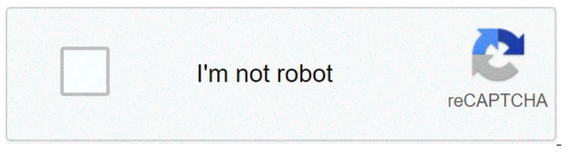

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The body's defense system worksheet answers

The immune system can be divided into three basic lines of defense against pathogenic infection:The first line of defense against infection are the surface barriers that prevent the entry of pathogens into the bodyThe second line of defense are the non-specific phagocytes and other internal mechanisms that comprise innate immunityThe third line of defense are the specific lymphocytes that produce antibodies as part of the adaptive immune responseThe Immune System: Three Lines of Defense First Line of DefenseThe primary defence against infectious disease are the surface barriers that prevent pathogens from entering the bodyThese surface barriers include intact skin (protect external boundaries) and mucous membranes (protect internal boundaries)Both the skin and mucous membranes release chemical secretions which restrict the growth of microbes on their surfacesIf pathogens cannot enter the host body, they cannot disrupt normal physiological functions and cause diseaseSecond Line of DefenseThe second line of defence against infection are the non-specific cellular and molecular responses of the innate immune systemThese defences do not differentiate between different types of pathogen and respond the same way upon every infectionPhagocytic leukocytes migrate to infection sites and engulf foreign bodies (dendritic cells then present antigens to lymphocytes)Inflammatory responses increase capillary permeability at infected sites, recruiting leukocytes but leading to localised swellingAntimicrobial proteins (such as cytokines and complement proteins) regulate immune activity within the bodyFever increases body temperatures to activate heat-shock proteins and suppress microbial growth and propagationThird Line of DefenseThe final line of defence against infection are the lymphocytes that produce antibodies to specific antigenic fragmentsEach B cell produces a specific antibody, and the body has millions of different B cells capable of detecting distinct antigensHelper T cells regulate B cell activation, ensuring that antibodies are only mass-produced at the appropriate timesBoth B and T cells will differentiate to form memory cells after activation, conferring long-term immunity to a particular pathogen Every day, you encounter things that can make you sick. From bacteria to viruses to fungi, the world around you is full of pathogens. Pathogens are organisms (usually microorganisms) that can cause disease. But in spite of all these pathogens, you might be in pretty good health. This is thanks to your immune system, a series of defense mechanisms in your body that work 24/7 to keep you healthy. The immune system includes specialized cells, proteins such as enzymes, and antibodies. It also includes parts of your body you might not have thought of as part of your immune system - such as your skin! Imagine you cut your finger and bacteria infected the wound. Let’s look at the war that would wage inside your body to keep you healthy. What is the body’s first line of defence against pathogens? Your immune system has three levels of defence. If a pathogen passes through one level, the next level takes over. The first line of defence is your innate immune system. Level one of this system consists of physical barriers like your skin and the mucosal lining in your respiratory tract. The tears, sweat, saliva and mucous produced by the skin and mucosal lining are part of that physical barrier, too. These quick and simple responses can eliminate some pathogens before they have a chance to reach your tissue or blood. For example, your skin is a physical barrier that prevents pathogens from entering the body. But if you cut the skin on a finger, bacteria would have a way to get into your body. At that point, the next level of your innate immune system would respond. Did you know? There’s a difference between an infection and a disease. An infection occurs when a microorganism invades and multiplies in your body. A disease occurs when the infection damages your cells and causes symptoms of illness. What is the body’s second line of defence against pathogens? The second level of the innate immune system consists of cells and proteins that attack invaders. Innate defences are non-specific. In other words, no matter what pathogen your body is fighting, the same response happens and the same cells and proteins are at work. Cells called phagocytes live in your tissue and blood stream. Macrophages and neutrophils are two types of phagocytes. Phagocytes recognize when something enters your body that doesn’t belong there and jump to work. They destroy the invaders using a process called phagocytosis. First, a macrophage identifies and binds to the invader. It then engulfs it and breaks it down with the help of lysosomes. This destroys the invader. Macrophages also sound an alarm by producing proteins called cytokines to recruit other types of white blood cells to help. These other types of white blood cells are called neutrophils, eosinophils and basophils. The process of phagocytosis (© 2019 Let’s Talk Science). Neutrophils make up 40-70% of the white blood cells (WBC). Their key job is to engulf and destroy (phagocytose) invading bacteria and fungi. Eosinophils make up only 5% or less of the WBCs. They contain toxins that can kill pathogens too large to be engulfed. They also release protein substances involved in producing inflammation. Often, this line of defence is enough to resolve the infection. At the very least, it can limit the spread of infection. For example, the bacteria that entered through the cut on your finger might not make it any further into your body. But there are some situations that the innate immune system can’t handle. For example, there might be too many bacteria, or the bacteria might multiply too quickly. That’s when your adaptive immune response kicks in. What is the body’s third line of defence against pathogens? The third level of your immune system consists of cells tailor-made to get rid of the specific microorganisms that have invaded your tissue. Special cells called dendritic cells are the liaison (point of communication) between innate and adaptive immunity. Remember macrophages? When they sound that alarm, dendritic cells are part of the crew that responds. They travel to the site of infection, where they phagocytose and break off small parts of the pathogen. They carry these parts to your lymph nodes, where adaptive immunity begins. The main cells and organs that make up the adaptive and innate parts of the immune system © 2019 Let’s Talk Science using images by ttsz, Vitalii Dumma and normaals via iStockphoto). The adaptive immune response involves two main types of specialized white blood cells called lymphocytes - B cells and T cells. B cells are found in the blood. Their main function is to mature into cells that produce antibodies to counteract the antigens (foreign invaders) that get into the body. To do this, they work with the T cells. In the lymph nodes, the dendritic cells search for T cells. Your body makes millions of different T cells. Each type of T cell can recognize a different type of pathogen. This means your body can combat almost every invader, even the ones it’s never seen before! In the lymph nodes, the T cells are fully mature, but have never encountered the pathogen they’re supposed to fight. These cells are essentially asleep. The dendritic cells’ job is to wake them up and bring them to the pathogens. Different kinds of T cells have different jobs: Memory T cells remember pathogens you’ve seen before. They help your body launch a quicker, more effective defence the next time around. Cytotoxic (“cell-killing”) T cells destroy any of your own cells that have been infected with a virus. T helper cells help other cells, such as B cells, often by releasing proteins called cytokines. These proteins bind to other cells in your body and tell them how to strengthen the immune response. For example, a cytokine might activate a B cell, which would make antibodies against the invading pathogen. When you’re dealing with a bacterial infection from a cut finger, a T helper cell is one of the more useful kinds of T cells. T regulatory cells are the police of the adaptive immune system. They shut down the attack launched by other immune cells once the pathogen has been cleared. This stops the immune response from getting out of control. Usually, T cells can eliminate a bacterial infection just days after they’ve been activated. At this point, your body can stop fighting, and you’ll start to feel better. Did you know? The 2018 Nobel Prize in Physiology and Medicine was won for discoveries of how the immune system is regulated. These discoveries led the way to immunotherapy drugs to treat skin cancer! As you can see, your immune system is a complex system working around the clock to keep you healthy. So the next time you’re feeling down, just remember: there are billions of cells in your body, and all they care about is you! If you cut yourself, what things can you do to help prevent an infection? What part of your immune system are you helping through these actions? Which cells in the immune system can you name? In what context have you heard about them before? Why does a doctor feel your lymph nodes during a physical examination? Have you ever felt that your lymph nodes were sore or swollen? When have you noticed this? During surgery, how is a person’s immune system exposed to pathogens? What steps do surgical teams take to avoid spreading infections during surgery? What physical barriers in the human body play an important role in the immune system? What is phagocytosis? At which stage of the immune response does phagocytosis take place? Where do dendritic cells originate? What is their role in the immune system? What do you know about how T cells were discovered? (Note: This question will require additional research.) Have you heard media stories about infection outbreaks at hospitals? (e.g., MRSA, Clostridium difficile, pneumonia, influenza.) What types of infections have been reported? Why are these instances usually reported as a serious problem? This article supports teaching and learning in Biology and Human Health related to the immune system, structure and function of the immune system, and the immune response. Concepts introduced include pathogens, macrophages, phagocytosis, innate immunity, adaptive immunity, dendritic cells and T cells. Before reading this article, teachers could provide students with a Vocabulary Preview to help engage prior knowledge and introduce new terms. Ready-to-use Vocabulary Preview learning strategy reproducibles are available in [Google doc] and [PDF] formats. To help consolidate and extend learning, teachers could have students watch one or more of the videos from the Learn More section. 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