HARVARD SUMMER PROGRAM
IMMUNOLOGY PROJECT

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BELFAST AREA HIGH SCHOOL
BELFAST, MAINE
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(REFERENCES ON LAST SLIDE)
WHAT WERE THESE RECENT TOPICS?

- EVOLUTION
  - WHY DO SCIENTISTS BELIEVE LIFE HAS EVOLVED?
  - IN THE PAST WHAT WAS THE BIGGEST EVIDENCE FOR EVOLUTION?
  - WHAT MODERN TOOLS/KNOWLEDGE DO SCIENTISTS LOOK FOR KNOW?
VIRUSES---------BACTERIA

- LIVING?
- WHY NOT?
- WHY ARE VIRUSES IMPORTANT TO LIVING BEINGS?

- LIVING?
- WHICH KINGDOMS ARE BACTERIA IN?
- WHAT TYPE OF CELLS ARE BACTERIA?
HOW LONG HAVE BACTERIA AND VIRUSES BEEN AROUND?

- MILLIONS OF YEARS?
- DO THEY EvOLVE OR ADAPT?
- HOW MANY VIRUSES ARE THERE? BACTERIA?
- WHY ARE WE STILL ALIVE?
HOW DO WE SURVIVE 1,000,000’S OF BACTERIA AND VIRUSES?

- WHAT IS AN IMMUNE SYSTEM?
- AFTER AN ANIMAL DIES - WHAT HAPPENS WITHIN A MONTH?
- YOUR IMMUNE SYSTEM IS DOING AN INCREDIBLE AMOUNT OF WORK, USUALLY WITHOUT YOU EVEN REALIZING IT
- WHEN DO PEOPLE USUALLY THINK ABOUT THEIR IMMUNE SYSTEM?
WHERE IS YOUR IMMUNE SYSTEM LOCATED IN YOUR BODY? HAVE YOU HEARD OF THESE ORGANS BEFORE?
WOW, YOUR IMMUNE SYSTEM IS EVERYWHERE!!

- ONE OF THE BIGGEST PARTS OF YOUR IMMUNE SYSTEM WASN’T LOCATED ON THAT PICTURE - WHAT DO YOU THINK IS THE 1ST LINE OF DEFENSE AGAINST BACTERIA AND VIRUSES ENTERING YOUR BODY?

- YOUR SKIN!! THE 1ST LINE OF DEFENSE IN YOUR IMMUNE SYSTEM
WHERE CAN BACTERIA AND VIRUSES GET PAST THE SKIN WHEN IT ISN’T CUT?

- MOUTH - WHAT’S IN YOUR MOUTH THAT COULD STOP THEM?
- EYES - WHAT’S IN YOUR EYES THAT COULD STOP THEM?
- NOSE - WHAT’S IN YOUR NOSE THAT COULD STOP THEM
- HOW/WHY DID SALIVA, TEARS (LYSOZYME), AND MUCUS DEVELOP?
WHY DO WE NEED ANYTHING BESIDES SKIN?

- If a bacteria or virus does get into the body, the immune system detects it as a foreign **antigen** and wants to eliminate it before it can make itself a home and replicate.

- If the virus or bacteria is able to replicate and starts causing problems, your immune system is in charge of eliminating it.
WHERE ARE THESE IN YOUR BODY AGAIN?

THYMUS

SPLEEN

LYMPH SYSTEM

BONE MARROW

Adenoid
Tonsil
Lymph nodes
Right lymphatic duct, entering vein
Thoracic duct, entering vein
Thymus
Thoracic duct
Peyer’s patch (small intestine)
Appendix
Bone marrow
Lymphatic vessels

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THE THYMUS!

- LOCATED DOWN FROM YOUR NECK BETWEEN YOUR BREASTBONE AND YOUR HEART
- WHERE A TYPE OF WHITE BLOOD CELL CALLED T-CELL LYMPHOCYTES NEED TO MATURE
- ESPECIALLY IMPORTANT FOR DEVELOPING BABIES
THE SPLEEN

- LOCATED ABOVE THE STOMACH AND BELOW THE DIAPHRAGM (LUNGS)
- ITS JOB IS TO FILTER YOUR BLOOD LOOKING FOR FOREIGN CELLS (ANTIGENS)
- WHAT DO YOU THINK A PERSON WITHOUT A SPLEEN WOULD HAVE HAPPEN MORE OFTEN?
THE LYMPH SYSTEM

- YOU’VE PROBABLY HEARD OF LYMPH NODES, DID YOU KNOW THEY WERE ALL OVER YOUR BODY?
- NODES ARE CONNECTED BY LYMPH VESSELS WHICH CARRIES A FLUID CALLED LYMPH (LIKE YOUR BLOOD VESSELS CARRYING BLOOD)
- MAIN JOB = FILTER AND REMOVE BACTERIA
- GET HELP FROM MANY LYMPHOCYTES (WBCS) THAT STAY IN THE NODES
- WHY DO YOUR LYMPH NODES SWELL WHEN YOU ARE SICK?
THE BONE MARROW

- PRODUCES NEW BLOOD CELLS, BOTH RED BLOOD CELLS (RBCS) AND WHITE BLOOD CELLS (WBCS)
- YOUR WHITE BLOOD CELLS ARE EXTREMELY IMPORTANT FOR YOUR IMMUNE SYSTEM!!
YOU HAVE HEARD OF RED BLOOD CELLS

THERE ARE 5 MAJOR TYPES OF WHITE BLOOD CELLS! - MANY WITH FUNNY NAMES

NEUTROPHILS, LYMPHOCYTES, MONOCYTES, EOSINOPHILS AND BASOPHILS - THEY HAVE DIFFERENT JOBS SO YOU WILL NEED TO KNOW SOME OF THEIR NAMES BESIDES JUST WHITE BLOOD CELLS.
NEUTROPHIL

- MOST OF YOUR WBCS ARE NEUTROPHILS
- BONE MARROW PRODUCES TRILLIONS OF THEM EVERYDAY, THEY GENERALLY LIVE LESS THAN A DAY
- ATTRACTED TO FOREIGN PARTICLES, INFLAMMATION, AND BACTERIA
- SEARCHES OUT AND DESTROYS!
- WHAT DO YOU THINK PUS IS?
EOSINOPHILS AND BASOPHILS

- MUCH LESS COMMON
- EOSINOPHILS FOCUS ON PARASITES!
- BASOPHILS CARRY HISTAMINE AND HELP CAUSE INFLAMMATION
- WHY WOULD INFLAMMATION HELP AN INFECTION?
MONOCYTES

- MONOCYTES END UP BEING CALLED A VARIETY OF NAMES SUCH AS MACROPHAGES AND DENDRITES
- THESE WBCS LIKE TO CLEAN UP
- THEY INGEST BACTERIA, MICROBES, DUST, SMOKE, DEAD NEUTROPHILS - PHAGOCYTOSIS
- ANIMATION

http://www.stolaf.edu/people/giannini/flashanimation/cellstructures/cell.swf
MONOCYTES - MACROPHAGES AND DENDRITES - PHAGOCYTOSIS
LYMPHOCYTES

- AT THE MOMENT, LYMPHOCYTES ARE GOING TO BE THE MOST COMPLICATED
- T LYMPHOCYTES AND B LYMPHOCYTES
- T HELPER AND T CYTOTOXIC LYMPHS
- B PLASMA AND B MEMORY LYMPHS
T HELPER LYMPHOCYTE JOB

- T HELPER LYMPHS - ACTIVATED BY MACROPHAGES/DENDRITES
- T HELPER LYMPHS THEN SEND OUT PROTEIN MESSENGERS TO ACTIVATE CYTOTOXIC T CELLS, B CELLS AND MORE T HELPER LYMPHOCYTES!
T CYTOTOXIC LYMPHOCYTE JOB

- T CYTOTOXIC LYMPHS (KILLER T CELLS) ARE ACTIVATED BY T HELPER MESSENGERS
- T CYTOTOXIC LYMPHS SEARCH OUT AND DESTROY CELLS INFECTED WITH THAT BACTERIA ANTIGEN (OR VIRUS, WORM, ETC)
Cell-mediated Immunity

Infected cell

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B LYMPHOCYTES
B PLASMA CELLS AND B MEMORY CELLS

- Activated by foreign antigens, macrophages and T helper lymph messengers.
- B plasma cells will make specific antibodies to the invading bacteria (virus, worm, etc.).
- B memory cells will hang out and remember that foreign antigen in case it infects the body again --> quickly producing plasma B cells to make antibodies against the invader!
ANTIBODIES!

IgG, IgM, and IgE

Neutralization

Agglutination

Precipitation

Activation of complement

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WHAT ARE VACCINATIONS?

- WHAT HAPPENS WHEN YOU ARE EXPOSED TO A FOREIGN ANTIGEN?
- WHAT WILL HAPPEN IF YOU NOW ARE EXPOSED AGAIN?
- WHAT THINGS HAVE YOU BEEN VACCINATED AGAINST?
YOUR IMMUNE SYSTEM!
WHAT ARE SOME OF YOUR NEW WORDS IN YOUR IMMUNE SYSTEM?
AND HOW DOES EVOLUTION FIT IN?

- DO ALL LIVING ORGANISMS HAVE IMMUNE SYSTEM?
- CAN ALL LIVING ORGANISMS BE INFECTED BY THE SAME VIRUS?
- CAN ALL LIVING ORGANISMS BE INFECTED BY THE SAME BACTERIA?
- WHAT COULD THIS TELL SCIENTISTS?
SO TELL ME WHAT HAPPENS NEXT!

The inflammatory response is the body's second line of defense against invasion by pathogens. Why is it important that clotting factors from the circulatory system have access to the injured area?

1. Damaged tissues release histamine, increasing blood flow to the area.
2. Histamines cause capillaries to leak, releasing phagocytes and clotting factors into the wound.
3. Phagocytes engulf bacteria, dead cells, and cellular debris.
4. Platelets move out of the capillary to seal the wounded area.
Invader antigens are everywhere!

What does it need to get by?

Skin!

- neutrophils
- Monoctyes (macrophages)

Invader dies!

- T - Helper lymphs
  - More T - Helper lymphs!
  - Cytotoxic T lymphs

Invader dies!!

- B lymphs
  - Memory B cells
  - Plasma B cells

Invader dies!!

Antibodies!!
Can you think of any way the immune system is interesting to you?

- Colds?
- Flus?
- Worms?
- Cancer?
- Autoimmunity?
- Allergies?
- Testing for some of the nasty critters that can infect you?
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