

# Immunology and Vaccines



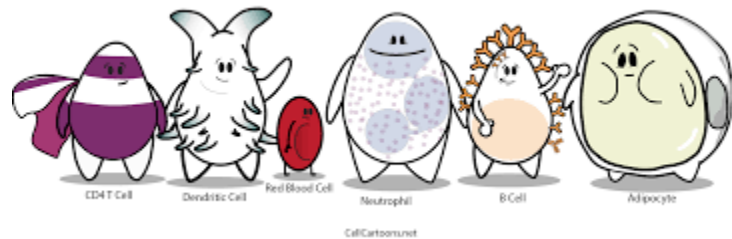
**Dr. Muna Oqal**

**Department of Pharmaceutics and Pharmaceutical Technology**

**Faculty of Pharmaceutical Sciences**

**Hashemite University**

**2021**



اي اشي مش  
مكتوب عنده  
شرح بتكون قرأته  
بس

# Objectives

- Definition of Immunology
- Importance of Immunology
- Historical background of Immunology
- Modern Immunology
- Outline the major principles of the human immune response (innate immunity, humoral immunity, and adaptive immunity)

ای جهاز سبکون من molecules - cells - tissues - organs

# Introduction

- **Immunology** stems from

- **Latin - *immunis*** = “exempt;” → كلمة لاتينية معناها إعفاء
  - English = protection from disease (جسمك محمي من الأمراض)
- Foreign molecules ←

- **Immunology is the study of our protection from foreign macromolecules or invading organisms and our responses to them.**

لوما في جهاز مناعة ما بنعيت / كل المحيها الي حولنا والاكل عباره عن microbes

ف الله اعطانا حمايه منها / ولما ماتقدر لغضى عهاى ال microbes بظاهر المرض

# Definitions

حکمت مراح ییجی تعریفیات بیس فہم

- **Immune system** = cells, tissues, and molecules that mediate resistance to infections
- **Immunology** = study of structure and function of the immune system

حصانہ

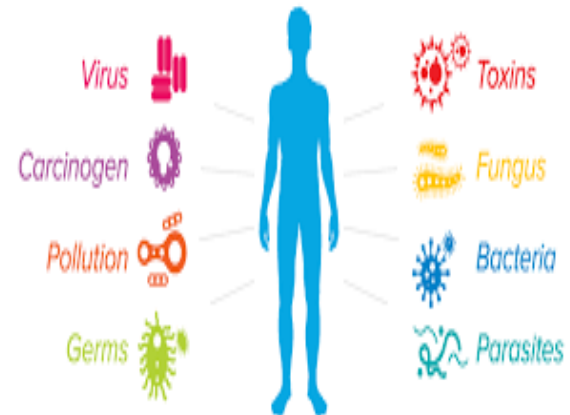
حصانہ ضد الاصابہ لاصولہا

- **Immunity** = resistance of a host to pathogens and their toxic effects
- **Immune response** = collective and coordinated response to the introduction of foreign substances in an individual mediated by the cells and molecules of the immune system

→ single cell مستوی

بشغل علی مستوی ارجیم کامل ۶ لختہ ارتقاہ  
عنہ Signalling نزی الاسحاق calling by بیجوا /  
mediators و

عتان یحرفوا الخلايا انه هاد الامکان فی infection



# Role of the immune system

- Defense against microbes
- Defense against the growth of tumor cells
  - ✓ kills the growth of tumor cells
- Homeostasis *يعمل توازن بين ال normal وال Dead cells*
  - ✓ destruction of abnormal or dead cells  
(e.g. dead red or white blood cells, antigen-antibody complex) *كحد اكليريا ال life span*

حسبنا يصنع خلايا سرطانية لكن جهاز المناعة يفتتها / وهما صارت في توابط  
وتتوق بين جهاز المناعة والسرطان

# non living organisms Virus vs. Bacteria

- Colds and influenza are caused by viruses.
- Viruses are which is a non-living particle that contains genetic material, and hijacks your cells to reproduce.
- Viruses cannot be "killed" with antibiotics.
- Bacteria are living organisms that have a metabolism, have DNA, and can reproduce on their own.
- Bacteria can be killed with antibiotics because these substances target key processes in bacteria, such as production of the bacterial cell wall.

← كتاب  
host  
عشان  
يكتاثر

Host او بعينه او امر يصنع الكونات لاساسية  
للكاثر

المقاومة من البكتيريا تجعل  
وتصير فيها level اعلى عشان اقضي عليها

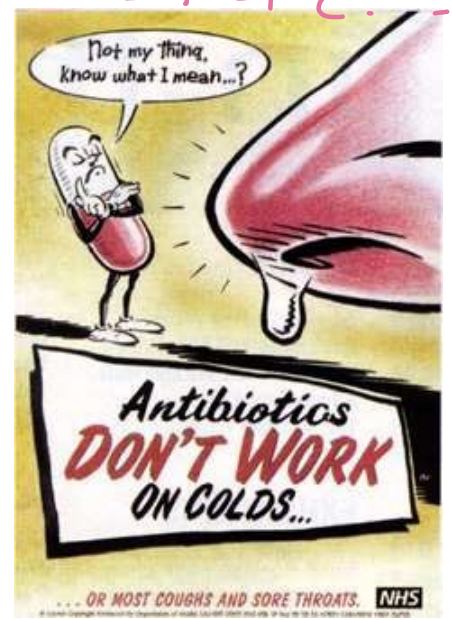
منظمة اخذوا الدواء اهدوا قانون  
جديد يمنع صرف ال antibiotics الا بوصفة



المقاومة ليصير بي المرض يوف اذوية  
ما الصاد اي رزي MRSA  
عالمه مقاومة

Figure: (a) Components of virus, (b) components of bacteria

viral infection → ما يصير اعليه antibiotic البكتيريا تنبذ  
للمقاومة ويبقى تتر normal flora



Viruses and bacteria are everywhere. Some of them want to invade your body.

How does your body defend itself against viruses and bacteria?

✳️ ال Spikes الى خال

Viruse بوضوحها وبعلموا

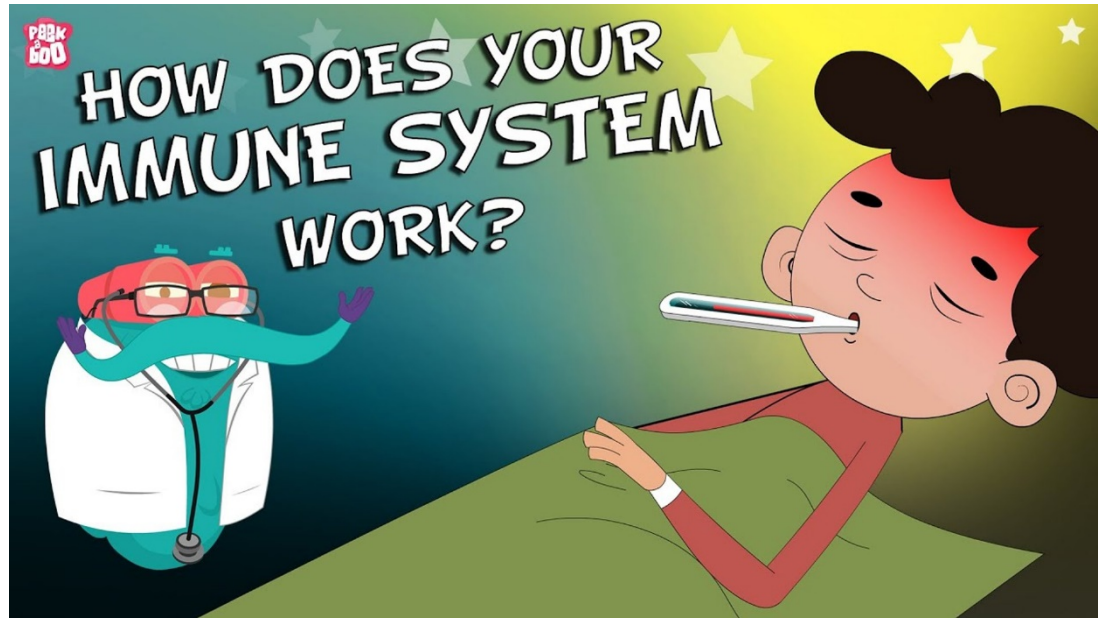
المعروف ومصنوعها عتبان جسمنا

يكون اعصاب مصارة



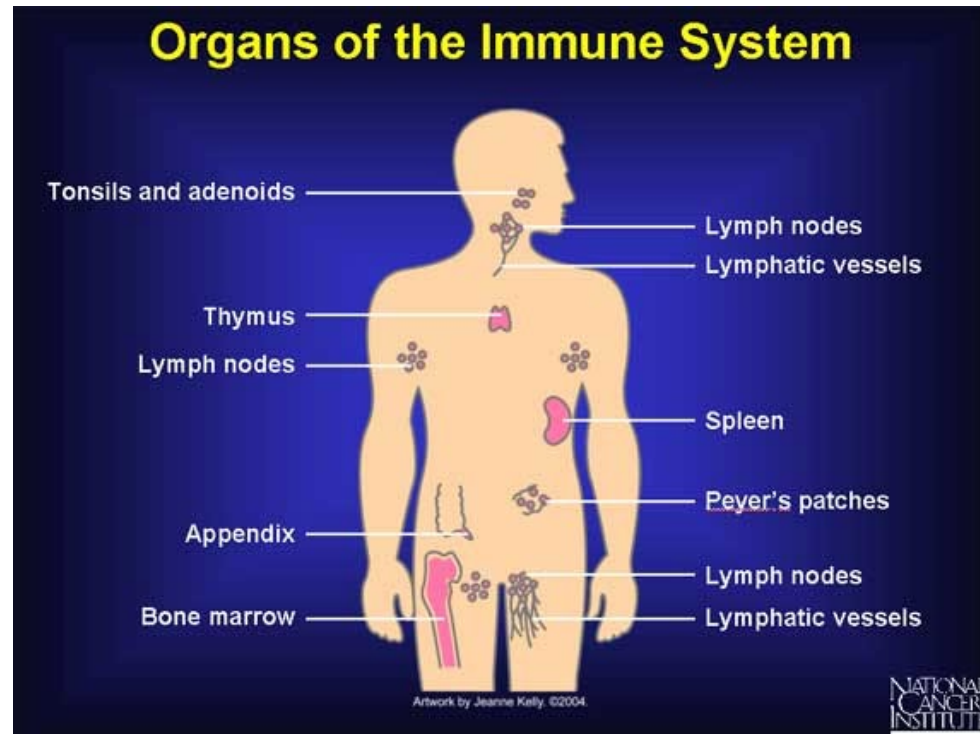
# Immune System

1. Organs
2. Cells
3. Molecules



# Immune System: (1) organs

- **Tonsils and adenoids** اللوز
- **Thymus** الغدة الليمفاوية
- **Lymph nodes** بحد مكان بالجسم
- **Spleen** → مقبرة الدم
- **Payer's patches** بالامعاء
- **Appendix** الزائدة وبس تلتهم ويمكن يكون الاسنان
- **Lymphatic vessels**
- **Bone marrow**



- tonsillitis: التهاب اللوز وهو دليل لضعف الجسم بقاءه، مع الحرارة التي تقتل الـ microbes

لا يشكل organism بحيثى الحرارة محيية اذا زادت بتقوت

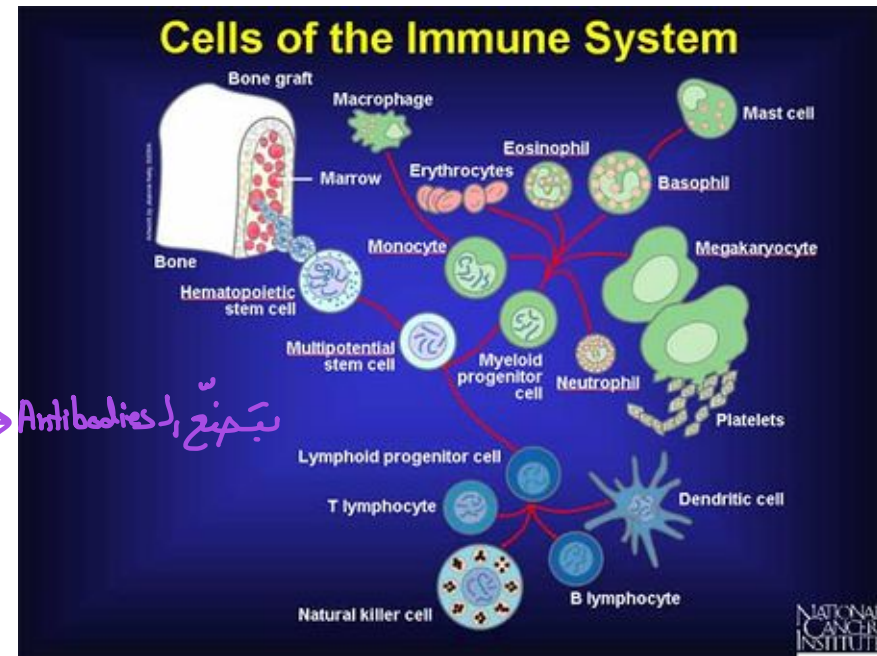
- بس متى صح الحرارة تنضج مرتفعة خاصة، لا هفقال خط احمر / اول اسقى يتنوف

كيف تنضج الحرارة / اذا هلت مرتفعة اول اسقى معنى يصير معه seizure وخلايا الدماغ يتنوف وهي ما بتتكاثر

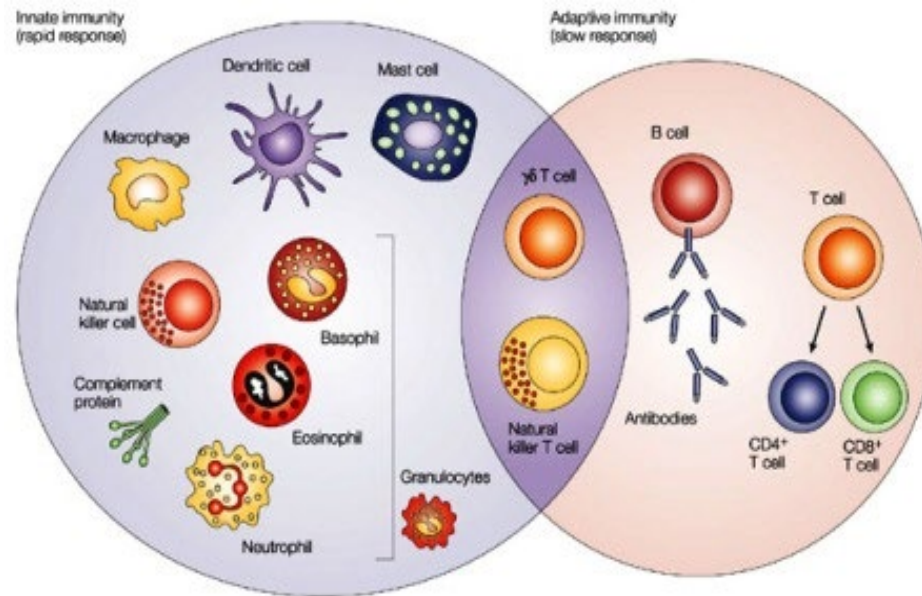


# Immune system: (2) cells

- Lymphocytes
  - T-lymphocytes
  - B-Lymphocytes, (plasma cells) → *بجنع، أنتيبوديز*
  - *بقتل الخلايا* natural killer lymphocytes
- *السرطان قاد virus* Monocytes, Macrophage
- Granulocytes



- neutrophils
- eosinophils
- basophils





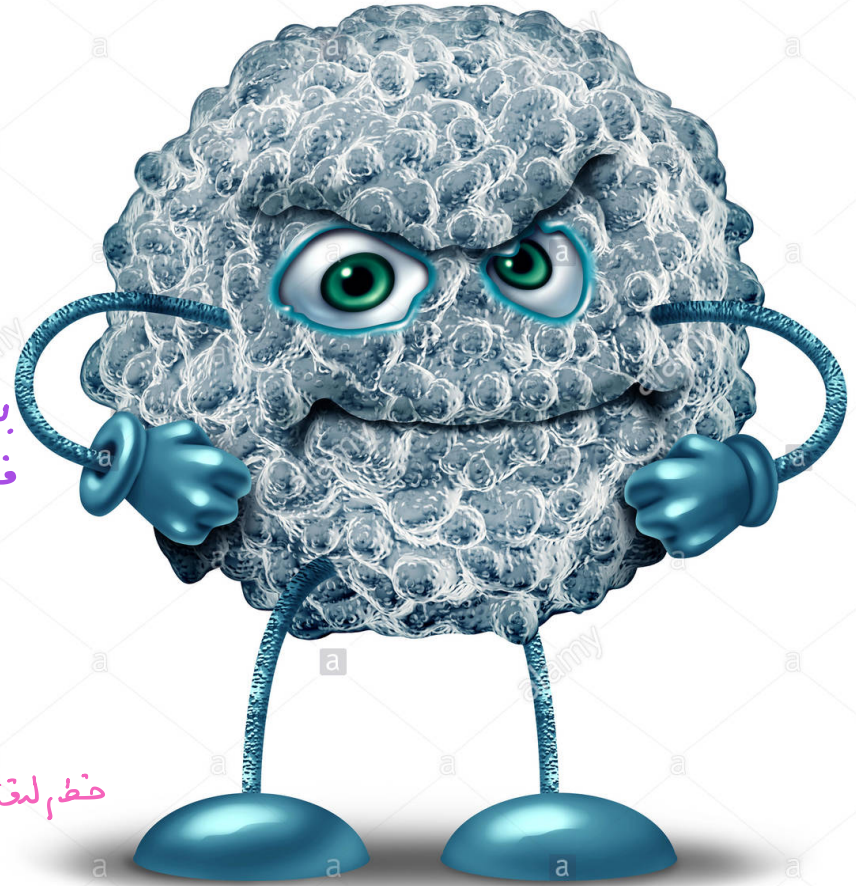
# Immune system: (3) molecules

الاحصاء المضادة / لازم تتعرضن لاد Foreign molecules  
وصياد يتعرف عليه ويتعرف عال antigen  
ويكون جسم مضاد خاصها منه فلما ترجع تتعرضن  
لنفس الinfection يكون الاعراض حفيضة جدا وهاد  
مبدأ المطعن

الاحصاء المضادة

- Antibodies *بحساج وقتة تكوينها*
- Complement
- Cytokines
- Interleukins
- Interferons

الجسم بصنعها  
بكميات قليلة  
فحقتها يكون غالي



فطر لتغاول بفرولة وبقائل لدا مازبط بتقتل السي

# Two types of immunity

لودبوس افترق الجلد ومسار لازم توخذ كزاز  
 ودليل اعظم عن اهمية الـ skin اننا كبري نصاب  
 بالحروق اهم استي نخادل ما يصير infection  
 والجراثيم تدخل عالمه ويصير تسمم بالدم  
 Septicemia

جاهزة  
 خط الدفاع الاول / موجود دائما =

- 1. Innate (non-adaptive) (skin) nonspecific**
  - first line of immune response يحتاج دفاع - ساعات
  - relies on mechanisms that exist before infection

واعلم اني بنحرقوا بهوتوا بسبب عدم التسمم  
 فكلوا محزولين بالـ ICU

- 2. Acquired (adaptive) specific**
  - Second line of response (if innate fails)
  - relies on mechanisms that adapt after infection
  - handled by T- and B- lymphocytes
  - one cell determines one antigenic determinant

\* في بالـ skin ايه يمنع الـ infection  
 منجوا ما اتسلوا كثير كثير عثمان  
 ما يصير جفاف

oil + sweat

فيهم chemicals و antibacterial

\* اذا خط الدفاع الاول ما اتفعل في خط دفاع ثاني وثالث

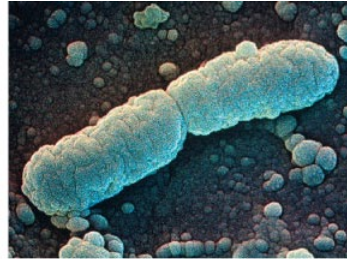
\* B-lymphocytes جزء منه يتحول لـ plasma cell الي بيكون antibodies

\* specific بيكون memory cells عثمان اذا تعرضنا لعض الـ organism

الـ memory cells بهي الـ Activation يتحول لـ plasma cells وبيكون antibodies  
 يتكسر سريع واقوي

ولا يكون الـ infection اخف = clonal expansion انه الـ daughter بيتصان  
 عثمان تعطى عدد كريات دم بيضاء كانية

# Defense Against Disease



**Nonspecific External Barriers**  
skin, mucous membranes



If these barriers are penetrated,  
the body responds with



**Innate Immune Response**  
phagocytic and natural killer cells,  
inflammation, fever



If the innate immune response is insufficient,  
the body responds with



**Adaptive Immune Response**  
cell-mediated immunity, humoral immunity

# Innate immunity

- Based on genetic make-up → *بجتمدعال genetic يمكن لقن الاكل-نخاي*
- Relies on already formed components *حدا يستمم وحدا لا / و كورونا ما صباب الكل*
- Rapid response: within minutes of infection
- Not specific
  - same molecules / cells respond to a range of pathogens
- Has no memory
  - same response after repeated exposure
- Does not lead to clonal expansion



# Innate immunity: mechanisms

اذا هارني injury ستوبصير ؟

external barriers الى حد ال Skin

هار منه damaged cells هاي بتعمل release لا mediators

بتحرك لا macrophages تقالوا عثمان تبليوا لا microorgan

هاي ال innate ( skin , mucus membrane )

لجدين بصير response ال phagocy.. ال natural killer cells

ادا ما اشتعل بشتغل ال Acquired

## • Mechanical barriers / surface secretion

- skin, acidic pH in stomach, cilia

## • Humoral mechanisms

- lysozymes, basic proteins, complement, interferons

## • Cellular defense mechanisms

- natural killer cells neutrophils, macrophages,, mast cells, basophils, eosinophils

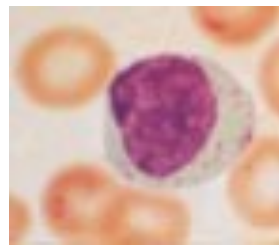
ال acidic pH ال stomach بتقصي على ال microbes الى بتدخل مع لاكل

- cilia بس تدخل يمكن في عنبره بتجهر لتحليس عثمان تطردھا / يحن هاي مقاومة

ال cilia الى بالرئتين حركتها لفوق عثمان تطرد ال sputum / productive cough او dry cough

ال productive هي ال منها sputum هاي دليل الحثانه في infection /

ادا كان ال sputum لونه green اكثر و viscous اكثر دليل على انه infection قوي



NK Cell



Eosinophils



Neutrophil



Basophils & Mast cells



Monocyte Macrophage

endocytosis عن طريق engulfment لا lysosomes

يكون lysosomes lysosomal Enzymes و acidic في lysosomes

و lysosomes microorganisms

# First line of defense

- **Non-specific** defenses are designed to prevent infections by viruses and bacteria.

These include:

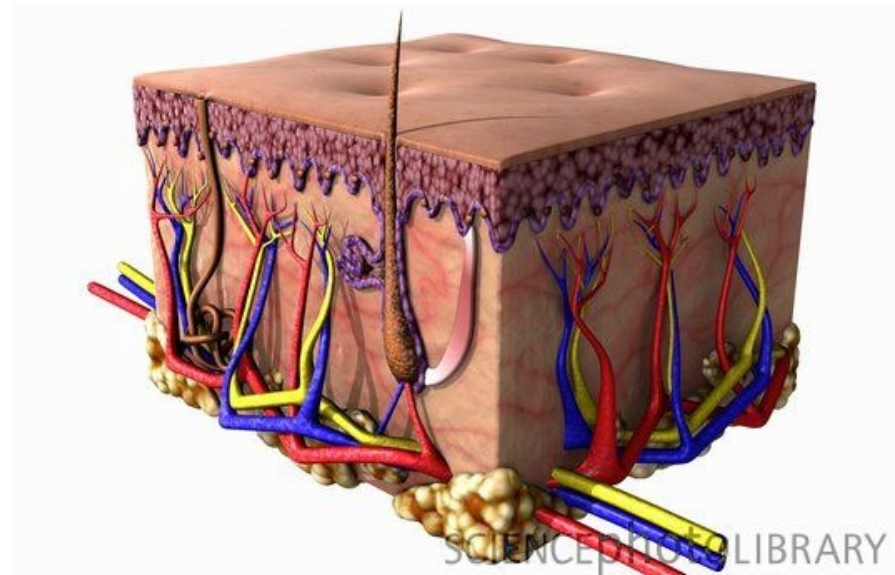
- Intact skin
- Mucus and Cilia
- Phagocytes

ال Skin يتجدد كل 28-21 يوم  
عشان هيك مشاكل ليرة عن نتعالج بدها من اقل  
من شهرين اذ 3 شهر الا اذا استخدمت products ثانية  
تسرع وتتغير

وربنا حظ بال Skin هاي الخاصة عشان ما يصير  
colonization لـ microbes بال Skin

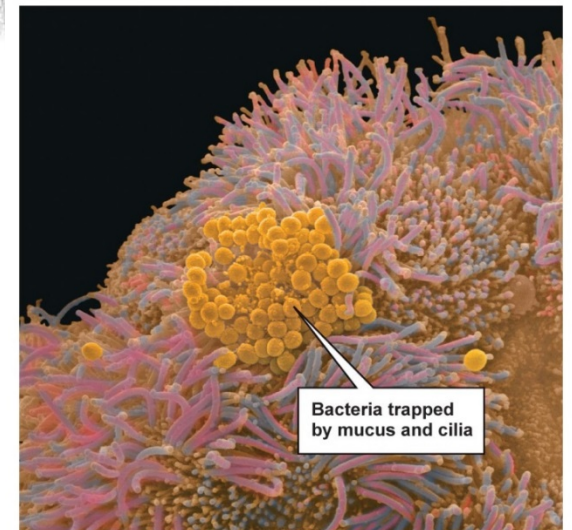
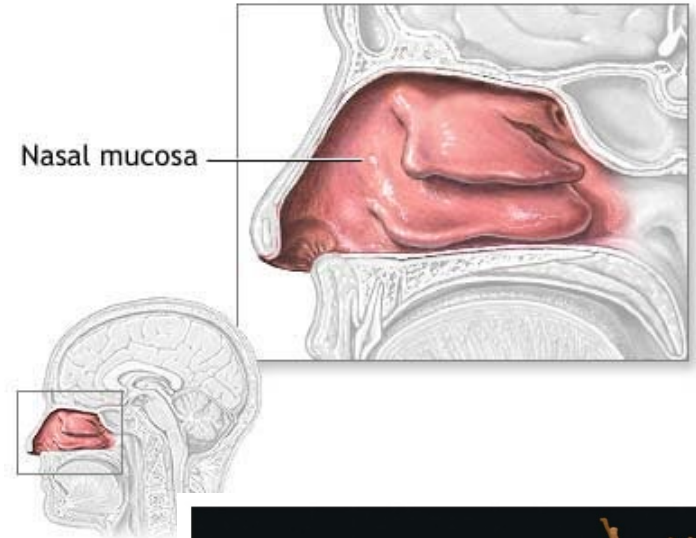
# Role of skin

- Dead skin cells are constantly sloughed off, making it hard for invading bacteria to colonize.
- Sweat and oils contain anti-microbial chemicals, including some antibiotics.



# Role of mucus and cilia

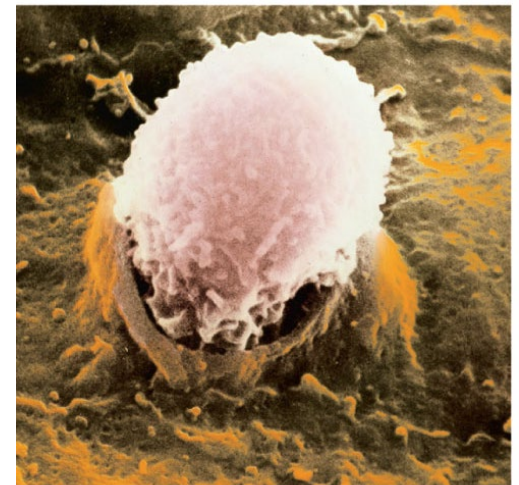
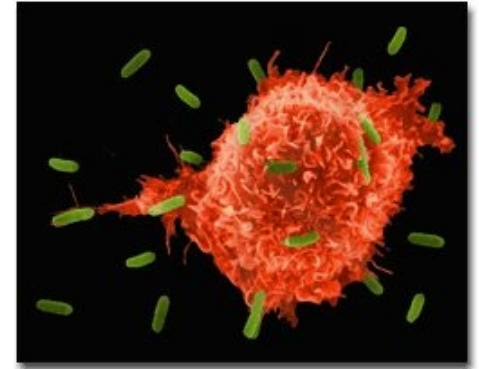
- Mucus contains lysozymes, enzymes that destroy bacterial cell walls.
- The normal flow of mucus washes bacteria and viruses off of mucus membranes.
- Cilia in the respiratory tract move mucus out of the lungs to keep bacteria and viruses out.



# Role of phagocytes

زى ال Vacuum  
بحالها لدرم يصير  
microorganisms  
بتبلع ال microbes وما يتجى  
Signalling من مكان الى منه

- Phagocytes are several types of white blood cells (including macrophages and neutrophils) that seek and destroy invaders. Some also destroy damaged body cells.
- Phagocytes are attracted by an inflammatory response of damaged cells.



# Role of inflammation

كيف اعرف انه في infection ؟

بصير inflammation

fluid / حرارة / احمرار / swelling لان في

inflammation وال

mast cells بخلقا ال

• Inflammation is signaled by mast cells, which release histamine. *التي صنفا ال histamine يزيد ال permeability عشان يسمح للخلايا الثانية*

تيجر عالوقح ، وبتعمل Swelling

Vasodilation فنبير

• Histamine causes fluids to collect around an injury to dilute toxins. This causes swelling. *وتزيد السوائل عشان تفل ال toxins dilution*

↑ Capillary blood flow

والحرارة بتزفغ عشان

تقمن عال microorganism

• The temperature of the tissues may rise, which can kill temperature-sensitive microbes.

لجدين بتيجي ال phagocytes بتلح البكتيريا وال dead cells



الخلية الحصاية بتفرز chemicals بالاول

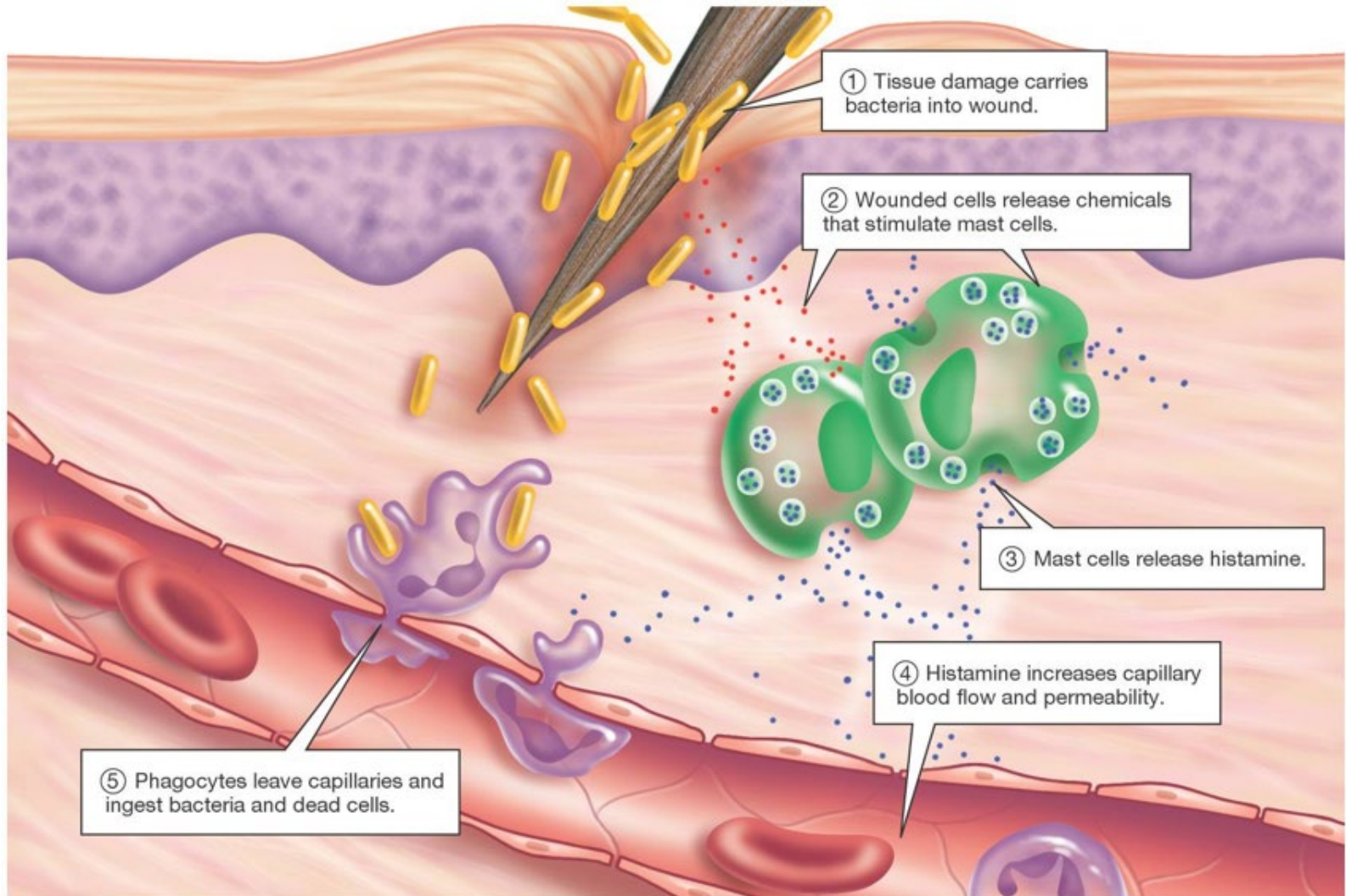
بتحاي كل هاد بصير activation له must

# Role of fever

- Fever is a defense mechanism that can destroy many types of microbes.
- Fever also helps fight viral infections by increasing interferon production.
- While high fevers can be dangerous, some doctors recommend letting low fevers run their course without taking aspirin or ibuprofen.



Ouch!



# Fever is caused by:

1. Toxins on the surface of viruses.
2. Release of histamines by damaged cells.
3. Your own body's accumulated toxins.
4. Your body's pyrogens signaling the hypothalamus.



# Adaptive immunity: second line of response

- Based upon resistance acquired during life
- Relies on genetic events and cellular growth
- Responds more slowly, over few days
- Is specific
  - each cell responds to a single epitope on an antigen
- Has anamnestic memory
  - repeated exposure leads to faster, stronger response
- Leads to clonal expansion

# Adaptive immunity: mechanisms

- Cell-mediated immune response (CMIR)
  - T-lymphocytes
  - eliminate **intracellular** microbes that survive within phagocytes or other infected cells
- Humoral immune response (HIR)
  - B-lymphocytes
  - mediated by antibodies
  - eliminate **extra-cellular** microbes and their toxins



**Plasma cell**  
(Derived from B-lymphocyte,  
produces antibodies)

# History of Immunology

كان لطاعون منتشر لاجلوا انه مجموعة مرضات  
 كونوا مناعة منه على الرغم من الفهم لاجلوا المصابين منه

دبار 15th century علماء صينيين وانراك

- 430 B.C.: Philosophers noted resistance to plague by those who recovered  
 "Only those who had recovered from plague can nurse for sick people because they would not contract the disease a second time"
- 15th century: Chinese and Turks use dried crusts of smallpox by inhalation or introduction into small cut of skin in order to prevent the disease
- 1796: Edward Jenner discovered that cowpox vaccination protected against smallpox. He inoculated an 8 years boy with fluids from a cowpox pustule and then intentionally infected the boy with smallpox but the child did not develop the disease

استخدموا او Dried crusts of smallpox

يملو inhalation ف جزء منهم يدرعنه

مناعة / او استخدموا على ر Skin cuts  
 to prevent disease



Jenner, 1796 الكشاف

او vaccination ل cowpox  
 6s smallpox

جانب fluids من  
 cowpox pustule

وطه بخلعوه و فكون مناعة

عقار من  
 Ethical

- In 1880: Pasteur discover Anti-cholera live-attenuated vaccine. He noticed that old cultures in his lab did not kill chicken after inoculation and that chicken become immune to cholera. He applies the same principle for anthrax and rabies vaccine



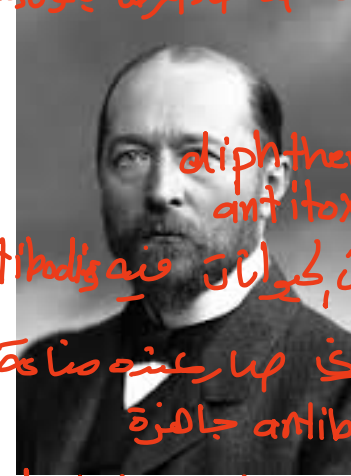
Pasteur اكتشف ال anti cholera / كان Vaccine

من مبي خلايا Choler موهرة و صغيفة و حصفنا ب Chicken فكونت صناعة

مب اار Vaccine كاله Killed-attenuated Virus لاد weaken

يعني ما بحصنه ب Vaccine life هبيك بنقله لمرضا ما مبي هبيك لبي احضر حجان الامانة همد هاد طرفن يكون antibodies

- In 1890: Von Behring and Kitasato discover diphtheriae antitoxin. They notice that serum from animals previously immunized to diphtheria could transfer the immune state to unimmunized animals



اكتشفوا ال diphtheria antitoxin

جايوا Serum من كيراتان فيه antibodies

و حصنو لحيوان ثاني هار عنده صناعة هبيك فخلت antibodies جالفة

- 1883 Ellie Metchinkoff that cells like phagocytes contribute to the immune state of animals



اكتشف ال phagocytes

هاي اصحا passive immunity لانه الجسم ما تقب و استغل اجبه ال antibodies جالفة

و هاد لمب ا استخدموه بحمان 2020 بشيخص مصاب ب كورونا بال ICU حصنوه بدم مريض طاب من كورونا

و عالم الدم ABO ونقل الدم لانه كانه مرة ترتبط مرة لا بسبب فصاحة المناعة للدم الغريب

AB صبياد antigen صباغة

# Blood Grouping and Immunology

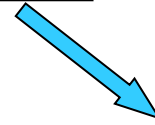
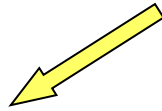
- Experiments with blood transfusions have been carried out for hundreds of years with out any success.
- In 1901, Karl Landsteiner discovered human blood groups, and blood transfusions became safer.
- He found that mixing blood from two individuals can lead to blood clumping. The clumped RBCs can crack and cause toxic reactions. This can be fatal.
- Karl Landsteiner work on blood grouping has discover the fundamental principles of Immunology



harmful materials inside our own body. The whole process can be understood as self-discrimination and elimination of foreign bodies in an attempt to create an internal equilibrium and provide physiological protection for the body. Thus, when the immune system is normal, health can be maintained. On the other hand, when the immune system is malfunctioning, disharmony will occur and give rise to illness. The above functions are carried out by an integrated body system, which includes organs (thymus, spleen and lymph nodes), tissues (skin and mucosal layers), cells (lymphocytes and macrophages) and cell products (immunoglobulin, antibodies and complement).

- When immune system is normal, health can be maintained.
- When the immune system is malfunctioning, disharmony will occur and give rise to illness.
- So the above functions are carried out by an integrated body system, which includes:
  - ✓ Organs (thymus, spleen and lymph node)
  - ✓ Tissues (skin and mucosal layers)
  - ✓ Cells (lymph cells and macrophage)
  - ✓ Cell products (immunoglobulin, antibodies and complement).

# Immune system

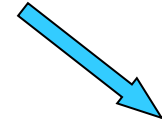
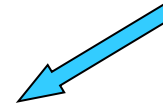


## Innate (non-specific) immunity

- Anatomic barriers (Skin,mucous membranes)
- Physiological barriers (temperature, pH)
- Phagocytic Barriers (cells that eat invaders)
- Inflammatory barriers (redness, swelling, heat and pain)

## Adaptive (specific) immunity

- Antigen specificity
- Diversity
- Immunological memory
- Self/nonself recognition



Humoral

Cellular

# Immunology- The Balance

اذا صار في حلق. بيها ز المناعة

بصير في Autoimmune Disease

بصير يميز اد antigens الطبيعية  
الى عالقدريا اذ احياء غريبة  
وتصيب النساء اكثر

الاعطال بنخلقوا بمشكلة جينية بتمنع اد T cells  
او B cells

او اد 2 ضاعفاً يمرضوا

وغالباً يموتوا

Hyporeactive  
Immunodeficiency

Hyperreactive  
Immunopathology

Health

Neutrophil Disorders  
Antibody Deficiency  
Complement  
Deficiency  
T & B Cells Dysfunction

Systemic  
Autoimmunity  
Organ-Specific  
Autoimmunity  
Allergies and Asthma



**Wear a mask. Save lives.**

Wear a mask

Clean your hands

Keep a safe distance