

CASE 2

PSEUDOMONAS

AERUGINOSA

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PATH 417A



A HOUSE FIRE

Rescued from a house fire Marian is hospitalized with second degree burns extending deep into the dermis layers in her upper limbs. After three days in hospital during which time she has regular changes of her wound dressings, she is released home to the care of her sister who expresses confidence in her ability to maintain the needed dressing changes. With a keen interest in natural remedies Marian and her sister treat her burn wounds with honey. A few days later Marian begins to experience pain associated with her burns and notices that they seem to be producing more fluid than before. After a bad nights sleep her sister takes her back to the hospital where the doctor notes that one of the wounds is expressing pus. A swab of the pus is sent to the laboratory and Marian is again hospitalized. The laboratory grows *Pseudomonas aeruginosa* from the wound and Marian is started on antibiotics.



Q1:What are the signs (objective characteristics usually noted/detected by a healthcare professional) and symptoms (subjective characteristics experienced by the patient)?

SIGNS

Excess fluid excretion

Pus

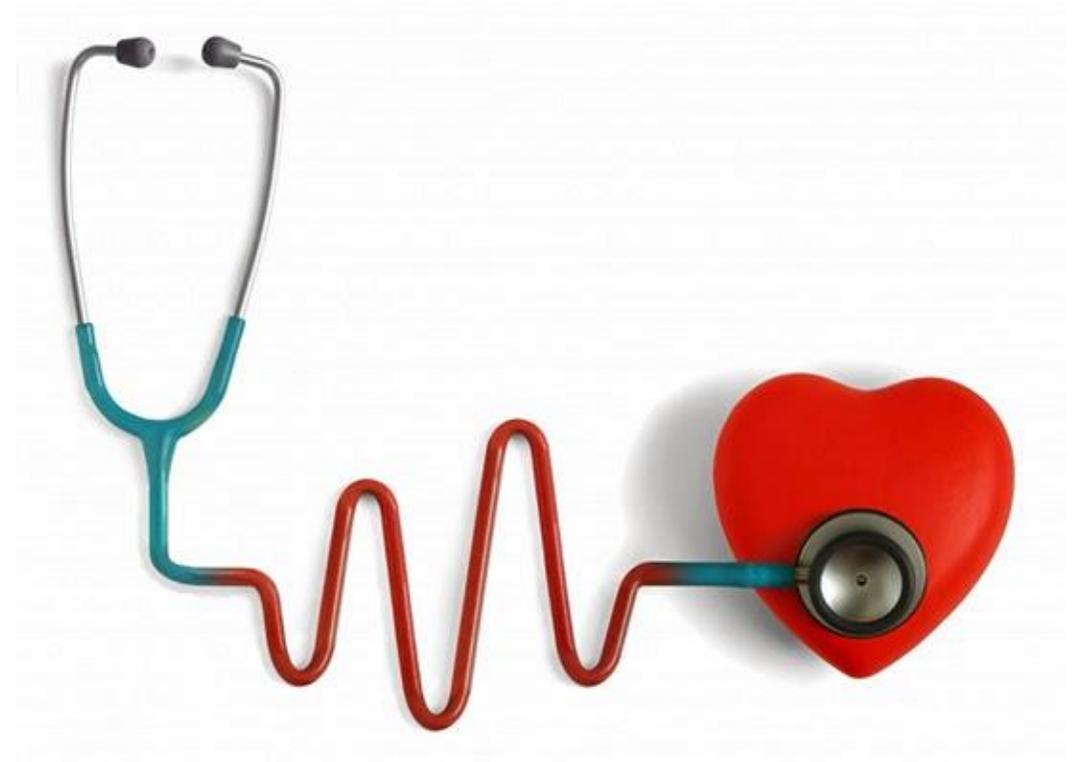
SYMPTOMS

Trouble sleeping

Fever

Pain

Redness



What's causing these signs & symptoms?

SIGNS

Excess fluid (burn exudate)

- Plasma, complement proteins, antibodies

Pus

- Dead leukocyte accumulation in an open wound infection
- Leukocytes used to fight infection at the epithelial layer
- *P. Aeruginosa* release alkaline protease + elastase to inhibit leukocyte activity

Trouble sleeping

- Malaise or fever upon amplified inflammatory response

Pain

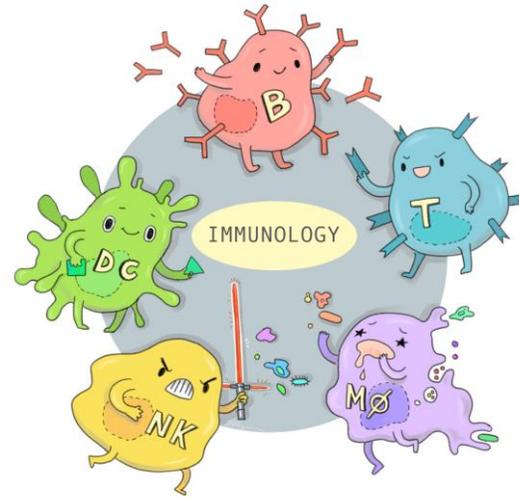
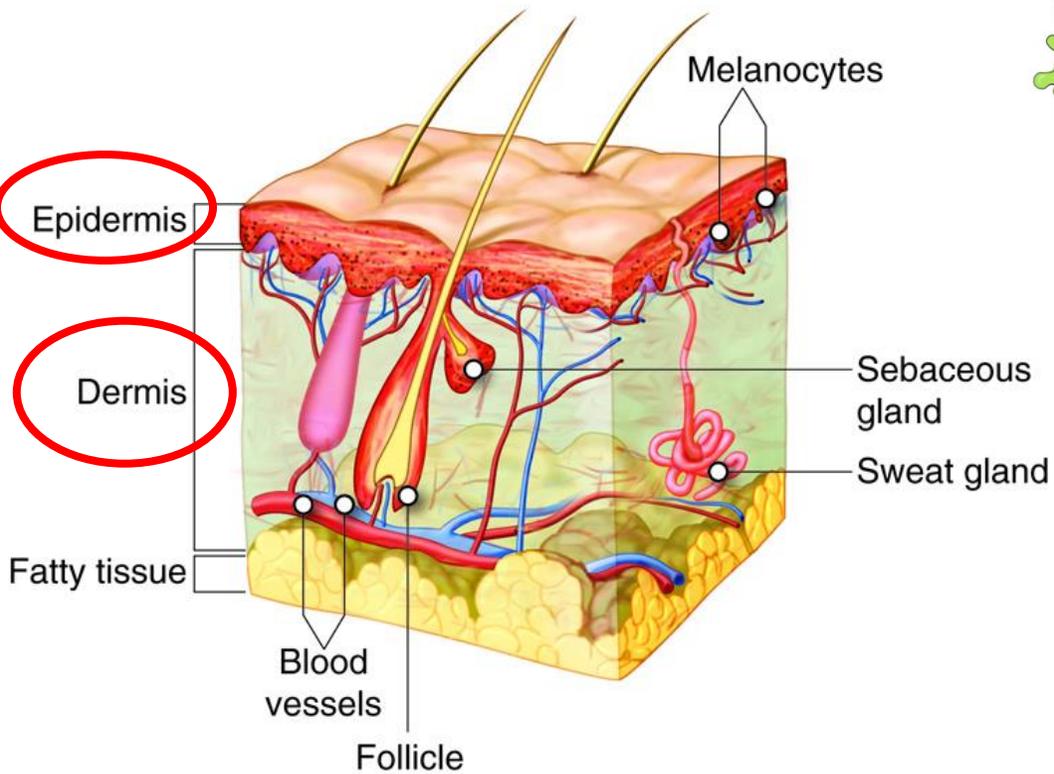
- Due to inflammatory response (leukocyte recruitment) and wound infection

SYMPTOMS

Redness

- Increased vascular permeability to permit white blood cell access to injury site

Marian's injury has damaged the **skin** of the **integumentary system** and affected the **innate and adaptive responses** of her **immune system**



Q2: Which body system is affected?
In what way has the normal physiological functioning of this area of the body been disturbed by the infection?

SKIN – Epidermis & Dermis

EPIDERMIS

Outermost skin layer

Primary line of defense against foreign substances

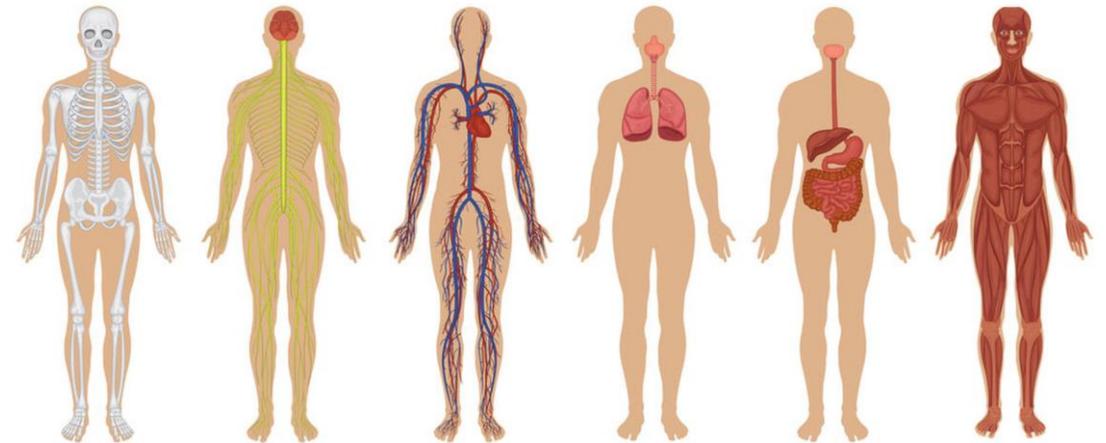
Harbours epithelial cells, keratinocytes, and Langerhans cells, all of which are all essential to the immune response

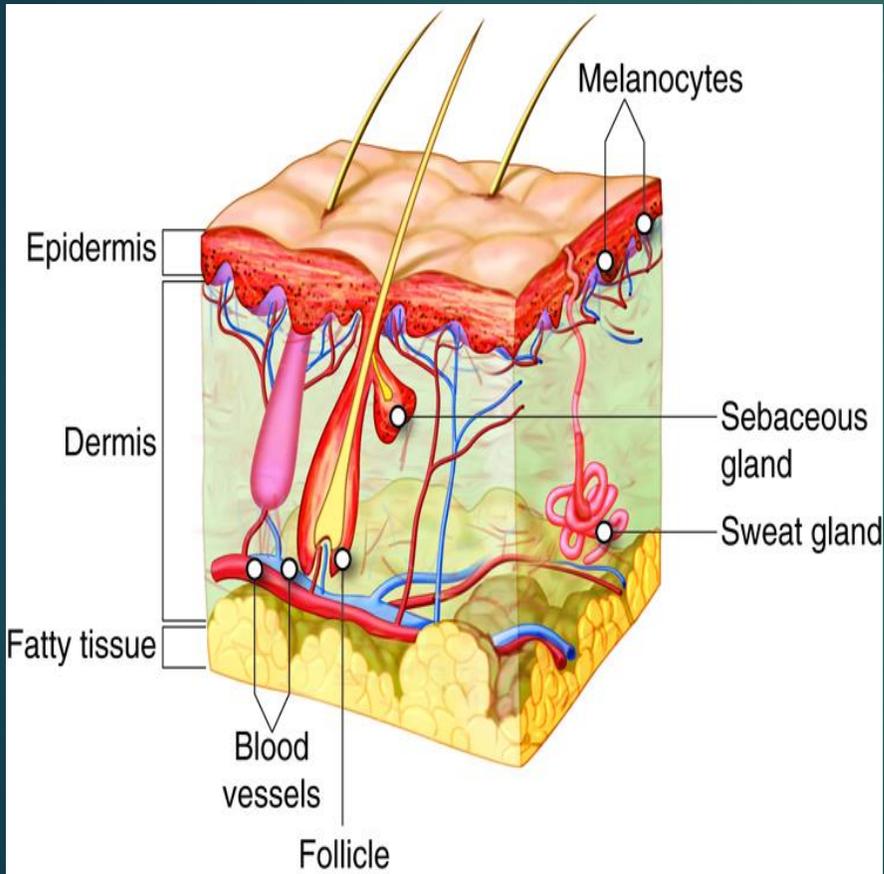
DERMIS

Sits beneath epidermal layer
Holds nerve endings, lymphatic and blood vessels

Contains lymphocytes, mast cells, and macrophages required for innate immunity

Involved in protection against trauma, thermoregulation, fluid balance, and dermal repair





Damaged epidermis

Loss of primary barrier allows for bacterial colonization

Loss of Langerhans Cells

High susceptibility to wound infection

BURN EFFECTS ON THE INTEGUMENTARY SYSTEM

Damaged Dermis

Delayed healing and high risk of infection

Blood Vessel Damage

Hinders immune cells from reaching injury site

Innate Immune System

Reduced macrophage
and NK cell activation
diminished neutrophil
chemotaxis, intracellular
killing

*Results in overall T-cell
suppression*

Complement Cascade

Alternative pathway
depression
Rise in C3a and C5a levels
Altered membrane attack
complex functions
*Results in blood pressure
changes and leukocyte
impairment*

BURN EFFECTS ON THE IMMUNE SYSTEM

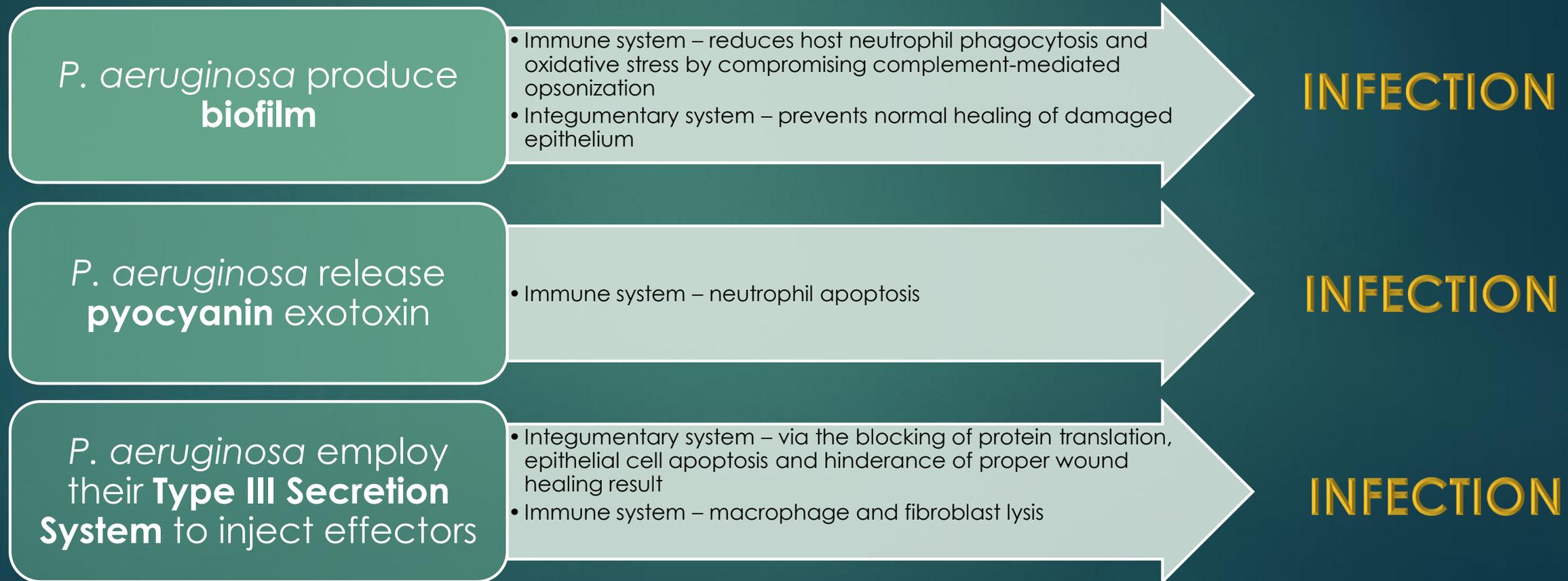
Other Effects

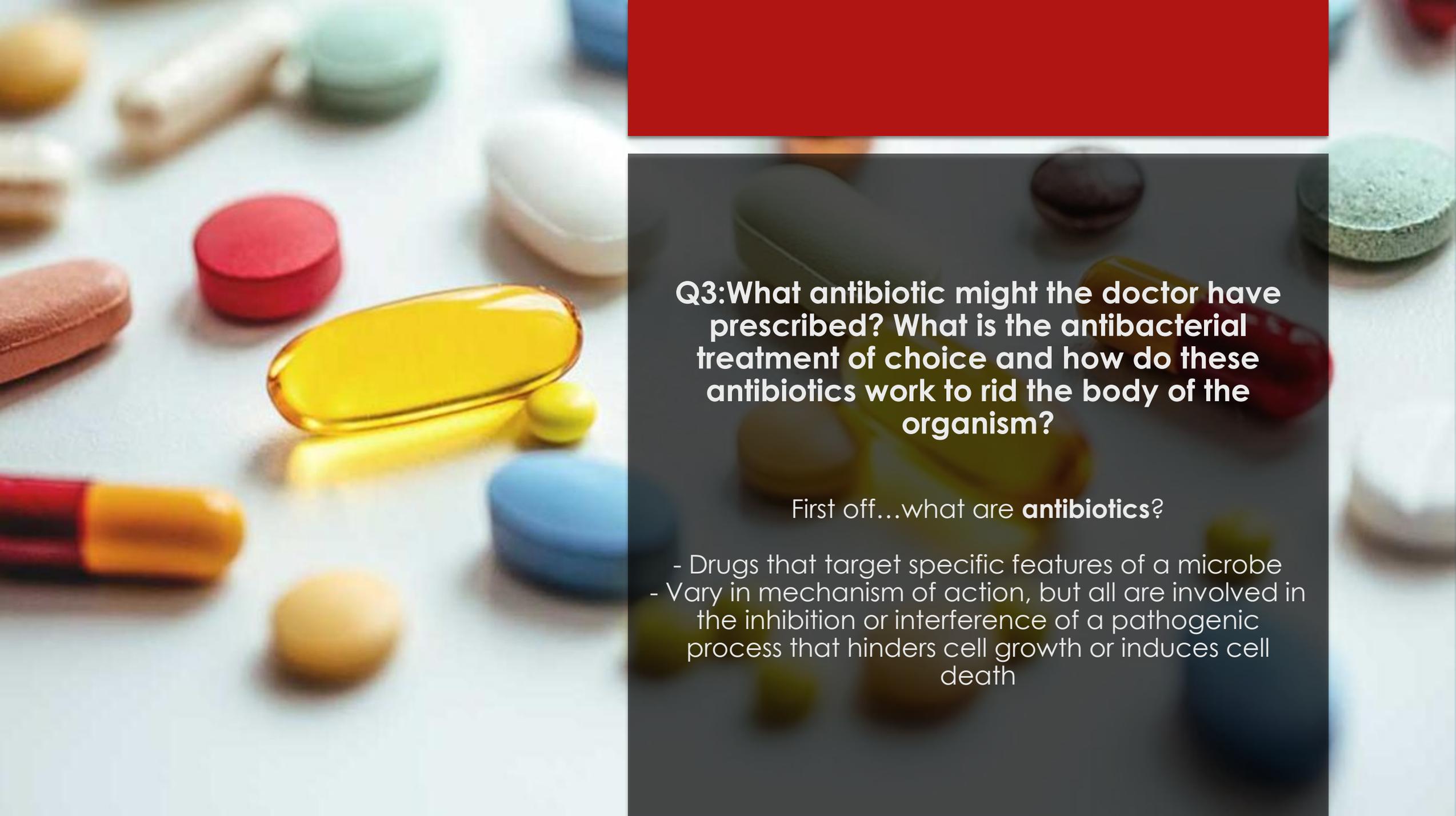
Generation of cell-
mediated immunity
Low IgG levels

T-cell Functions

Low T-cell proliferation
Low CD4+ T helper cells
*Results in overall increased
cytotoxic events at site of injury*

As a result of impaired integumentary and immune system functions, *Pseudomonas aeruginosa* is able to colonize and cause infection...



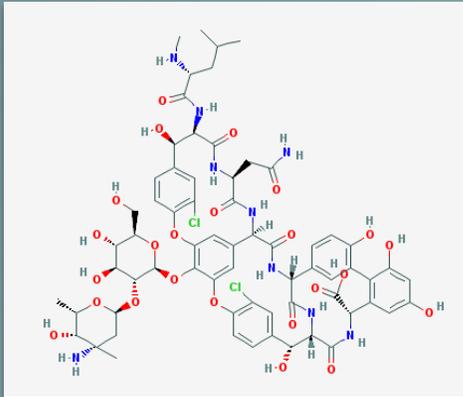


Q3: What antibiotic might the doctor have prescribed? What is the antibacterial treatment of choice and how do these antibiotics work to rid the body of the organism?

First off...what are **antibiotics**?

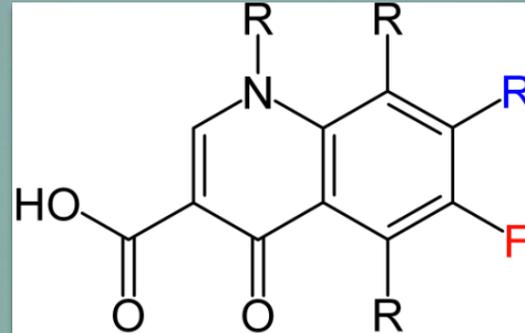
- Drugs that target specific features of a microbe
- Vary in mechanism of action, but all are involved in the inhibition or interference of a pathogenic process that hinders cell growth or induces cell death

Without knowing that the cause of infection is *P. aeruginosa*, the doctor's initial antibacterial treatments would include **broad spectrum antibiotics** to target a wide range of bacteria types



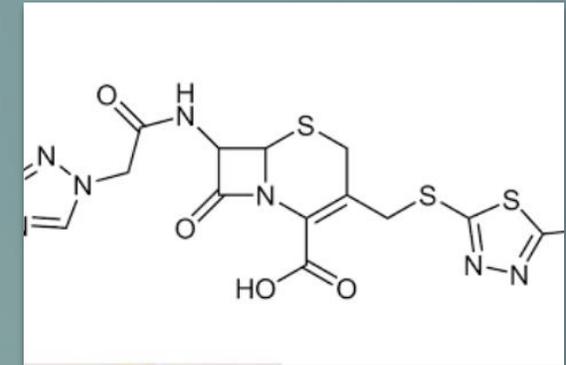
VANCOMYCIN

Kills potential MRSA



FLUOROQUINOLONE

Kills gram negative bacteria



CEFAZOLIN

Kills gram positive bacteria

To target gram negative *P. aeruginosa* specifically, a combination of a **β -lactam** drug and an **aminoglycoside** or **fluoroquinolone** antibiotic is used

β -lactam

*Ex: Penicillin,
Cephalosporin*

- Targets bacterial penicillin-binding proteins (PBPs)
- PBPs mediate the formation of the bacterial cell wall
- By targeting PBPs, the integrity of the cell wall is lost, causing impaired cell wall synthesis, osmotic instability, and autolysis

Aminoglycoside

Ex: Gentamicin, amikacin

- Binds ribosomes in bacteria to inhibit protein translation
- As a result, pathogen can not build enzymes, receptors, or other proteins required to cause infection

Fluoroquinolone

*Ex: Ciprofloxacin,
ofloxacin*

- Binds and damages the DNA-enzyme complex, comprised of DNA gyrase, helicase, and topoisomerase IV, found during DNA replication
- Upon damage of the bacterial DNA, cell death is induced

Q4: What alternative therapies have been studied for the treatment of burns and what is known about their therapeutic actions and success?

NON-HERBAL ALTERNATIVE TREATMENTS

Cold water application

- Immediate application of cold water to the site of burn injury minimizes the negative effects of burning as well as tissue damage

Petroleum jelly

- Provides the injury site with a moisturizing barrier to allow for more effective healing

Occlusive dressing

- Offers a moisturizing protective layer to expedite the healing process and prevent bacterial infection

Vacuum dressing

- Through negative pressure application, this method reduces the chance of excess fluid secretion, increases blood flow, prevents bacterial infection, and expedites wound healing

NON-HERBAL ALTERNATIVE TREATMENTS

Acetic acid

- Effective treatment antiseptic that helps prevent infection via changing the environmental pH, causing electrolyte imbalance

Hydrogen peroxide

- Cytotoxic antiseptic agent used against pathogen infection
- Can slow healing time

Silver and silver- containing products

- Silver interferes with the thiol group of enzymes involved in bacterial respiration
- Commonly used to inhibit or heal bacterial infection

HERBAL ALTERNATIVE TREATMENTS

Curcumin

- Reduces wound size and inflammation, as well as stimulating the growth of new epithelial cells
- Diferuloyl-methane is the key molecule in curcumin that provides it with anti-inflammatory and antioxidant characteristics

Moist Exposed Burn Ointment (MEBO)

- Provides the injury site with a moisturizing barrier to allow for more effective healing and prevention from infection

Green tea extract

- Effective treatment that inhibits bacterial growth
- Contains polyphenolic compounds that prevent bacterial adhesion and protein translation

Scrophularia striata

- Plant extract containing phenyl propanoic glycoside that allows for antiseptic and anti-inflammatory properties
- Blocks secretion of PGE-2, IL-4, IL-1 B inflammatory factors

Honey

- High sugar content and low pH in honey allows for osmotic imbalance to occur in bacteria
- Stimulates immune system functions, anti-inflammatory and antioxidant activity, cell growth

