

SIMULATING LIFE : Handout

Immune system response following bacterial invasion

The immune system, which is made up of special cells, proteins, tissues, and organs, defends people against germs and microorganisms every day. In most cases, the immune system does a great job of keeping people healthy and preventing infections. But sometimes problems with the immune system can lead to illness and infection.

☞ *The objective of this simulation is:*

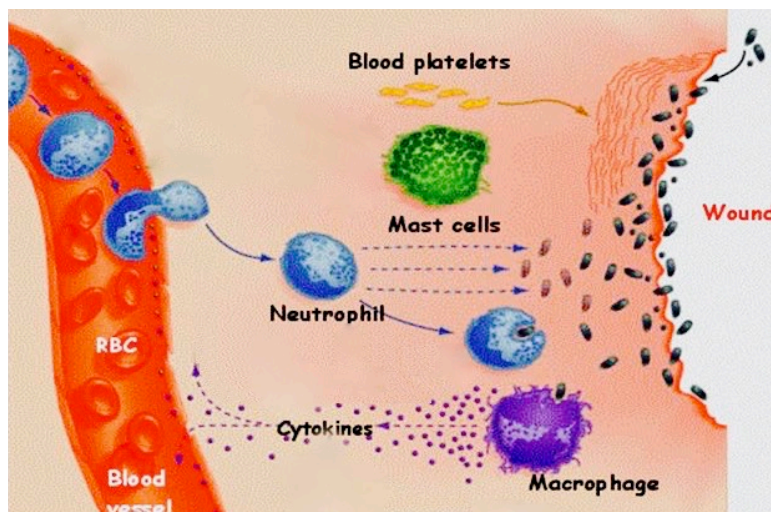
- *To show the indispensable role of the immune system in everyday life.*
- *To understand the necessity of a communication between all the levels of the immune response.*
- *To demonstrate the link between the number of bacteria in the wound and the response of the immune system.*

How does it work in real life ?

As a result of superficial injury, a number of bacteria settle in the wound, thereby activating the immune system in a primary response.

In other cases, the process of diapedesis will allow a secondary response of the immune system to support the primary response. This process causes different symptoms like an increased temperature, swelling, irritation and redness.

The 2 different responses will involve a particular type of white cell, phagocytes, that chew up invading organisms. First, we will have the macrophages located in the epidermis and the dermis. They kill bacteria by phagocytosis and produce cytokines, which allow them to communicate with the neutrophils. These cytokines induce the migration of neutrophils through the capillary wall by altering the elongation of endothelial cells. Neutrophils will in turn be able to eradicate the pathogen.



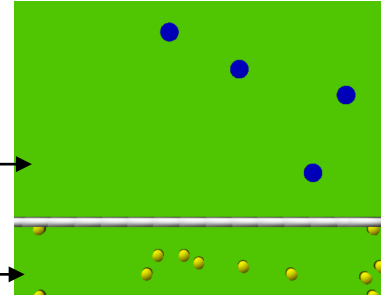
Picture : schema of immune system response to bacterial invasion

How does it work in the simulation ?

➤ The « world » of the simulation

epidermis & dermis

blood vessel



➤ Agents and their behaviors

- **Bacteria (30 or 70)** → proliferate and multiply



↳ The bacteria enter into the lesion and multiply.

- **Macrophages (6)** → kill enemies, communicate, synthesize cytokines

Normal

Excited



↳ The macrophages kill bacteria, create 3 cytokines and loose energy.

- **Neutrophils (12)** → activate other cells, kill enemies

Normal

Excited



↳ The neutrophils kill bacteria but loose energy too.

- **Endothelial cells**



- **Cytokines** → induce diapedesis



↳ The cytokines touch the endothelial cells and reduce their size - so that neutrophils can go out of the blood vessel.

➤ Simulation in 2 different conditions

- ☐ **Small lesion**, meaning a small number of bacteria in the wound.

Example : a cut or a splinter

- ☐ **Big lesion**, meaning a big number of bacteria in the wound.

Example : a cat scratch

➤ Graphic

These curves represent the number of **bacteria**, **macrophages** and **neutrophils** as a function of time. They allow to show the death of phagocytes due to energy loss resulting from ingestion of bacteria, but also, the possibility for the bacteria to multiply in the favorable conditions of the

