**The Invisible Enemies: Infectious Diseases and Pathogens**[Exploring the Cellular and Molecular Pathology of Human Diseases: A Case-Based Approach]

*Transcript updated on March 6, 2024*

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| **Slide 1** | *Title slide* |
| **Slide 2** | In this module, we will begin with an introduction to the immune system. We will then shift our focus to infectious agents and how they interact with the human body. Finally, we will further our understanding through a case study analysis. |
| **Slide 3** | Our immune systems consist of innate and adaptive immunity to battle infectious agents.  Innate immunity responds quickly, but only to a limited number of pathogens. Adaptive immunity is slower to react but can respond to an infinite variety of pathogens. The immune system can be categorized into humoral or cell-mediated immunity.  Treating infectious disease is most effective when the site of infection and specific infectious agents have been identified. Clinical signs and symptoms are the first step in identification. For instance, a cough is usually indicative of a respiratory infection, while vomiting or diarrhea suggests a gastrointestinal infection. |
| **Slide 4** | There are various classes of infectious agents.  Ectoparasites include ticks, fleas, and lice, which attach to and inhabit the skin. They may cause disease directly or act as vectors for other organisms. For example, a deer tick acts as a vector to transmit Lyme disease caused by the bacterium *Borrelia burgdorferi*.  Fungi are an important part of healthy microbiota but often act as opportunistic pathogens in patients with weakened immune systems.    Bacteria are often classified by their shape. There are three classifications of shape: cocci, which means round; bacilli, which means rod-like; and spirochetes, which means spiral-shaped. Bacteria can also be classified based on their response to gram staining. Gram-positive bacteria possess a thick cell wall and retains the stain. In contrast, gram-negative bacteria have a thin cell wall and do not retain the stain. Normal bacterial flora may become pathogenic if immune defenses are down. |
| **Slide 5** | Viruses are obligate intracellular infectious agents and must overtake the genetic apparatus of host cells to replicate. Viral genomes may be single-stranded or double-stranded, DNA or RNA, and are surrounded by a capsid. A capsid is a protein coat that protects the viral genome. Additionally, viruses may have a lipid envelope. Illness caused by viruses can be acute, chronic or latent. Some viruses may even transform host cells into neoplastic cells. For instance, HPV could cause cervical cancer.  Prions are infectious proteins developed from an abnormal form of a normal host protein. Prions induce host proteins to undergo conformational changes, which confers resistance to degradation. Examples of infectious diseases involving prions include Creutzfeldt-Jakob disease and ‘Mad Cow’ disease. |
| **Slide 6** | Infectious agents can cause disease by multiple mechanisms:   * Firstly, they can cause cell death through direct contact. * Infectious agents could also produce toxins or enzymes that lead to disease. * They could pathologically trigger the host immune response. * Finally, infectious agents can disturb the normal physiological functions of organs or organelles.     The host will in turn attempt multiple methods to prevent the progression of disease:   * It will limit the infectious agent’s replication and gene expression. * The host will try to capture and destroy the agent. * It will try to kill infected cells. * Lastly it will attempt to prevent re-infection through immunological memory. |
| **Slide 7** | Let's take a look at a case study. Amari Musa is a 65-year-old male. He comes to the clinic with complaints of fever, cough, and chest pain. Mr. Musa has a history of smoking, chronic obstructive pulmonary disease, and hypertension. He states he’s had no recent travel, contact with sick people or exposure to animals. |
| **Slide 8** | Mr. Musa explains he feels the following symptoms. Note, symptoms are subjective complaints described by the patient. He says he feels pleuritic chest pain, fatigued with malaise, and has a loss of appetite. Malaise is defined as a general feeling of discomfort and unease. Anorexia is the medical term for a loss of appetite.  We also gather the following signs from Mr. Musa. Signs are observations from a patient that can be objectively measured. Mr. Musa has a fever, tachycardia, and tachypnea. He also presented with hypertension and hypoxemia. Lastly, we find Mr. Musa has a mass in his lower right lung through a chest X-ray. |
| **Slide 9** | *Laboratory Test Findings* |
| **Slide 10** | We perform a blood culture for Mr. Musa. We observe gram-positive *Streptococcus pneumoniae* in his blood sample. |
| **Slide 11** | In Mr. Musa’s sputum examination, we observe gram-positive *Streptococcus pneumoniae*. This indicates ongoing pneumococcal pneumonia. |
| **Slide 12** | We perform a frontal chest radiograph for Mr. Musa. We observe an area of increased density in the upper lobe of his right lung indicating an infection. |
| **Slide 13** | The most likely diagnosis for Mr. Musa is community-acquired pneumonia caused by *Streptococcus pneumoniae*. This is supported by his clinical presentation, chest X-ray findings, and positive urine antigen test.    *Streptococcus pneumoniae* is the most common cause of community-acquired pneumonia, especially in elderly patients with underlying lung disease. |
| **Slide 14** | Community-acquired pneumonia can cause many possible complications. Let's go through them.   * Pleural effusion is the accumulation of fluid in the pleural cavity surrounding the lungs. * Empyema involves the collection of pus and bacteria in the pleural cavity. This puts pressure on the lungs causing shortness of breath and pain. * Lung abscess occurs when there is necrosis of the pulmonary parenchyma. * Bacteremia denotes the presence of bacteria in the blood. * Septic shock refers to a dangerous drop in blood pressure resulting from overwhelming infection. This can cause damage to the lungs, kidneys, liver, and other organs. * Meningitis is the inflammation of the protective membranes covering the brain and spinal cord. This causes swelling of the meninges. * Endocarditis presents as the inflammation of the inner lining of the heart chambers and heart valves. |
| **Slide 15** | Let’s take a closer look at septic shock. Septic shock occurs when a bacterial infection causes enough inflammation to result in dramatically low blood pressure and multi-organ failure. This can be caused through excessive vasodilation and increased vascular permeability.  All the complications mentioned are more likely to occur in patients with severe pneumonia, comorbidities, or inadequate antibiotic treatment. |
| **Slide 16** | Mr. Musa’s infection can be prevented by smoking cessation, influenza vaccination, and pneumococcal vaccination. Smoking cessation reduces the risk of respiratory infections.  The pneumococcal vaccine is recommended for all adults aged 65 years or older, like Mr. Musa, and for younger adults with certain medical conditions or risk factors. |
| **Slide 17** | Mr. Musa was prescribed antibiotics to treat his *Streptococcal pneumoniae* infection. His condition improved gradually over the next few days: his fever resolved, cough became less productive, and chest pain subsided.    His repeat chest X-ray showed resolution of the opacity in his right lung. He was discharged from the hospital and took oral levofloxacin, a broad-spectrum antibiotic, for 10 days.    He was advised to quit smoking, receive influenza and pneumococcal vaccines, and follow up with his primary care physician to ensure he remains infection-free. |
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