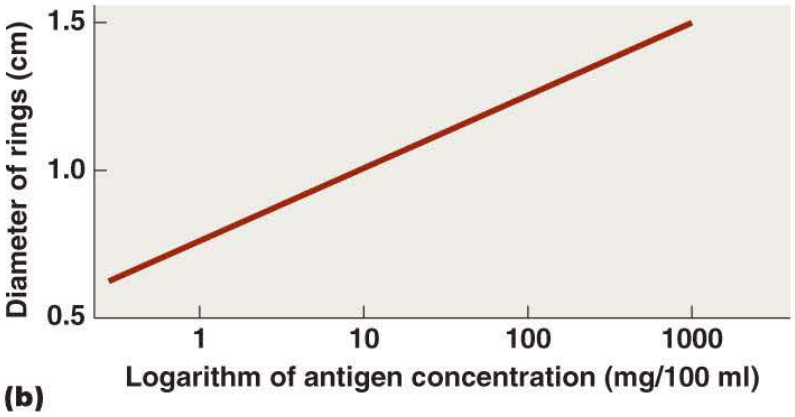
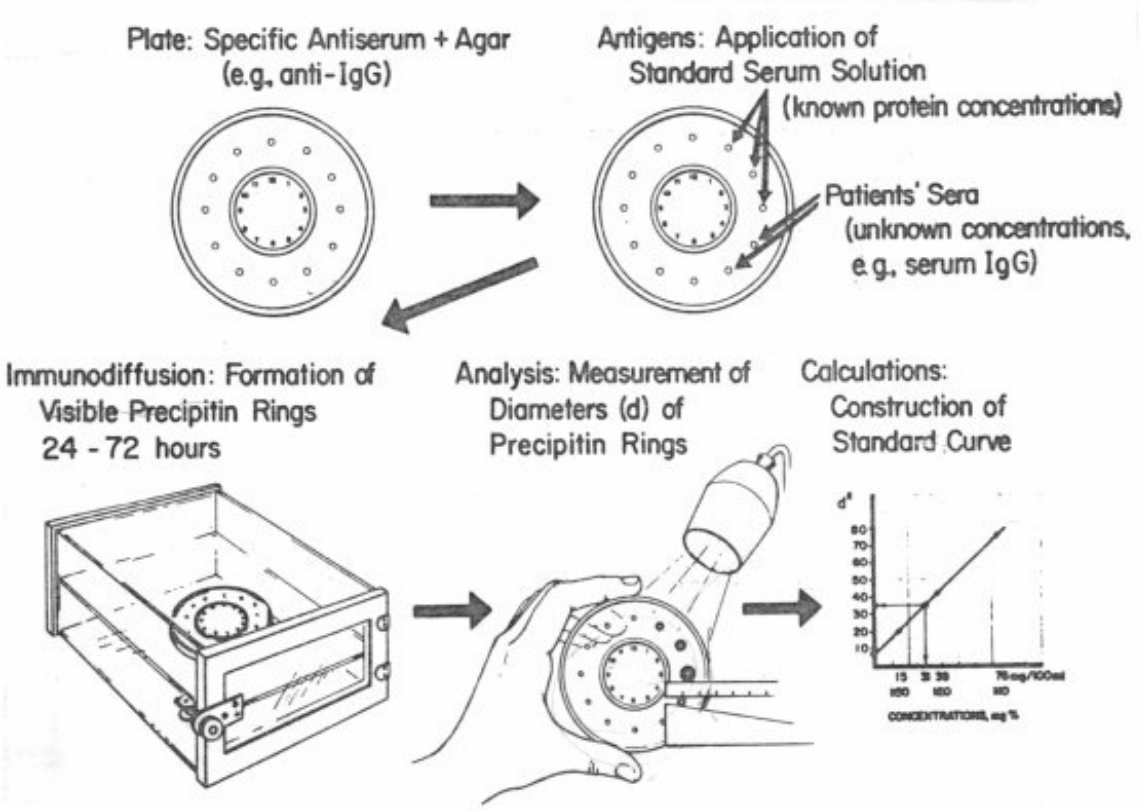


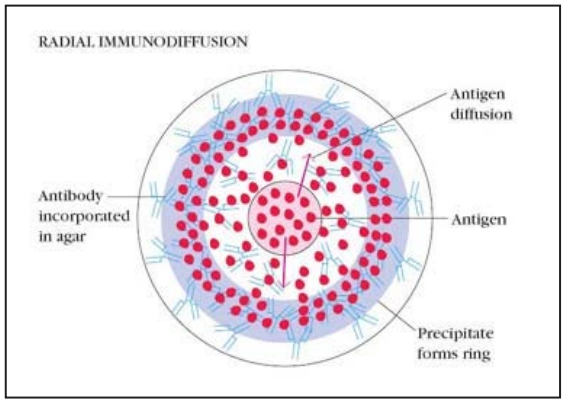
Figure 17.8

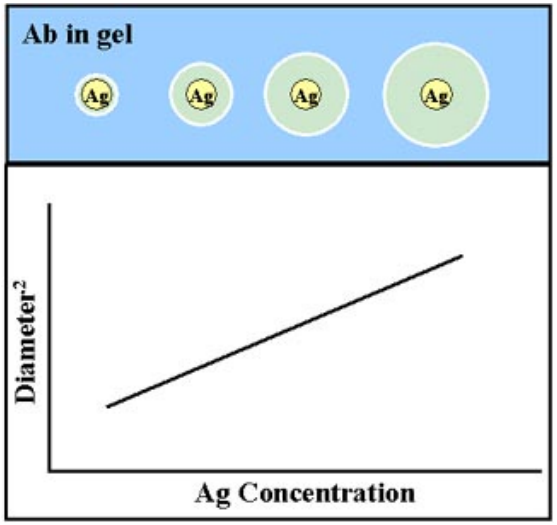
Immune Testing

- Precipitation Tests
  - Radial immunodiffusion 輻射免疫擴散
    - Used to measure specific antibodies in a person's serum
    - Produces anti-antibodies
    - The human antibodies are the "antigen" in the test, and the antibody is anti-human antibody

Radial immunodiffusion



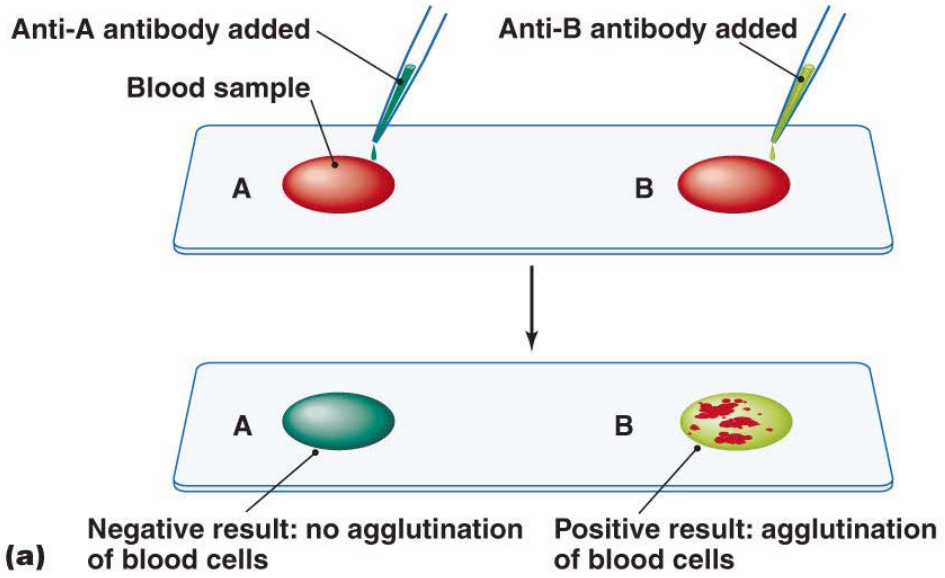




Immune Testing

- Agglutination Tests 凝集測試
  - Agglutination occurs due to the cross-linking of antibodies with particulate antigens
    - Agglutination is the clumping of insoluble particles
    - Precipitation involves the aggregation of soluble molecules
  - Reactions are easy to see and interpret with the unaided eye
  - Hemagglutination
    - Agglutination of red blood cells
    - Can be used to determine blood type

Use of hemagglutination to determine blood types



(a)

(b)

Figure 17.9

The use of agglutination to quantify antibody in a sample

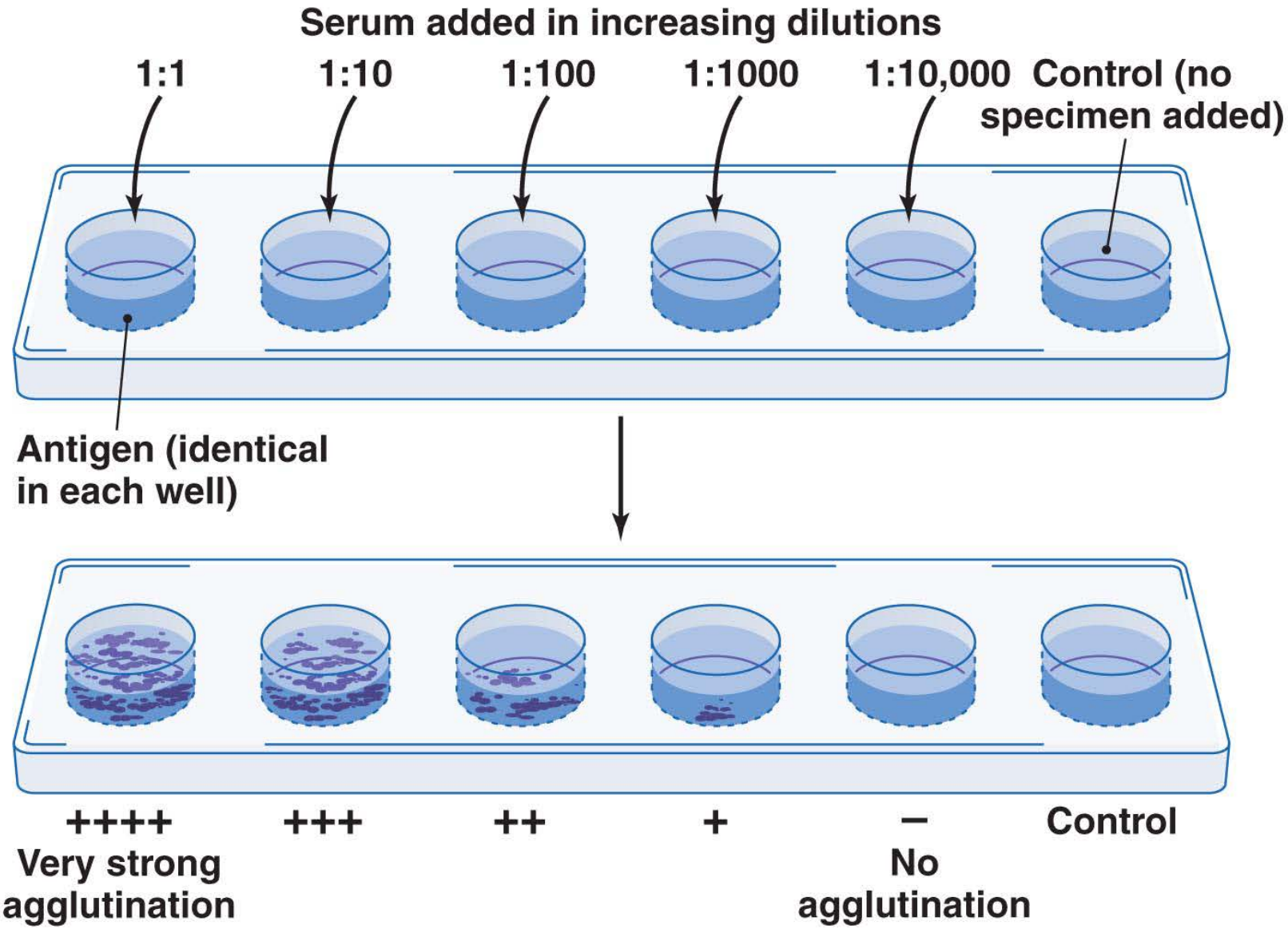


Figure 17.10

Immune Testing

- Neutralization Tests 中和測試
  1. Viral neutralization
     - Cytopathic effect 細胞病變效應
       - Viruses introduced into appropriate cell cultures will kill the cells
     - Ability of virus to kill culture cells is neutralized when virus is first mixed with antibodies against it
     - Absence of cytopathic effect indicates presence of antibodies
     - Test can identify whether individual has been exposed to a particular virus or viral strain

Immune Testing

- Neutralization Tests
  2. Viral hemagglutination inhibition test
     - Useful for viruses that *aren't* cytopathic
     - Based on viral hemagglutination
       - Ability of viral surface proteins to clump red blood cells
     - Individual's serum will stop viral hemagglutination if the serum contains antibodies against the specific virus
     - Commonly used to detect antibodies against influenza, measles, and mumps

Immune Testing

- The Complement Fixation Test 補體固著測試
  - Based on generation of membrane attack complexes during complement activation
  - Used to detect the presence of specific antibodies in an individual's serum
  - Can detect antibody amounts too small to detect by agglutination

Immune Testing

- Labeled Antibody Test
  - Uses antibody molecules linked to some “label” that enables them to be easily detected
  - Used to detect either antigens or antibodies

Immune Testing

- Labeled Antibody Test 標定抗體測試
  - Fluorescent antibody tests
    - Use fluorescent dyes as labels
    - Fluorescein is one dye used in these tests
    - Fluorescein-labeled antibodies used in two types of tests
      - Direct fluorescent antibody tests
      - Indirect fluorescent antibody tests

The direct fluorescent antibody test

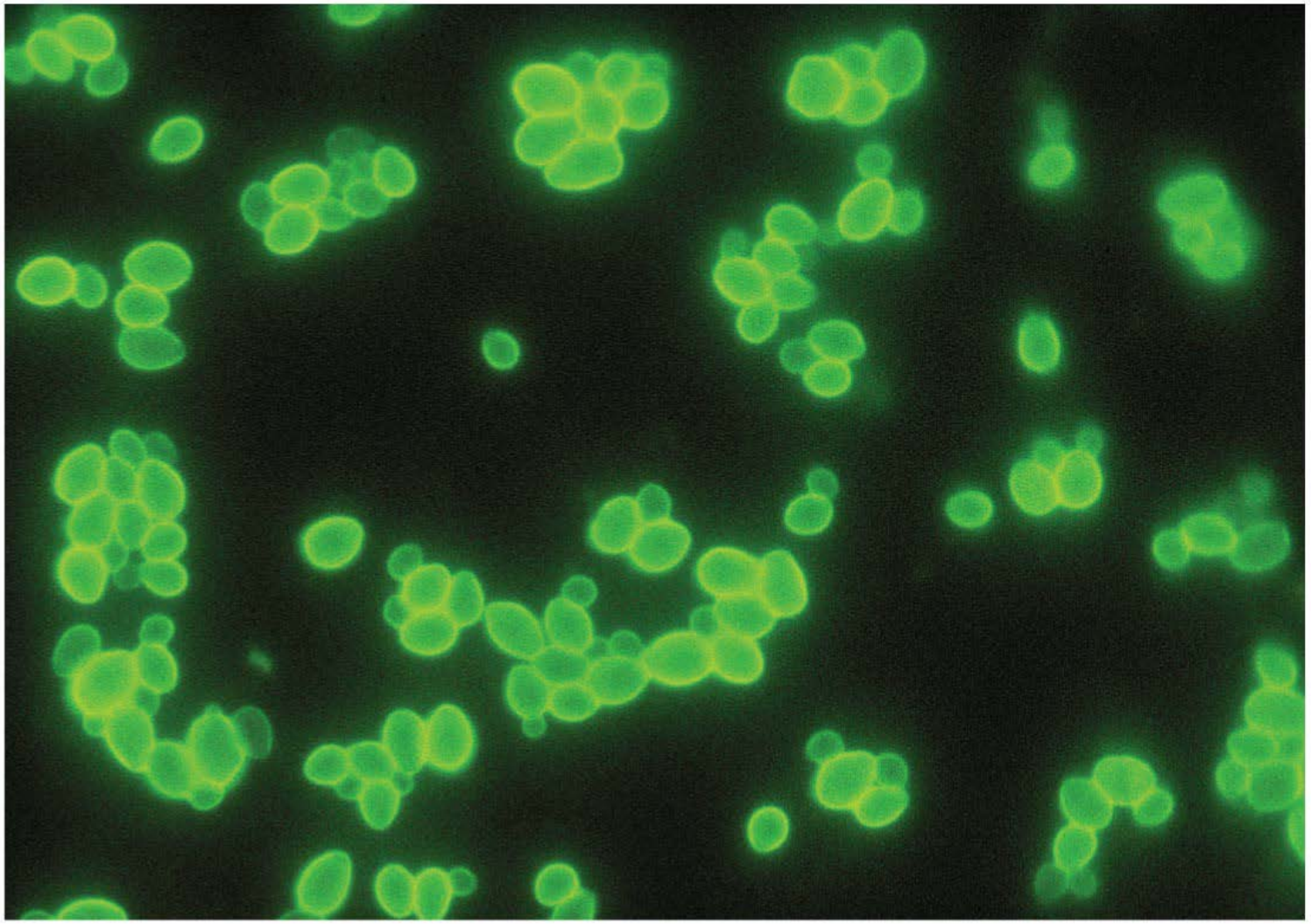


Figure 17.11

The indirect fluorescent antibody test

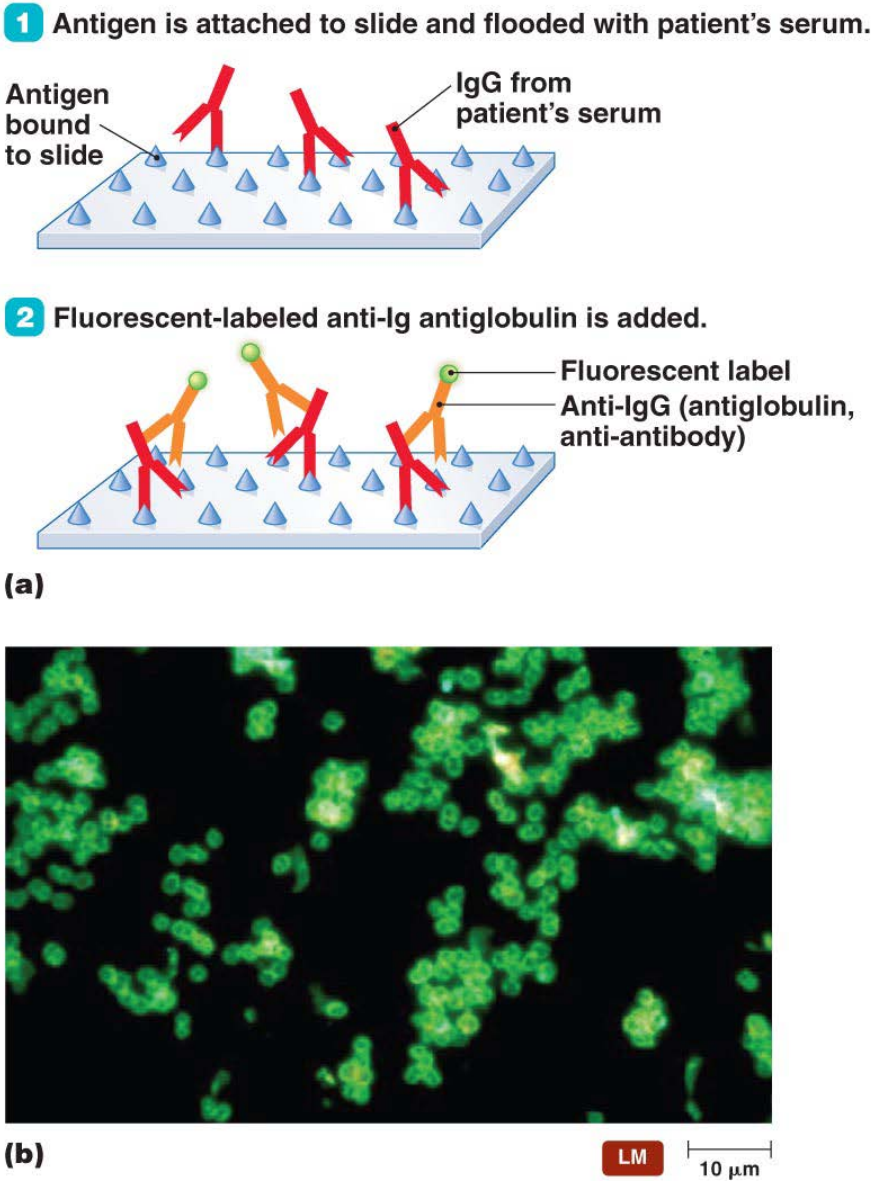
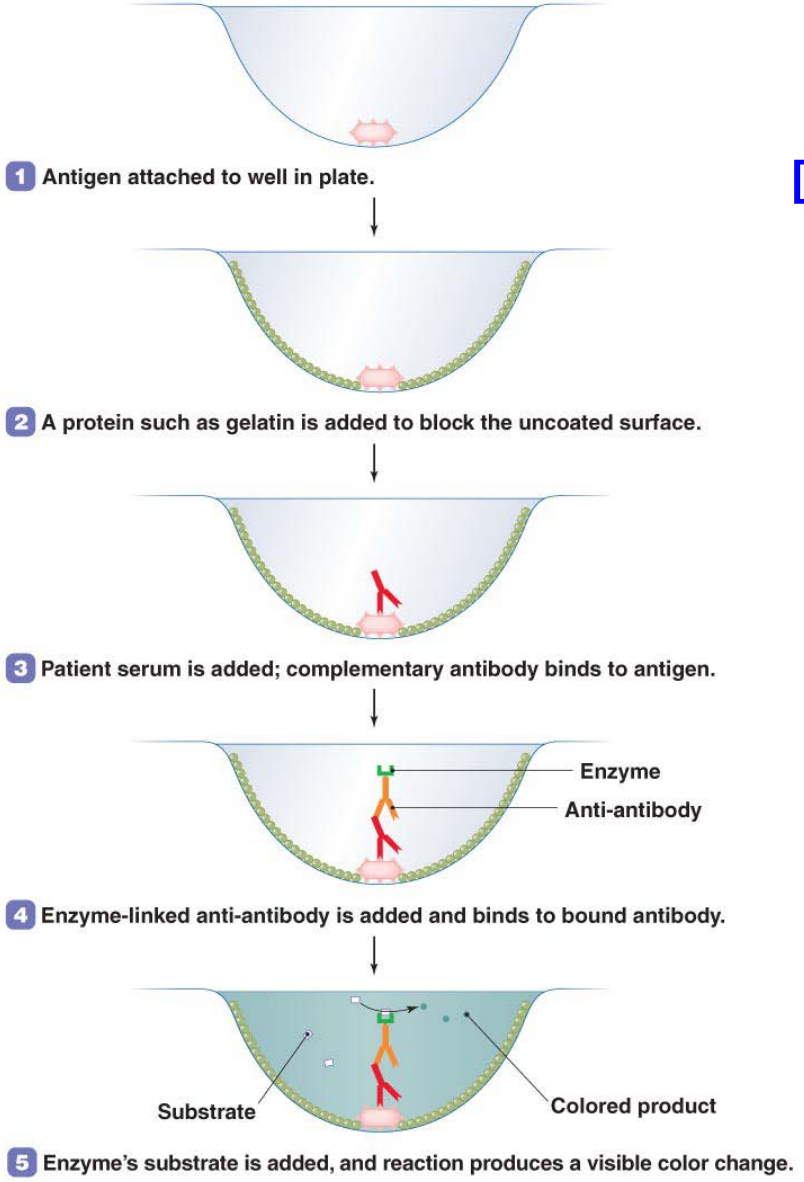


Figure 17.12

Immune Testing

- Labeled Antibody Test
  - ELISA
    - Stands for enzyme-linked immunosorbent assay
    - Uses an enzyme as the label
      - Reaction of enzyme with its substrate produces a colored product indicating a positive test
    - ELISA is commonly used to detect the presence of antibodies in serum

The enzyme-linked immunosorbent assay



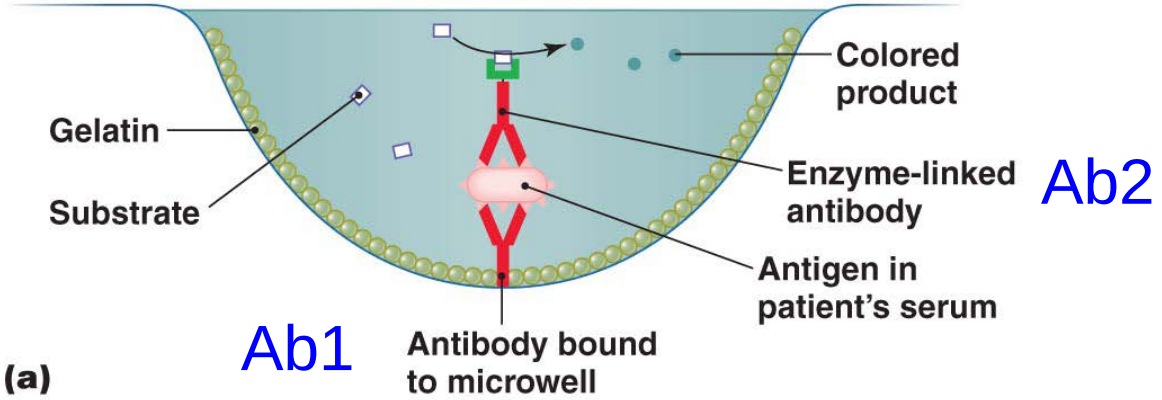
Direct ELISA

Figure 17.13

Immune Testing

- Labeled Antibody Test
  - Antibody sandwich ELISA
    - Modification of the ELISA technique
    - Commonly used to detect antigen
      - Ab1 + Ag + Ab2
      - Ab1: capturing Ab
      - Ab2: detection Ab
    - Antigen being tested for is “sandwiched” between two antibody molecules

An antibody sandwich ELISA



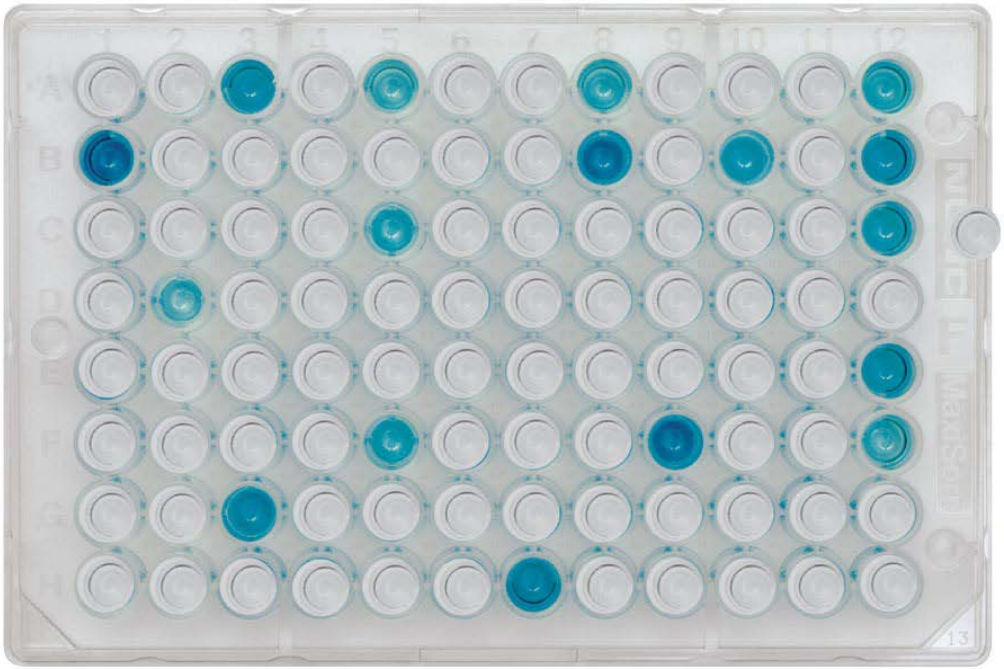


Figure 17.14

Immune Testing

- Labeled Antibody Test
  - ELISA
    - Advantages of the ELISA
      - Can detect either antibody or antigen
      - Can quantify amounts of antigen or antibody
      - Easy to perform and can test many samples quickly
      - Plates coated with antigen and gelatin can be stored for later testing

Immune Testing

- Labeled Antibody Test
  - Western blot test
    - Technique to detect antibodies against multiple antigens
    - Can detect more types of antibodies and is less subject to misinterpretation than other tests

A western blot

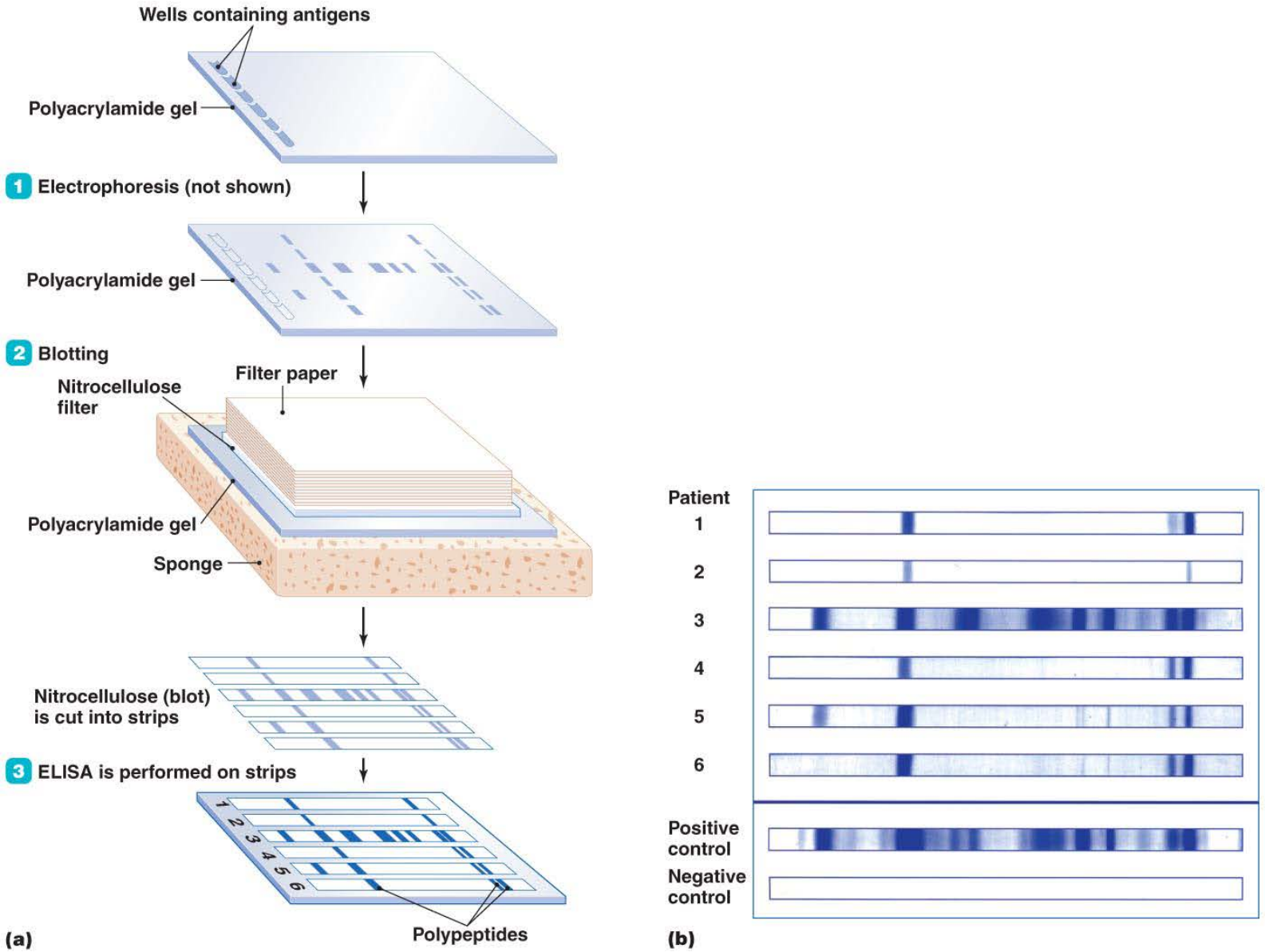


Figure 17.15

Immune Testing

- Recent Developments in Antibody-Antigen Immune Testing
  - Simple immunoassays that give results in minutes
  - Useful in determining a preliminary diagnosis
  - Immunofiltration and immunochromatography are most common
  - Immunofiltration
    - Rapid ELISA that uses antibodies bound to membrane filters rather than polystyrene plates
    - Membrane filters have large surface area, making the assay quicker to complete

Immune Testing

- Recent Developments in Immune Testing
  - Immunochromatography
    - Very rapid and easy to read ELISAs
    - Antigen solution flows through a porous strip, where it encounters labeled antibody
    - Visible line produced when antigen-antibody immune complexes encounter antibody against them
    - Used in pregnancy testing to detect human chorionic growth hormone

Immunochromatographic dipstick

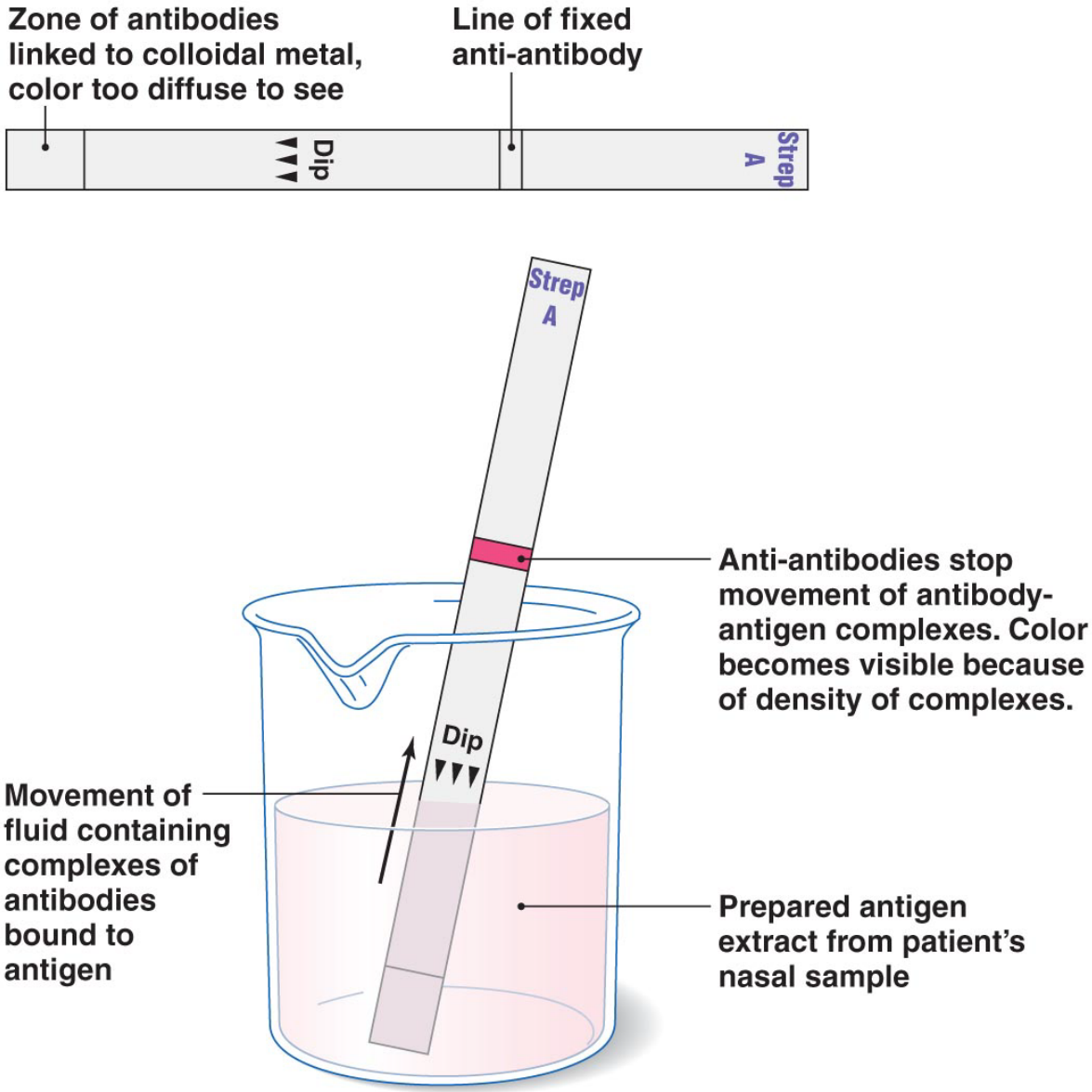


Figure 17.16

End of Chapter