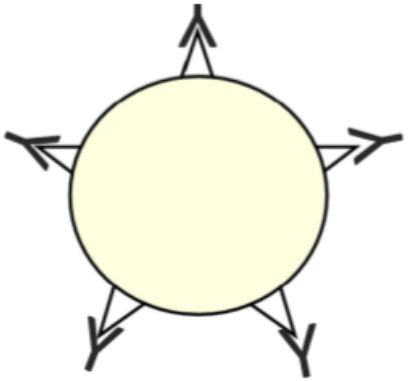


Defense Against Infectious Disease

Stephen Taylor
Bandung International School

Diseases can be *pathogenic* or *non-pathogenic*

(infectious) (non-infectious)

See if you can categorise these diseases:

pathogenic or *non-pathogenic*

Pathogenic or Non-Pathogenic?

Grade 10 Pathogens & Disease

Stephen Taylor

Bandung International School

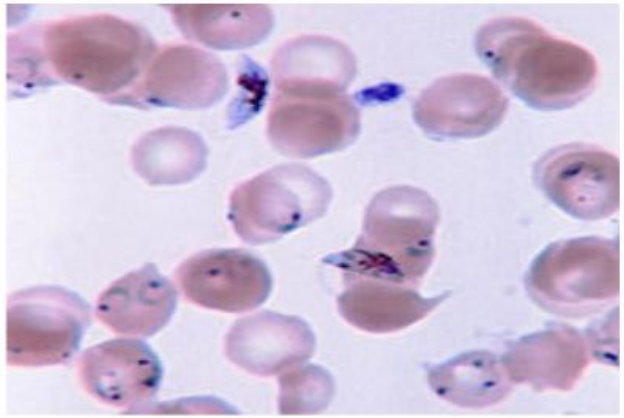
Image: 'virus'
www.flickr.com/photos/14784969@N08/2192450204

http://www.slideshare.net/gurustip/pathogenic-or-nonpathogenic

A pathogen is a disease-causing organism

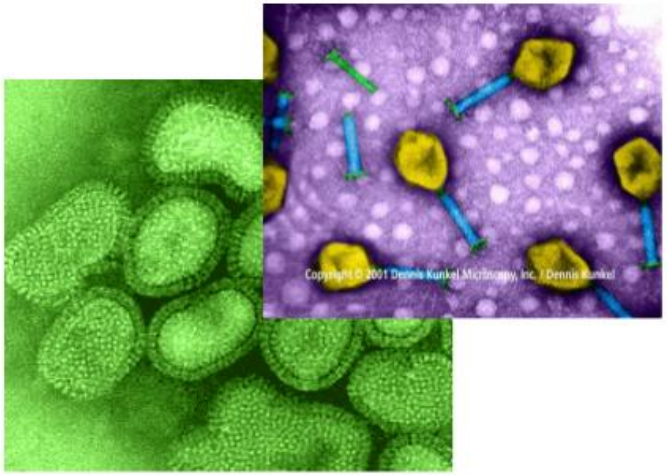
Bacteria, e.g. *E. Coli*

http://www.thebacteriabusters.com/E_coli_O157H7.jpg



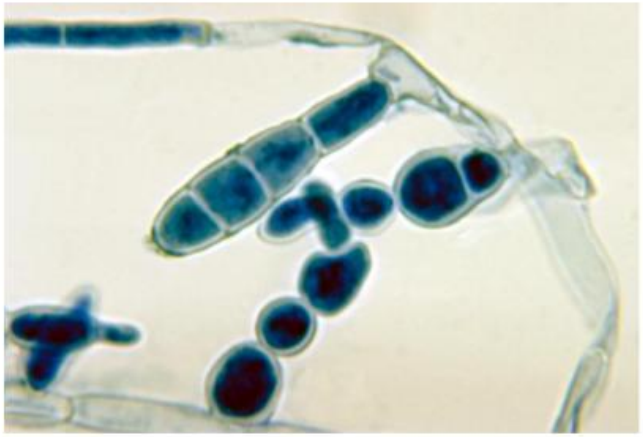
Protozoa, e.g. malaria parasite

http://en.wikipedia.org/wiki/Malaria



Viruses, e.g. *Influenza*, HIV

http://www.estrellamountain.edu/faculty/farabee/biobk/BioBookDiversity_1.html



Fungi, e.g. *Epidermophyton* (Athlete's foot)

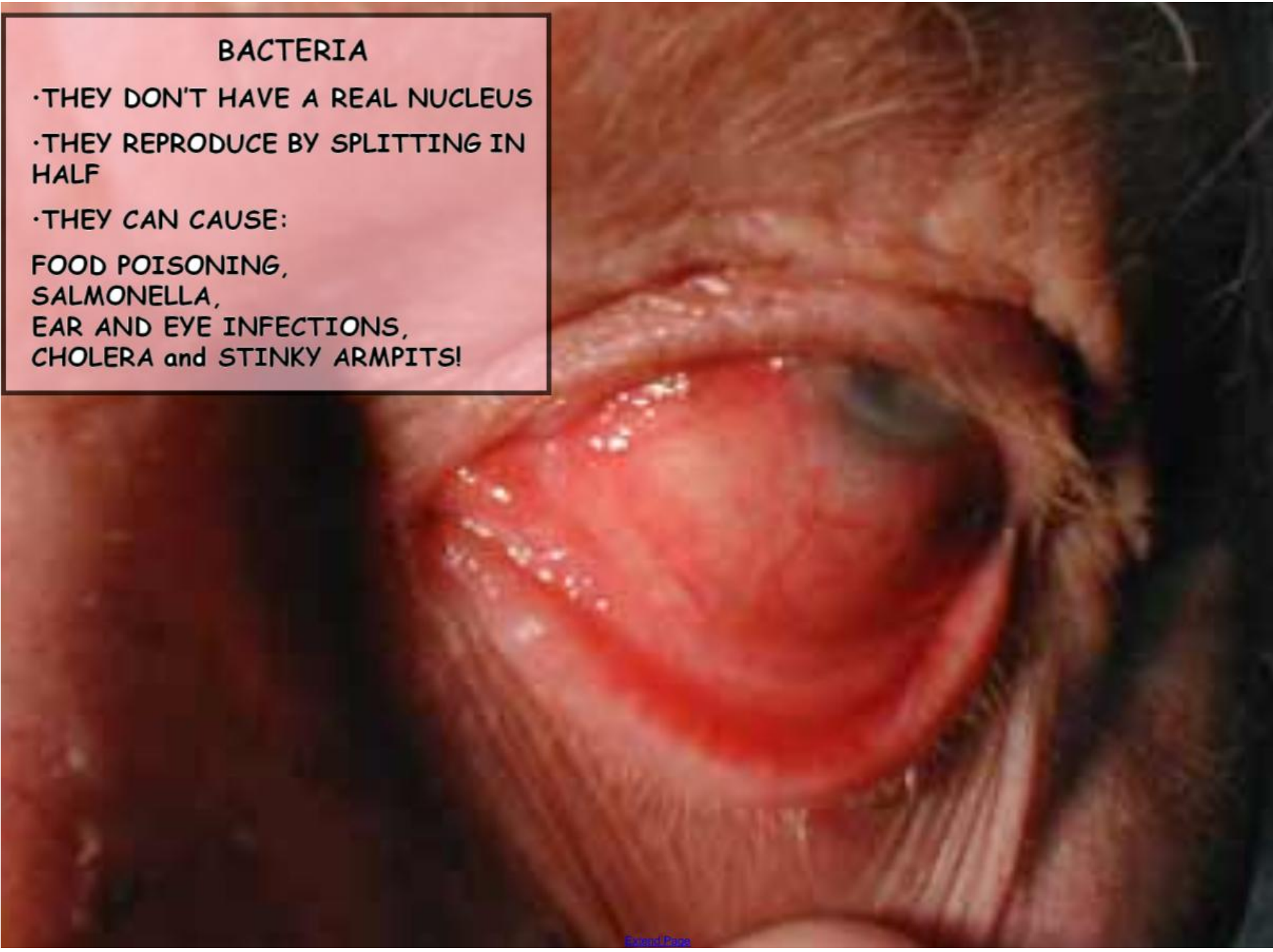
A bacterium walked into a restaurant.

"I'd like a pizza please," he said.

"I'm sorry, we're not doing food today," the waiter replied.

"Why not?"

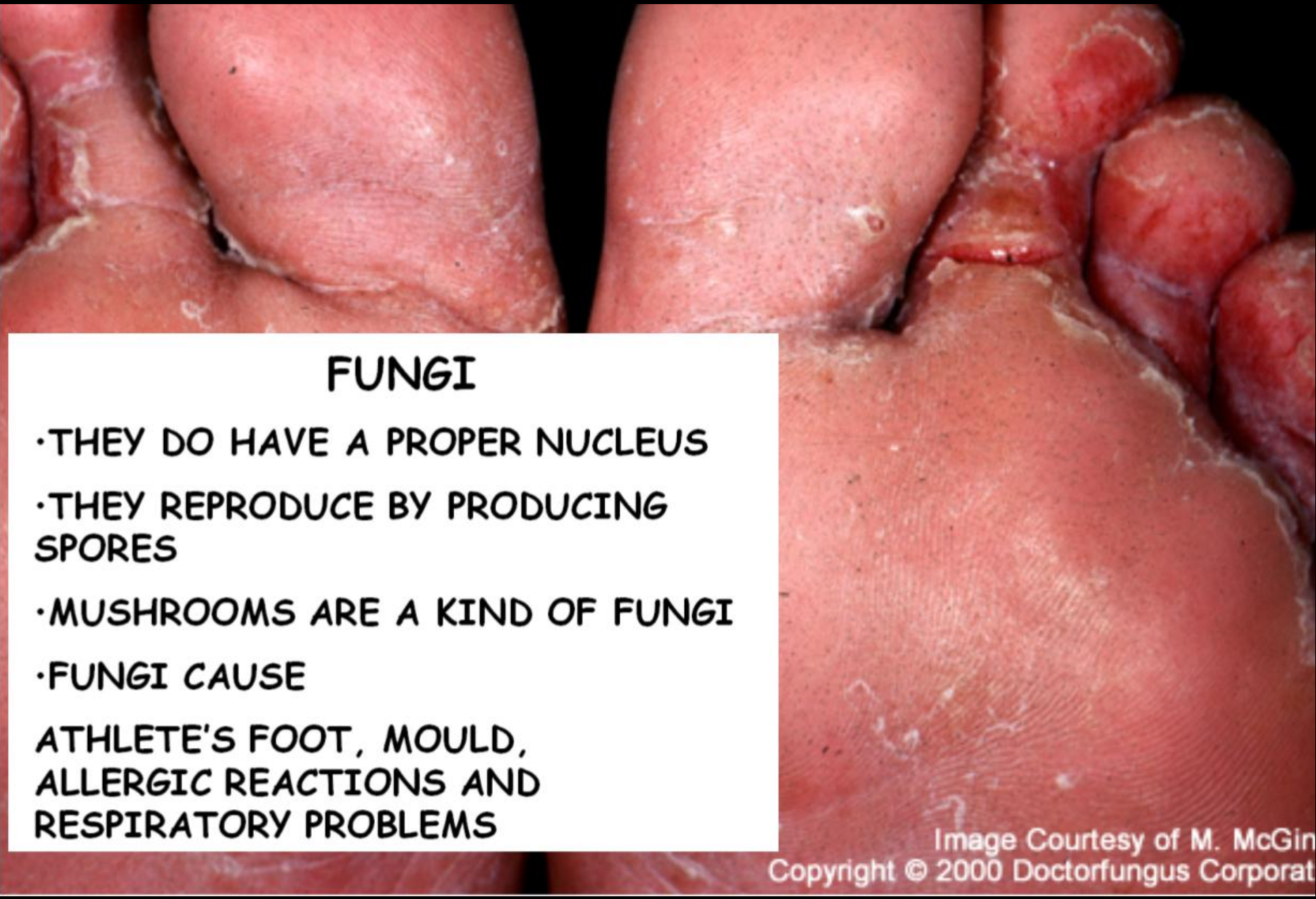
"We don't have the staph."


BACTERIA
·THEY DON'T HAVE A REAL NUCLEUS
·THEY REPRODUCE BY SPLITTING IN HALF
·THEY CAN CAUSE:
FOOD POISONING,
SALMONELLA,
EAR AND EYE INFECTIONS,
CHOLERA and STINKY ARMPITS!

VIRUSES

- THEY HAVE DNA BUT NO NUCLEUS
- THEY NEED TO ATTACH TO ANOTHER CELL TO REPRODUCE
- THEY CANNOT BE KILLED BY ANTIBIOTICS
- THEY CAUSE THE COLD, FLU, MRSA, HIV AND AIDS, and many more…

http://reformationnation.files.wordpress.com/2007/12/ebola.jpg



FUNGI

- THEY DO HAVE A PROPER NUCLEUS
- THEY REPRODUCE BY PRODUCING SPORES
- MUSHROOMS ARE A KIND OF FUNGI
- FUNGI CAUSE

ATHLETE'S FOOT, MOULD, ALLERGIC REACTIONS AND RESPIRATORY PROBLEMS

Image Courtesy of M. McGin

Protozoans are the 'first animals'.
They are heterotrophic and can be symbiotic or parasitic.
Malaria is the best-known protozoan disease.
This man has a disease called *leishmania*.

http://abyssaldepths.wordpress.com/2008/04/28/warning-disturbing-visual-images/

Paramecium: an example of a (non-pathogenic) protozoan

Take a small sample of water from the school pond.

Add a few drops to a concave slide and see if you can observe the movement of paramecium in the water.

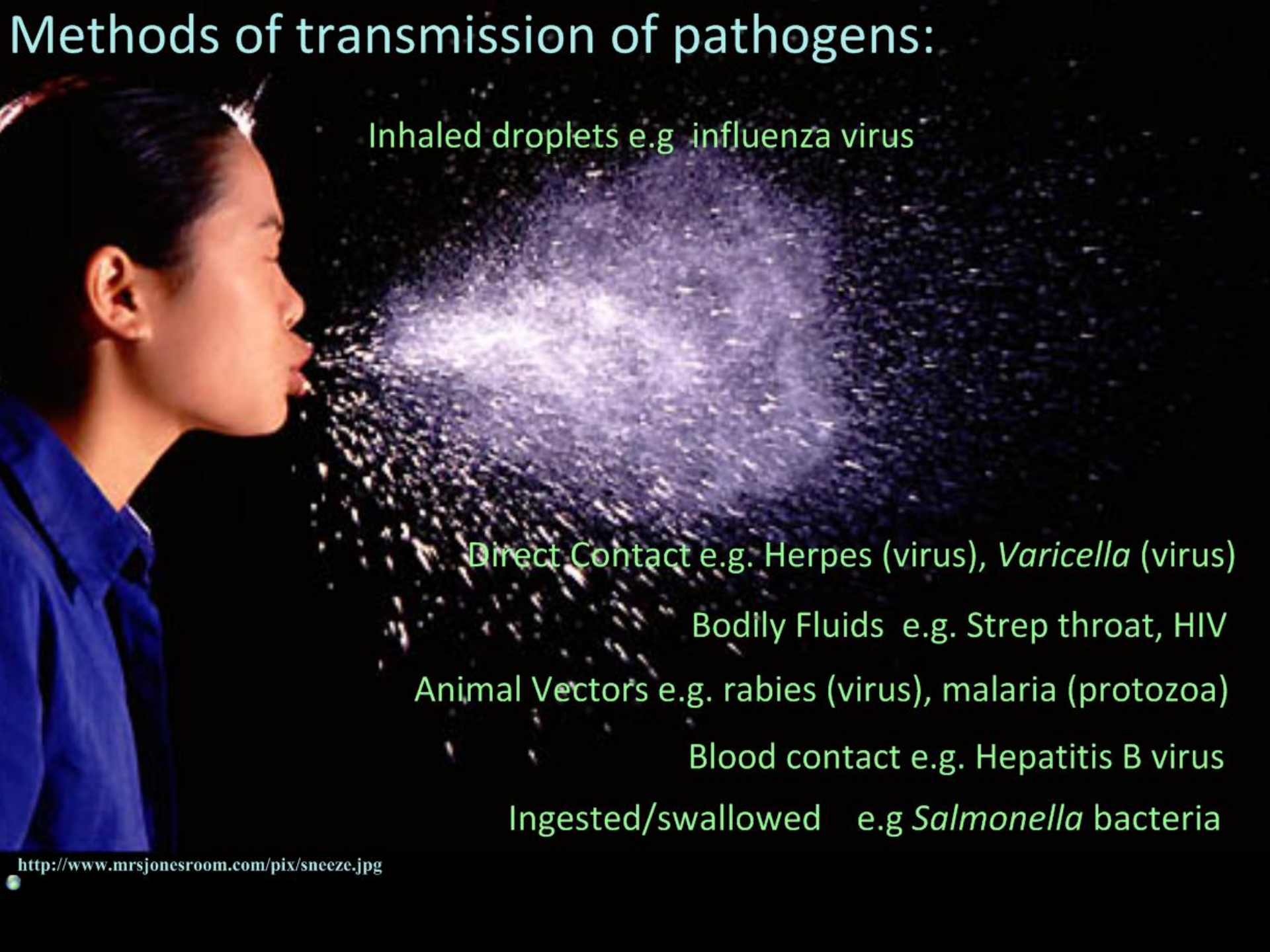
Record your observations.

http://www.youtube.com/watch?v=fmwN_mD7TvY

What pattern of movement did you observe?

Did you see any 'eating'? If so, describe what happened.

Methods of transmission of pathogens:



Inhaled droplets e.g influenza virus

Direct Contact e.g. Herpes (virus), *Varicella* (virus)

Bodily Fluids e.g. Strep throat, HIV

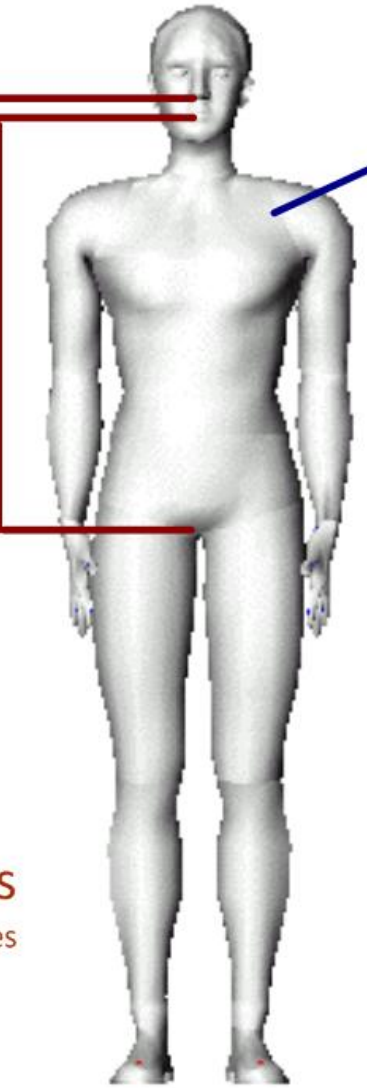
Animal Vectors e.g. rabies (virus), malaria (protozoa)

Blood contact e.g. Hepatitis B virus

Ingested/swallowed e.g *Salmonella* bacteria

http://www.mrsjonesroom.com/pix/sneeze.jpg

Physical barriers against pathogens:



Mucous Membranes

sticky mucus
- traps invaders

pH
- not favourable to pathogens

lysozyme
- enzymes break down pathogens

natural organisms
- competitive exclusion by non-harmful microbes

Skin

continuous
- hard to find an opening

many layers/tough

dry

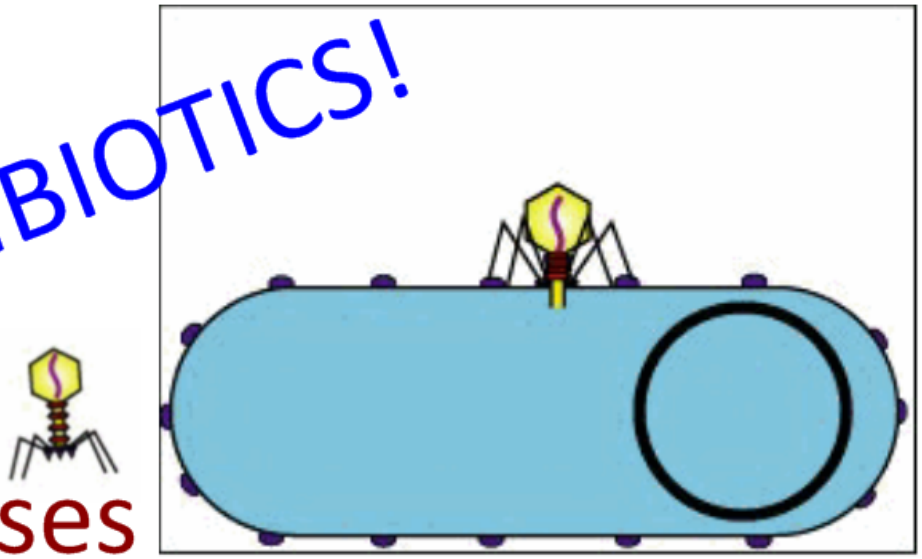
pH
- not favourable to pathogens

lysozyme
- enzymes break down pathogens

natural organisms
- competitive exclusion by non-harmful microbes

Viruses vs Bacteria

NO ANTIBIOTICS!



viruses

bacteria

small (100nm = 1/10µm)	SIZE	larger (1µm)
no - has a protein coat	CELL WALL	yes
No - has RNA	DNA?	Yes, in loops
No - RNA is free	NUCLEUS	No - has a nucleiod
Has spikes for invasion	CELL SURFACE	Has flagella for movement and pili for recognition

http://biology.about.com/od/virology/a/aa11108a.htm

All this fits inside a... plant cell (100µm)

10µm

animal cell (15µm)

nucleus (6µm)

membrane thickness (10nm)

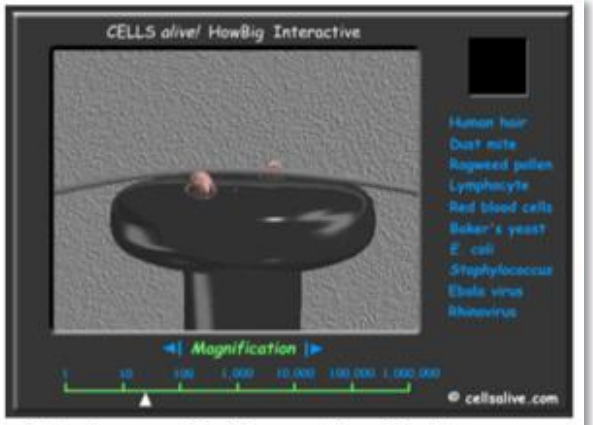
ribosome (20nm)

mitochondria (3µm)

bacterium (1µm)

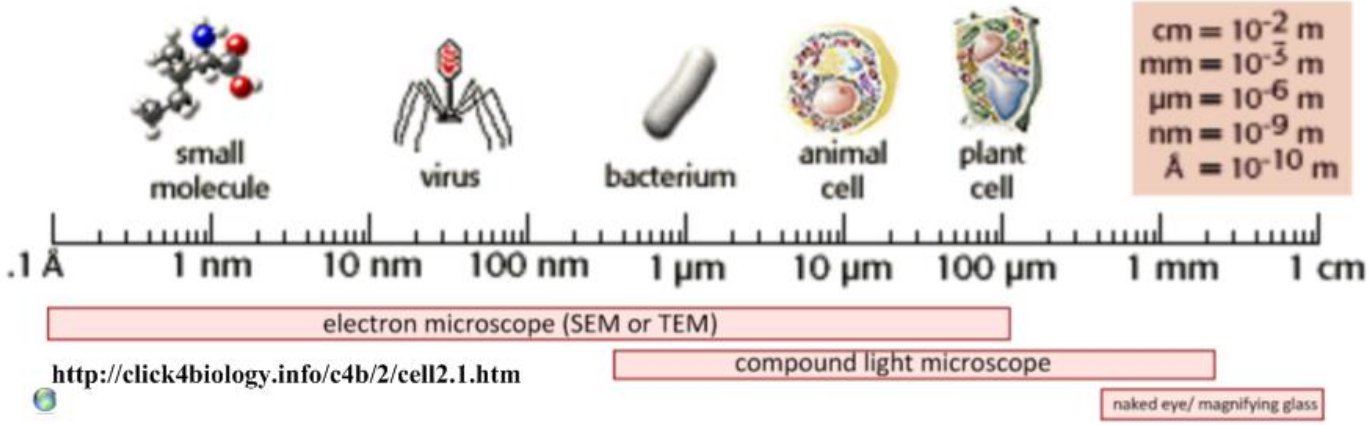
virus (100nm)

molecules (1nm)



http://www.cellsalive.com/howbig.htm

Review!

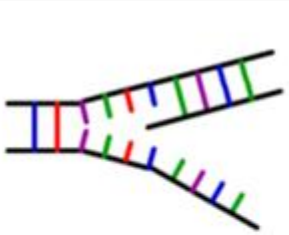


http://click4biology.info/c4b/2/cell2.1.htm

Cell Theory

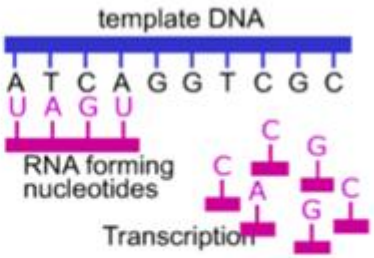
How do antibiotics work?

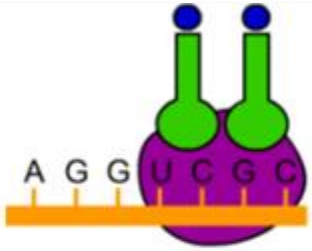
They block specific metabolic pathways:



DNA replication

cell wall and membrane

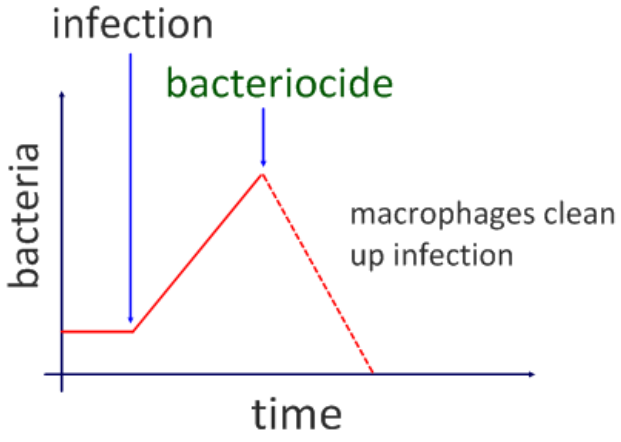


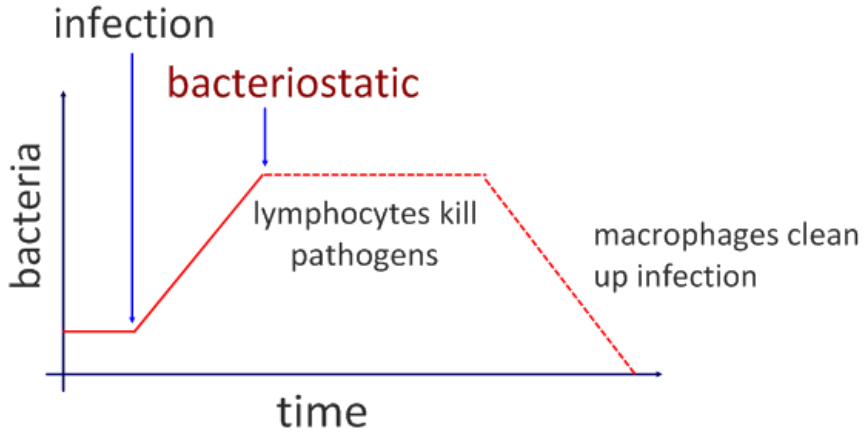


RNA translation

great tutorial: **http://www.hhmi.org/biointeractive/Antibiotics_Attack/frameset.html**

Antibiotics can be bacteriocides or bacteriostatic:

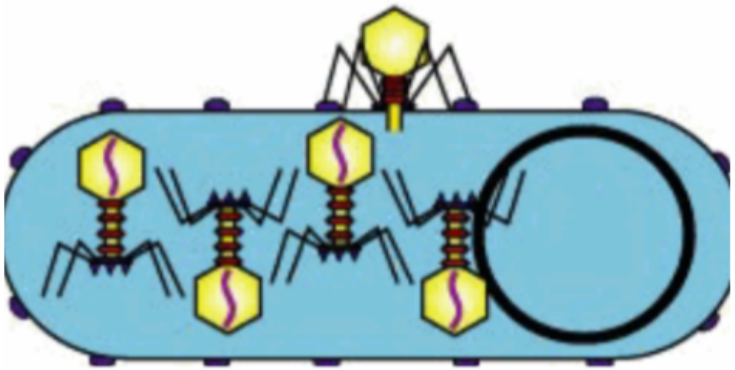




after **http://click4biology.info/c4b/6/hum6.3.htm#one**

Why don't antibiotics work against viruses?

viruses use
host cell metabolism



viruses have different metabolic pathways to bacteria - so the antibiotic drugs have nothing to target

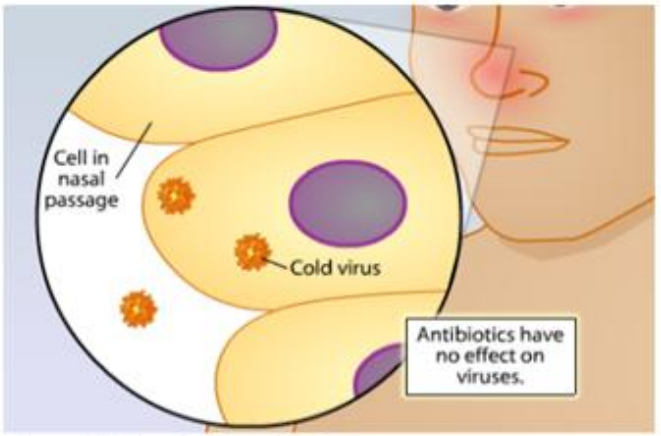
viruses are protected
by the host cell structure

viruses have different structures, e.g. protein coat instead of cell wall

Indiscriminate use of antibiotics can lead to antibiotic resistance

- antibiotics become ineffective against bacteria
- example of evolution by natural selection
- over many generations, multiple-resistant strains of bacteria can develop

Look it up: MRSA (the hospital superbug)

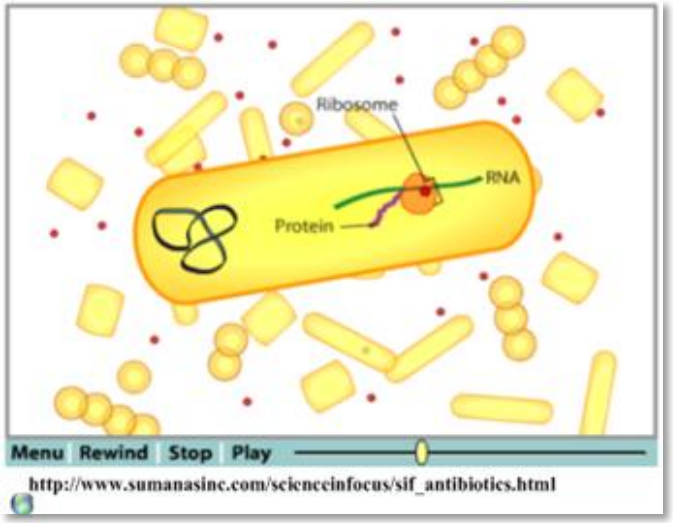


Antibiotic resistance:
http://www.sumanasinc.com/scienceinfocus/sif_antibiotics.html

Extend Page

Antibiotic Resistance: evolution in action

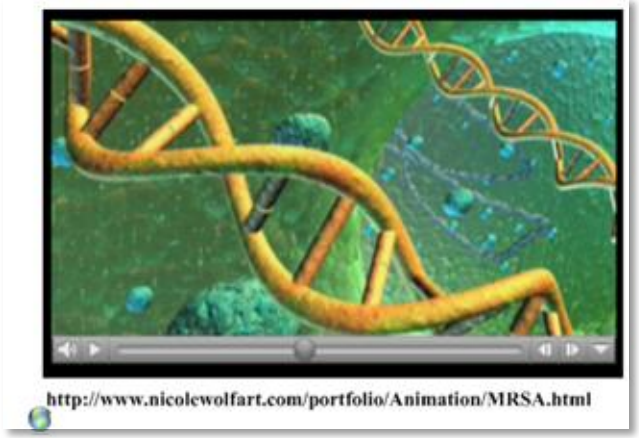
Staphyloccoccus aureus - bacteria



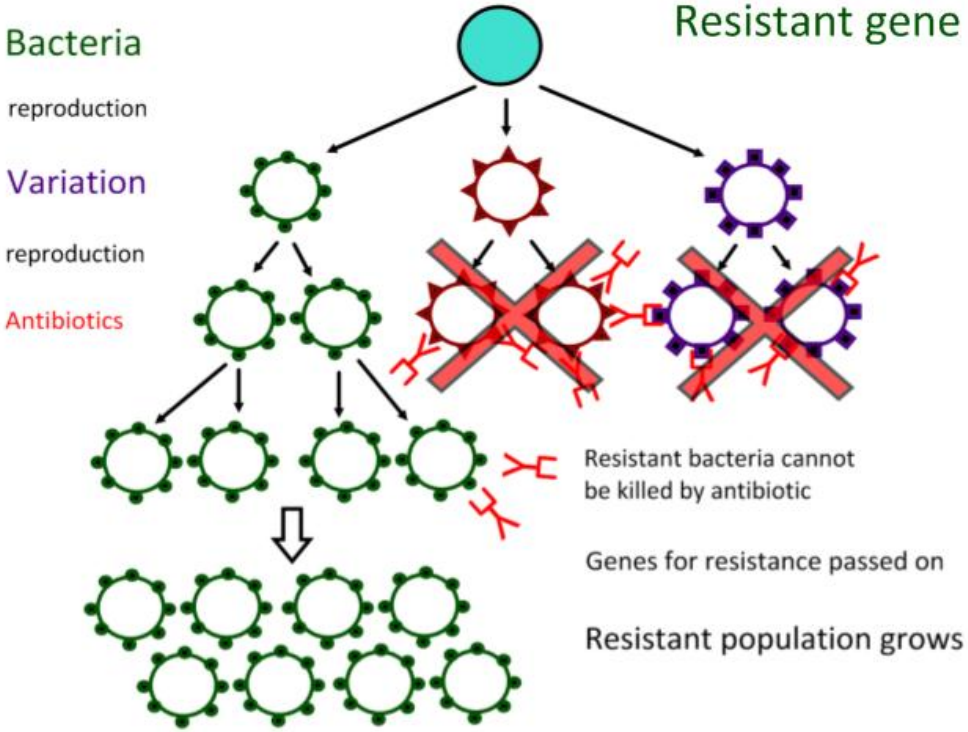
Variation: Methycillin-*resistant* (MRSA)
Methycillin-*susceptible* (MSSA)

Environmental change: application of methycillin

Result: MSSA is killed
MRSA survives
MRSA reproduces
Resistant gene proliferates



MRSA population increases



MRSA is dominant strain

Methycillin is no longer effective against infection

Go back and revise Evolution!

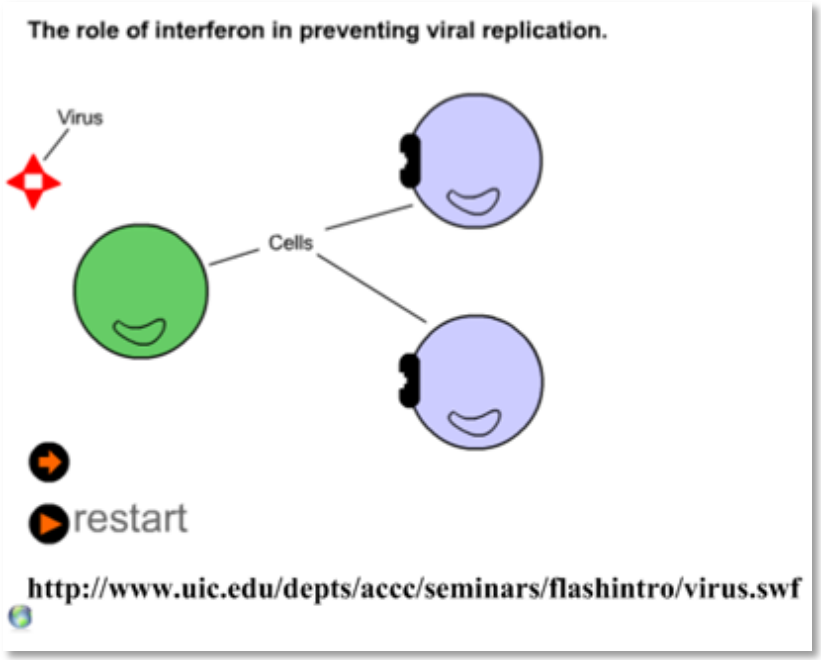
How are antiviral drugs effective against viruses?

- Interferons stimulate the immune system to prevent replication of the invading virus.

- some antivirals target specific proteins

- many others target a specific stage of the viral life cycle

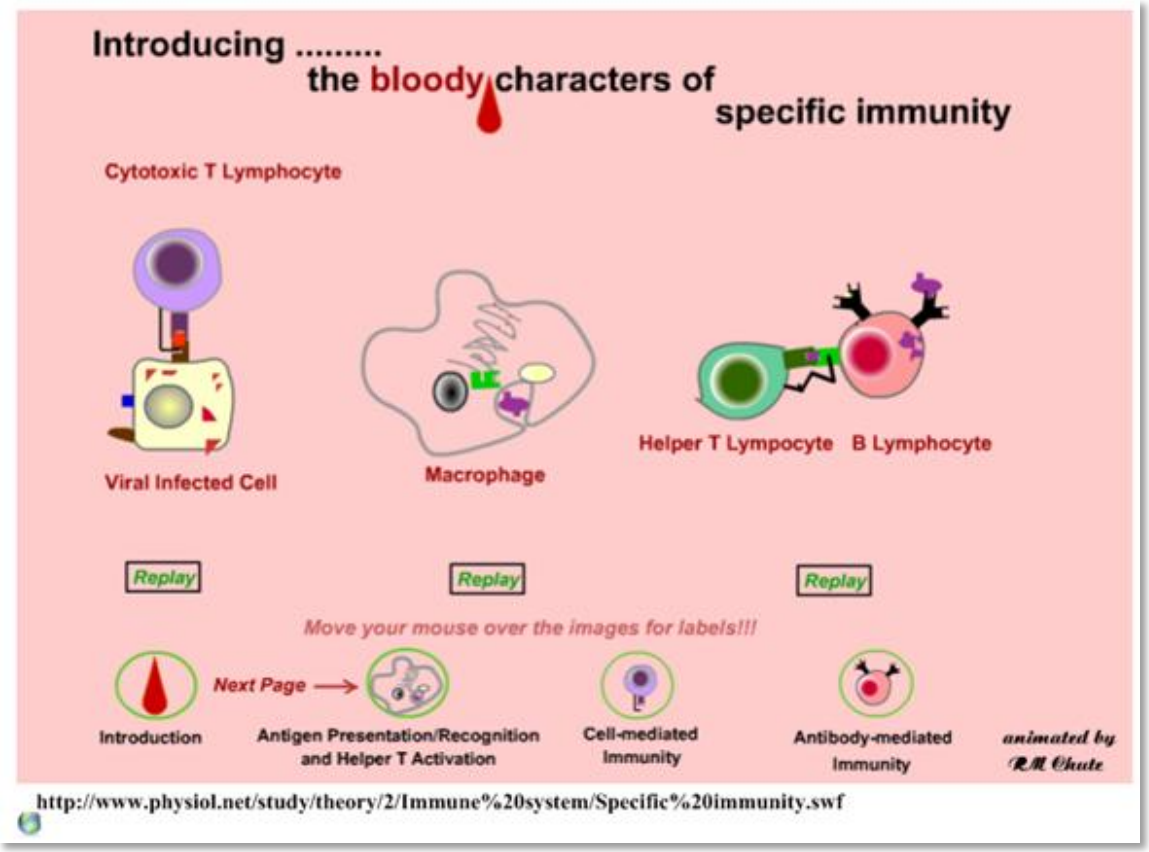
  (attachment, release of genes, replication, manufacture, release of new viruses)



When you have a viral infection, you are prescribed a specific antiviral drug for that pathogen - don't use anything else!

Leukocytes
(white blood cells)

- **Phagocytes**
  - **Neutrophil** — bacteria/fungi
  - 'vacuum cleaners'
- **Oesinophil** — parasites
- **Basophil** — allergies
- **Lymphocytes** — help
  - B-cells
  - T-cells
  - Killer cells

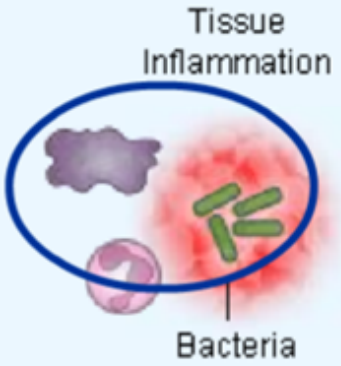


If a pathogen enters the body, the first line of defense are:

Phagocytic leukocytes

'eating' cells white blood cells

Phagocytosis - How your body eats microbes and cellular debris



- Macrophages and neutrophils are attracted out of the bloodstream to a site of inflammation in the body by chemicals released when micro-organisms, such as bacteria, damage the body's tissues.

PLAY AGAIN NEXT

http://www.mydr.com.au/health-images/animation-phagocytosis

Neutrophil on the warpath:

http://youtube.com/watch?v=MgVPLNu_S-w

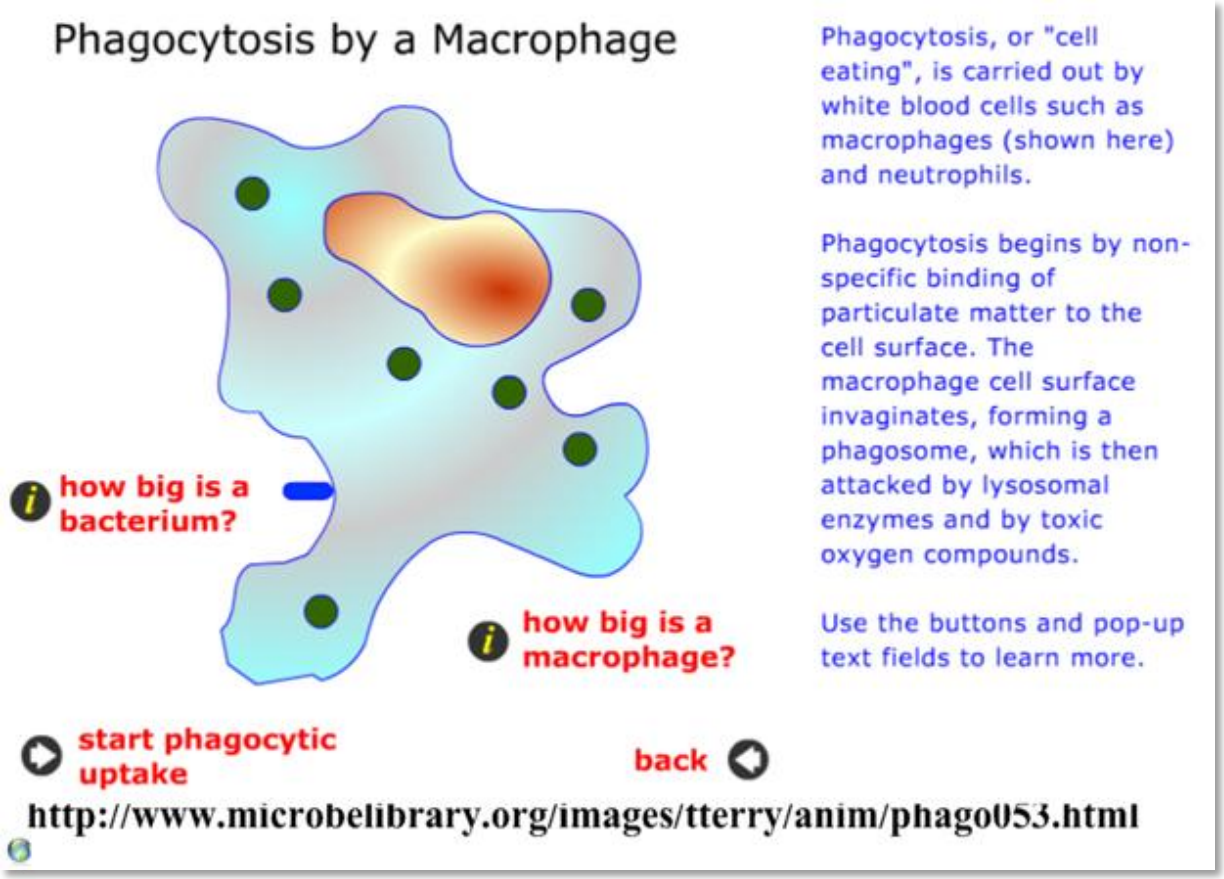
This white blood cell is engulfing a bacterium which ends up in its cytoplasm.

http://www.kscience.co.uk/animations/phagocyte.htm

Phagocytosis

Macrophages engulf foreign bodies:

- detect and move towards particle by chemotaxis
- flow over particle
- engulf
- lysosomes release lysozymes, killing and digesting microbes.

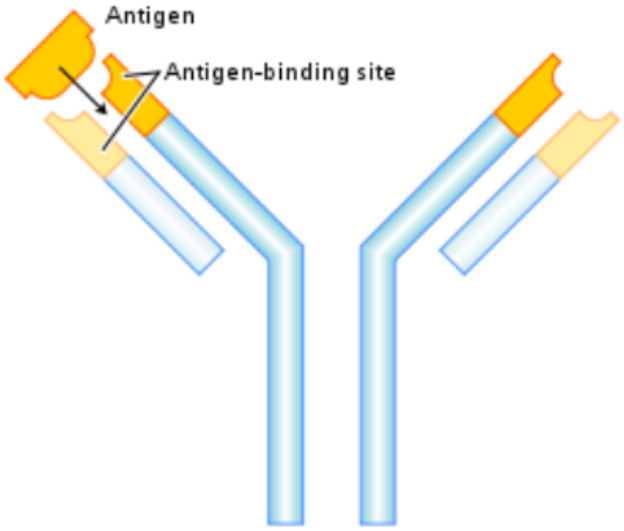


http://216c.sl.pt

Revise: Membranes

http://216d.sl.pt

Revise: Eukaryotes



http://www.antibody2.com/

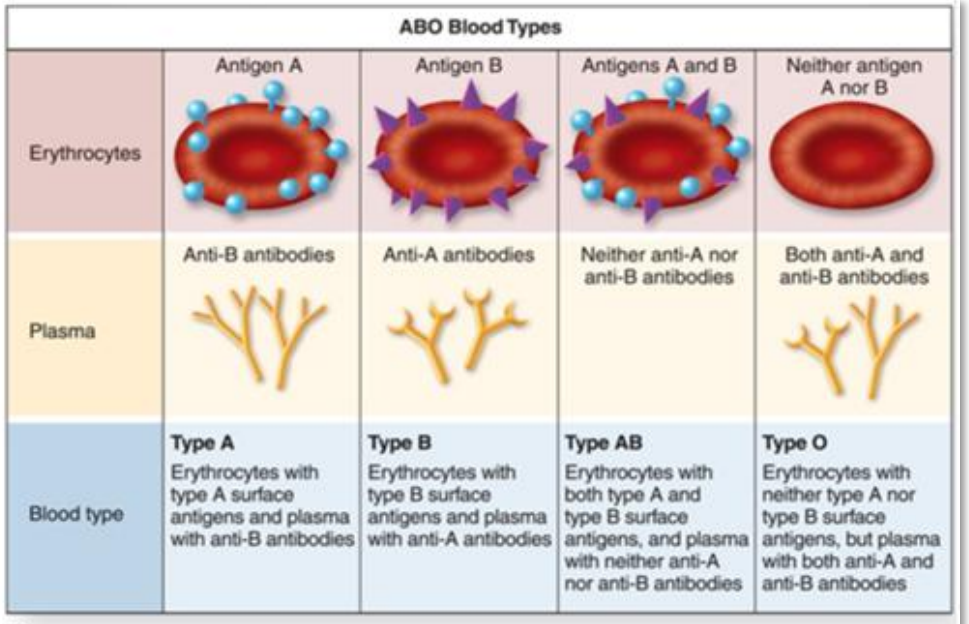
Antigen: a substance or molecule, often found on a cell or virus surface, that causes antibody formation (characteristic to the surface of a cell/ cell type)

Antibody: a globular protein that recognises a specific antigen and binds to it as part of an immune response.

Antibodies are specific to certain antigens.

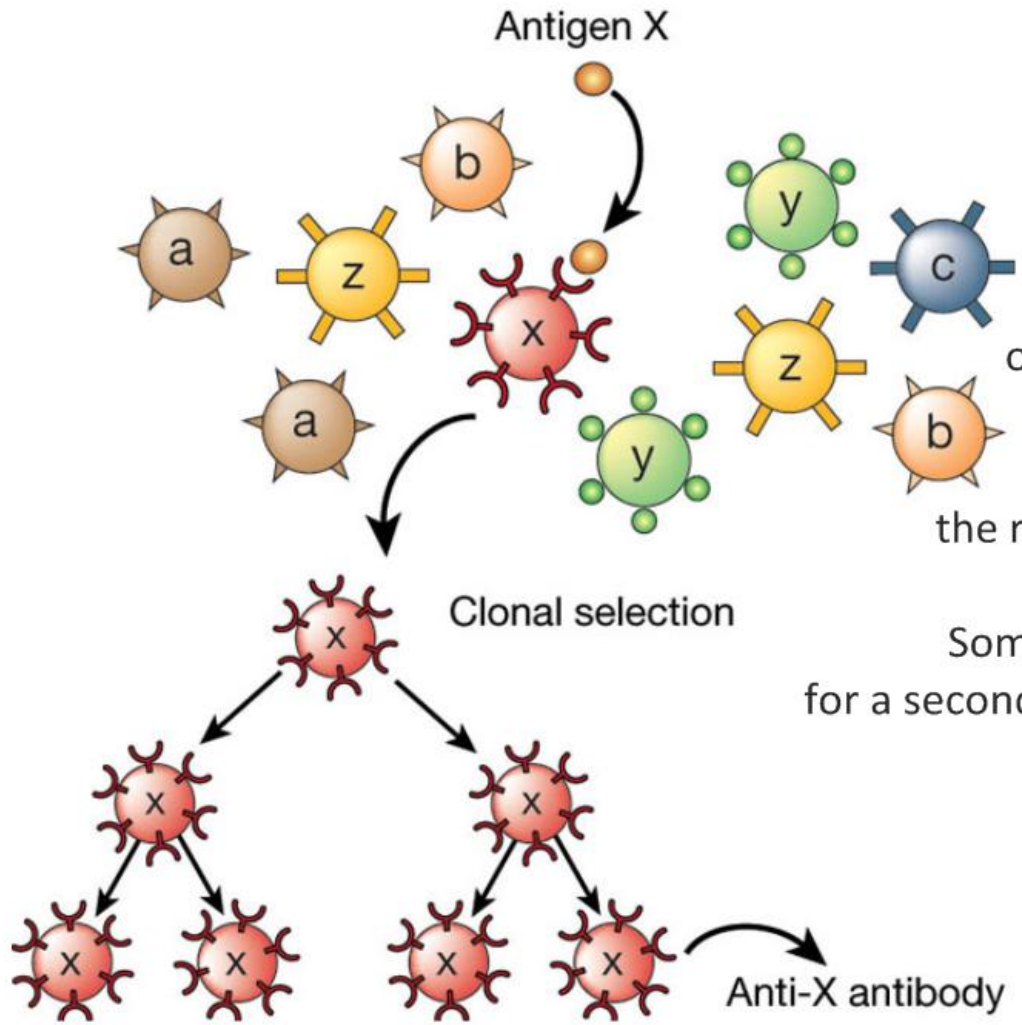
An immune response is triggered by non-self cells, which is why matches are crucial in transplants and blood transfusions - and why stem cell technologies are so promising.

Antibody-antigen relationships in ABO blood types:



http://waynesword.palomar.edu/aniblood.htm

Production of antibodies:



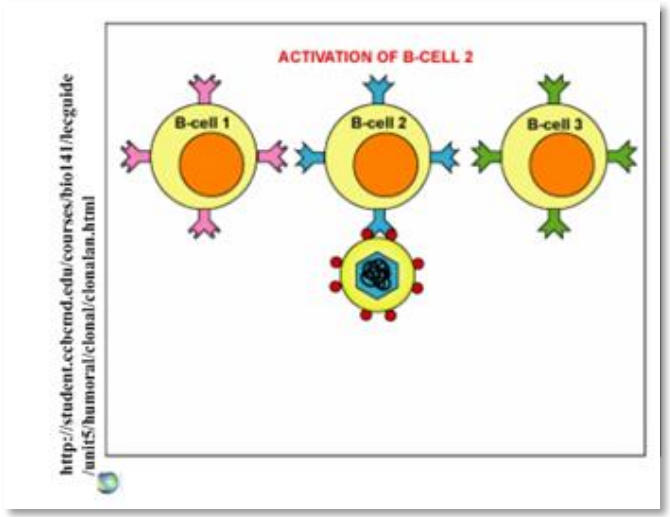
http://www.nature.com/nature/journal/v421/n6921/images/nature01409-f1.2.jpg

Many different lymphocytes exist. Each type recognises one specific antigen. When the immune system is challenged by the invasion of a pathogen, the corresponding lymphocyte responds.

It makes many clones of itself, each of which produce antibodies to the pathogen.

This process is called clonal selection, as the right lymphocyte is selected and then cloned.

Some cloned cells remain as memory cells, ready for a second invasion by the pathogen. This is immunity.



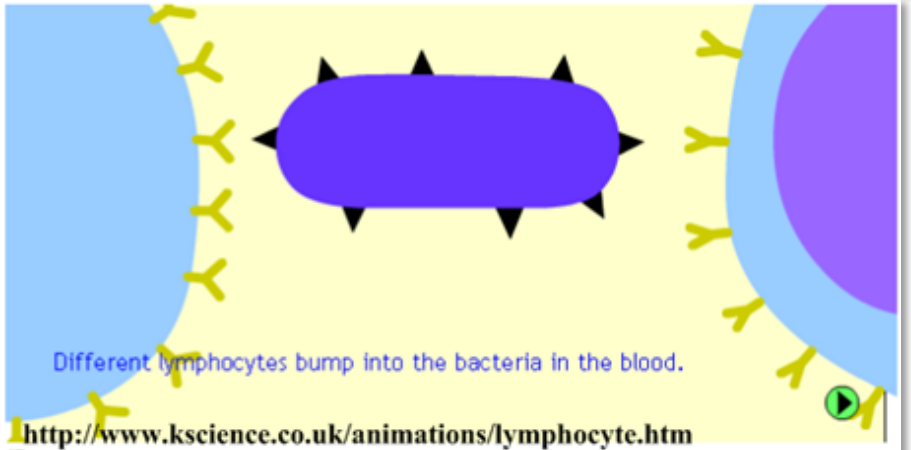
Clonal Selection theory: ready to fight back (and win a Nobel)

Burnet & Medawar's Theory of Clonal Selection:

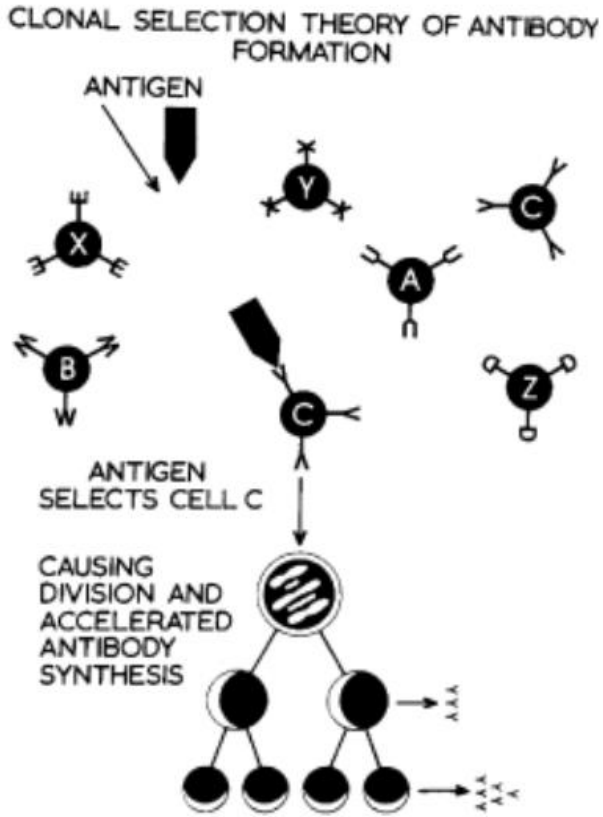
http://www.youtube.com/watch?v=HUSDvSknIgI

Burnet (top) and Medawar worked together and won the 1960 Nobel Prize for Medicine.

Read Burnet's Nobel speech here:
http://nobelprize.org/nobel_prizes/medicine/laureates/1960/burnet-lecture.pdf



http://www.kscience.co.uk/animations/lymphocyte.htm



http://nsw.royalsoc.org.au/journal_archive/nossal_2.html

Extend Page

Case Study

Abracadabra:

Magic Johnson and Anti-HIV Treatments

"It's not going to happen to me. And I'm here saying that it *can* happen to anybody, even me, Magic Johnson." These words were spoken by basketball hall-of-famer Earvin "Magic" Johnson at a press conference on November 7, 1991, to the shock of an entire nation. Johnson represents one of the first sports celebrities to publicly announce his HIV-seropositive status. A star basketball player who is HIV positive? How could this have happened?

In 1992, Magic played in the NBA All-Star Game and on the gold-medal-winning U.S. Olympic basketball team. He served as head coach of the Lakers in 1994 and returned as a player on the team in 1996, but decided it was time to retire and channel his energies into other arenas outside of basketball. Currently, Johnson is CEO of his own business, Magic Johnson Enterprises (MJE). He also has established the Magic Johnson Foundation, which helps inner-city communities deal with issues surrounding HIV/AIDS and raises funds for research and prevention efforts. His time is also spent with his wife and three children.

Johnson exercises regularly and eats a healthy diet. He currently does not experience any of the symptoms associated with HIV infection or AIDS.

Questions

1. What is the difference between HIV and AIDS?
2. List and explain the major routes of HIV transmission.
3. What does seropositive mean and how is a person tested for HIV?
4. What are some symptoms associated with acute phase HIV infection? What are the symptoms of AIDS?
5. What benefits are associated with Magic Johnson's announcement concerning his HIV-positive status? What risks or drawbacks can you think of associated with his announcement?

This case study has three stages

Start the case study here:

http://www.sciencecases.org/aids/aids1.asp

MAGICJOHNSON FOUNDATION

Find out more about Magic's programmes:

http://www.magicjohnson.com/index.php?/foundation/

Once you've finished the Case Study, watch this interview with Magic Johnson:

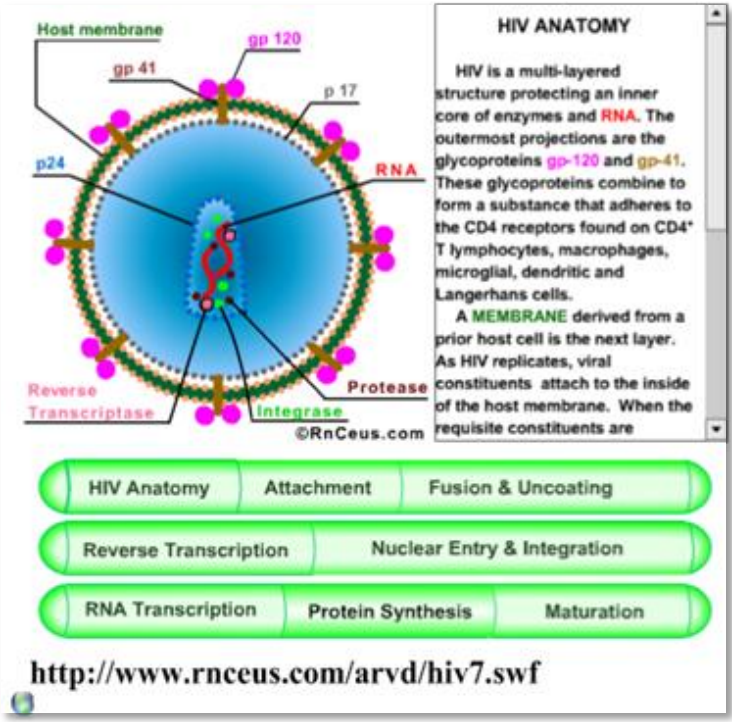
http://www.youtube.com/watch?v=oiTTLeky2Gs

The HIV virus attacks the immune system

HIV is a retrovirus: it inserts its own RNA into the host cell, which then incorporates the RNA in its DNA.

HIV attacks T-helper cells ($CD4^+$ macrophages), binding to the $CD4^+$ protein on their surface.

http://216i.sl.pt



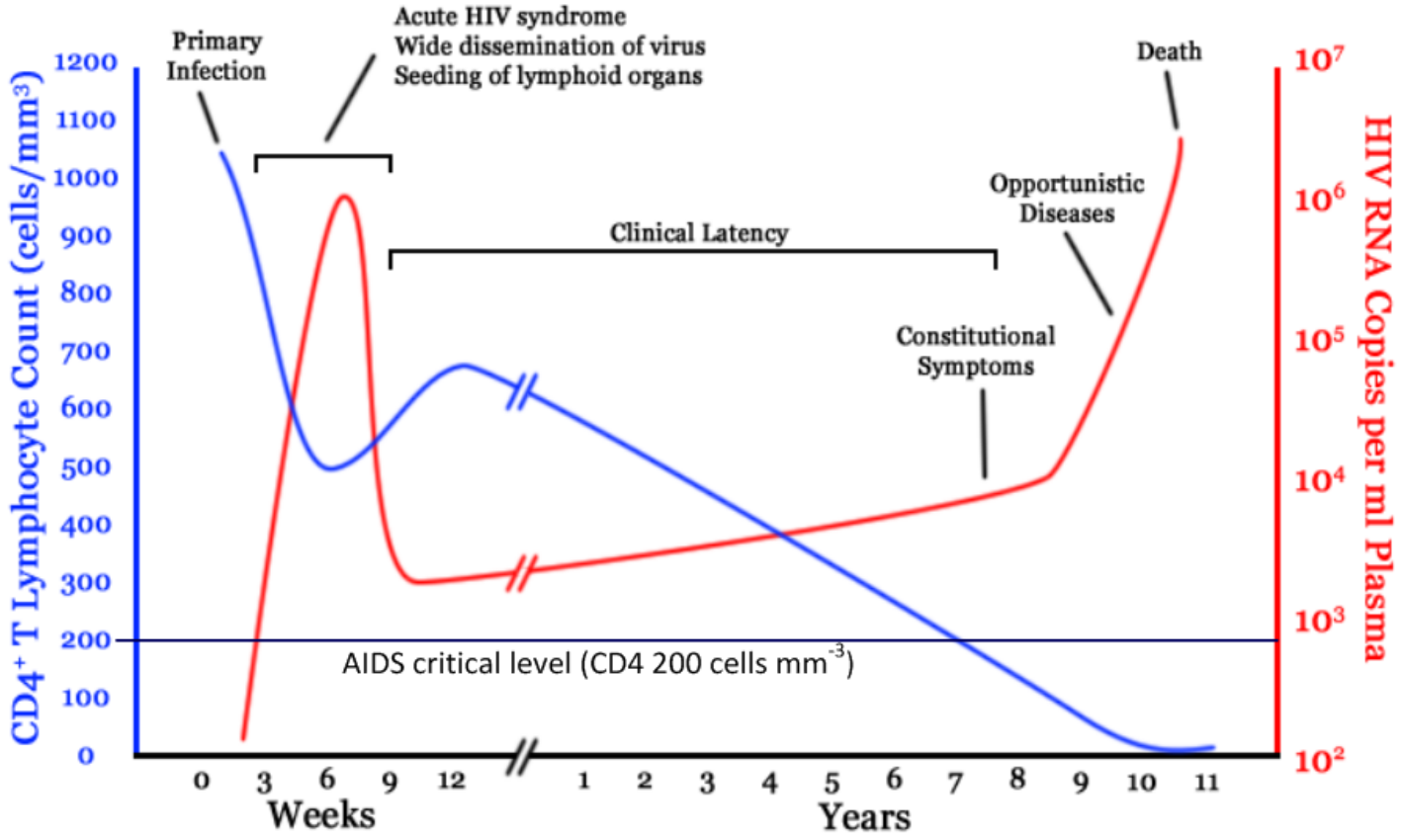
http://www.rnceus.com/arvd/hiv7.swf

Once inside the cell, the HIV RNA is inserted into the macrophage genome.

Transcription now includes the HIV's code, resulting an output of more viral RNA - and subsequent transcription to HIV particles.

As a result, the immune system is weakened and fewer antibodies can be produced.

Eventually, production of HIV particles damages the T-cells, reducing in a drop in numbers.

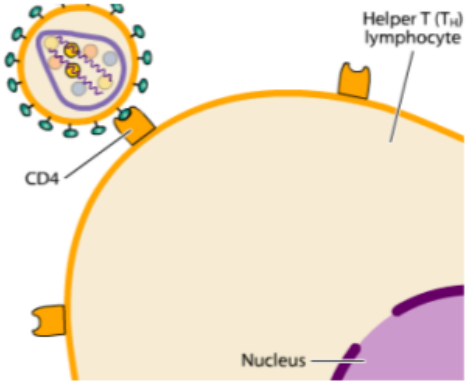


http://en.wikipedia.org/wiki/HIV

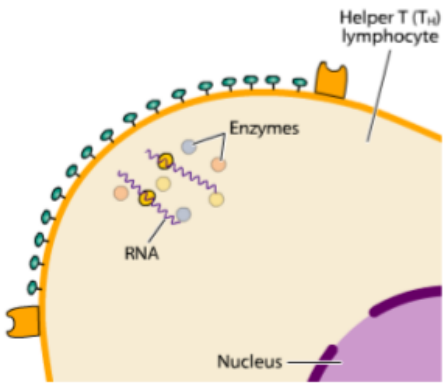
Once $CD4^+$ cells drop below a critical level, the immune system is ineffective and the patient has AIDS: Acquired Immune Deficiency Syndrome http://www.aids.org/factSheets/124-T-Cell-Tests.html

Patients with AIDS are very susceptible to opportunistic infections, which may prove lethal.

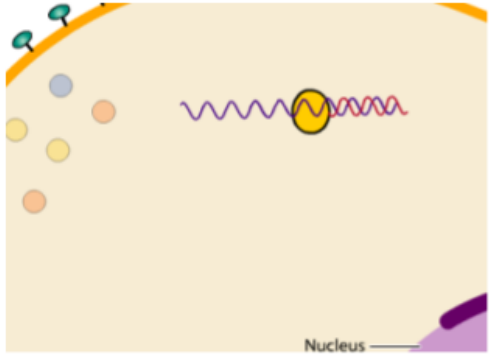
Life Cycle of HIV:



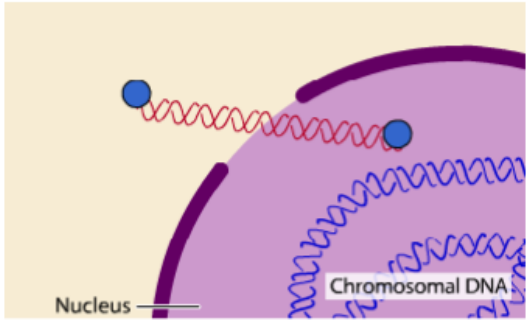
Virus particle infects T-cell



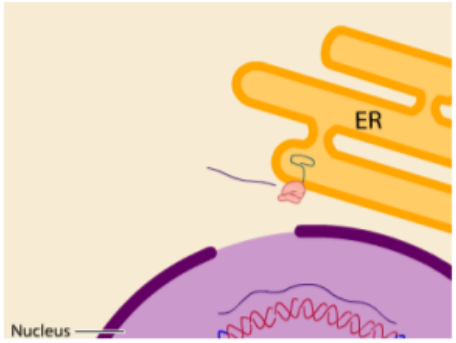
Protein coat breaks down, exposing viral RNA



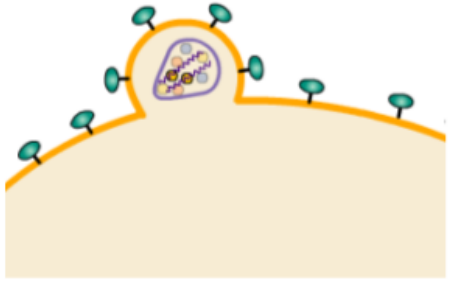
RNA is converted to cDNA



cDNA is inserted into the nucleus of the T-cell



T-cell starts producing HIV virus parts



New HIV virus particles are released from the T-cell.

Images taken from: **http://www.sumanasinc.com/webcontent/animations/content/hiv.html**

What are the risk factors in HIV transmission?

No Risk

Lowest Risk

Highest Risk

sexual intercourse

mosquitoes

ingestion

saliva/ kissing

breastfeeding

toilet seats

childbirth

oral sex

skin contact

blood-blood contact

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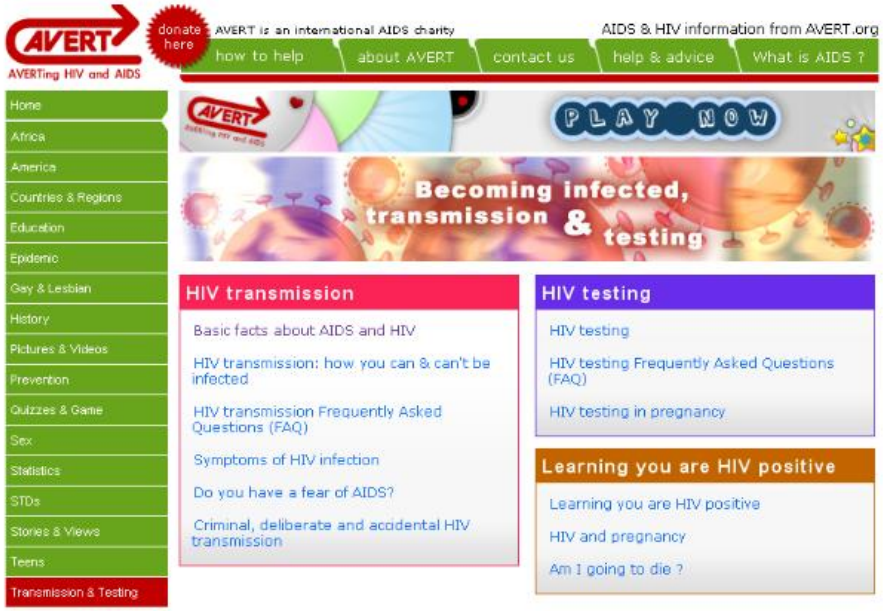


Find out more and stay safe:

www.avert.org

What are the impacts of HIV/AIDS?

UNAIDS
JOINT UNITED NATIONS PROGRAMME ON HIV/AIDS
UNHCR UNICEF WFP UNDP UNFPA UNODC ILO UNESCO WHO WORLD BANK

http://www.unaids.org/en/default.asp

Social Impacts:

- discrimination and stigma from those around
- abuse and harrassment
- may not be able to find work
- may not be healthy enough to work
- expense of medications bankrupts families
- risk of spreading in a family or community
- burden of care for the sick

Economic Impacts:

- working-age population is reduced
- GDP suffers as a result
- more children have to work, so less are in school
- education of the nation suffers
- heavy economic burden of medications and care
- international stigma and impacts on trade/ industry

Read this!

AIDS Action in Africa

AIDS takes an economic and social toll

Impact on households and economic growth most severe in Southern Africa

By Belinda Beresford
Johannesburg

In Southern Africa, as elsewhere in the continent, the AIDS epidemic is not just a health crisis. It is also "a major threat to development and to human society," as Executive Director Peter Piot of the Joint United Nations Programme on AIDS (UNAIDS) put it at a conference in Nairobi in April. While wreaking havoc on the present generation, the disease jeopardizes the future as well, undermining African economies and countries in ways that often are not immediately apparent.

Taking a narrow economic approach, however, some have argued that AIDS is unlikely to inflict severe damage on national economies because those infected are, in their great majority, the poor and unskilled, who contribute little in pure economic terms. This view ignores not only the human dimension, but also the broader social and economic aspects of development. It likewise ignores the existing evidence of the many insidious ways in which AIDS already is harming key sectors in those countries most seriously affected by the epidemic.

Harvard University economist Jeffrey Sachs pointed out at an international AIDS conference in South Africa last year that HIV/AIDS damages society just as it does the human body: it begins by killing those parts responsible for building society, the women and breadwinners who sustain and safeguard the community as a whole. Ultimately, AIDS undermines economic growth and human development, but its impacts hit first at the "cellular" level, among African households.

> HIV/AIDS damages society just as it does the human body: it begins by killing those parts responsible for building society, the women and breadwinners who sustain and safeguard the community as a whole.

Of all parts of Africa, the Southern African region has the highest infection rates (see map, page 21). In South Africa and Botswana, 15-year-olds currently have a one-in-two chance of dying of HIV/AIDS. The US Census Bureau last year forecast that Botswana, Zimbabwe and South Africa would experience negative population growth as a result of HIV. Slowly won development gains, such as life expectancy, education and literacy, are being eroded. In Botswana, it has been forecast that HIV will cut in half life expectancy at birth.

South Africa, once seen as the economic powerhouse for the region, is thought to have the greatest number of infections in the world — an estimated one in nine of the population has HIV. The spread of the virus is not expected to peak for another five years, when the estimated number of infected people may rise from 5.2 million to 8.2 million, or nearly 17 per cent of the total population. Such projections, of course, do not take into account new medical breakthroughs or changes in people's behaviours, which could impede the disease's progression.

Families hit hard

Among households, the direct costs of HIV/AIDS can be measured in the lost income of those who die or who leave their jobs because of their illness. Household savings fall, consumption on items other than health and financial declines and expenditure patterns are distorted as families struggle to cope with the demands of the sick and dying.

Mr. Robert Greener of the Botswana Institute of Policy Analysis told *Africa Recovery* that while government revenue from its diamond industry has been relatively unaffected by the AIDS crisis, that of households has been hit hard. Overall poverty rates will not unnecessarily get worse, "but the rate of improvement will not be what it was. We found that HIV will have a major effect on how [people] can invest in their own future." He estimates that between 17 and 25 per cent of households will lose an income earner in the next 10 years, with total income falling by 15 per cent in the poorest homes. A government AIDS-impact study estimated that overall household per capita income will fall by 8 per cent, and as much as 17 per cent for the poorest quarter.

Households which otherwise might have remained above the poverty line are pushed below it. This in turn can feed the epidemic. As the UN programme, UNAIDS, has pointed out, at least two of the behavioural responses to poverty can exacerbate the epidemic: migration in search of work and employment in the sex trade. When people are mired in poverty, "taking care to avoid HIV/AIDS may seem a less immediate concern for many people than simple survival." Combating poverty, in turn,

Farmers in Zambia: Loss of a family member to AIDS can push households deeper into poverty.

JUNE 2001 Africa Recovery 19

http://www.un.org/ecosocdev/geninfo/afrec/vol15no1/151aids9.htm

How has social perception of HIV changed over time?

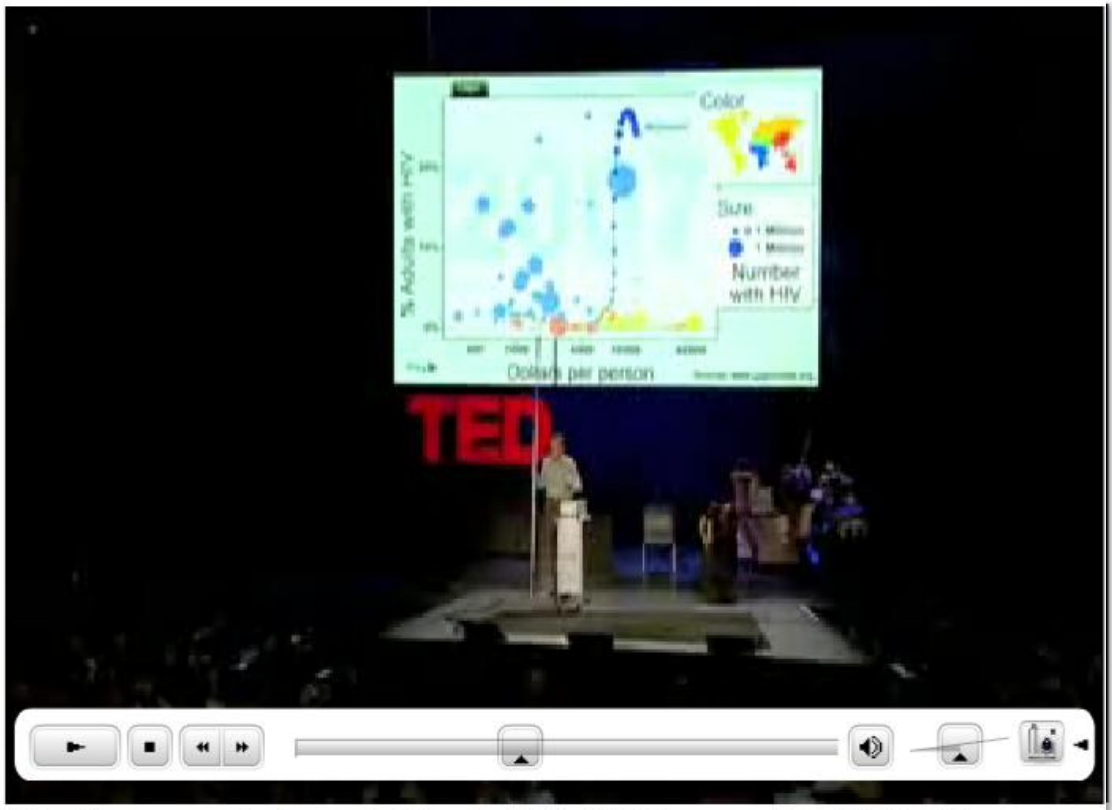
1987

http://www.youtube.com/watch?v=U219eUIZ7Qo

2007

http://www.youtube.com/watch?v=Hmm59BIr4zE

The Current State of the Global HIV Epidemic



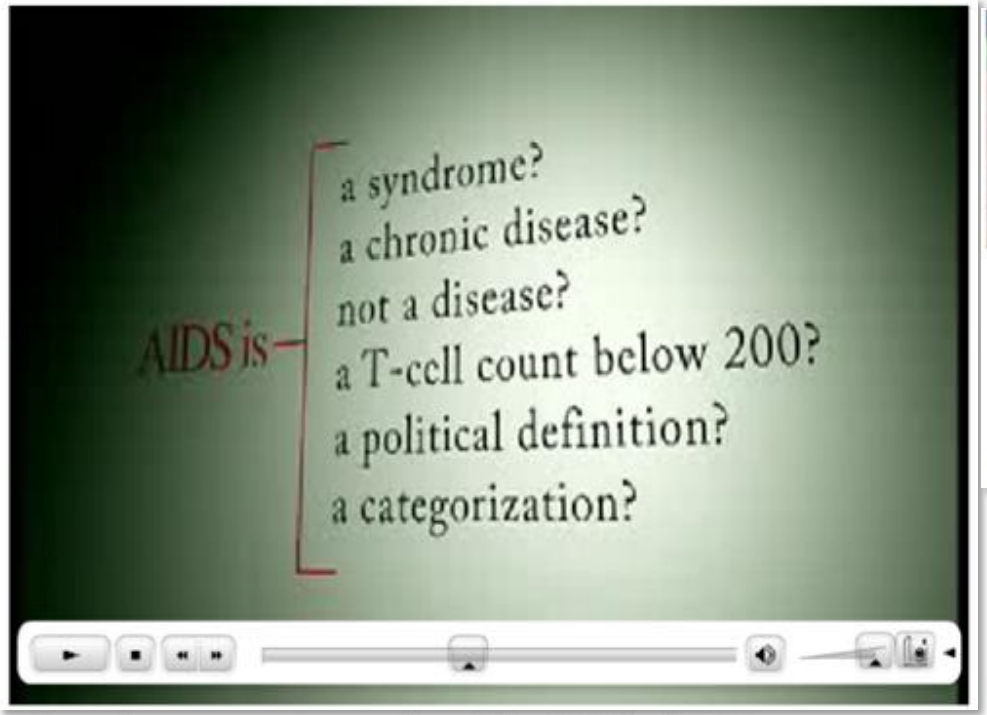
http://www.gapminder.org/videos/ted-talk-2009-hans-rosling-hiv-facts/

See the data for yourself:

GAPMINDER

http://www.gapminder.org/

House of Numbers: Bad Science in the popular media



http://www.youtube.com/watch?v=X_N4zgjF0K0

Visit AIDSTruth.org for a comprehensive rebuttal of the pseudoscientific claims made in the documentary, House of Numbers:

http://www.aidstruth.org/features/2009/real-answers-fake-questions-%E2%80%9Chouse-numbers%E2%80%9D

What happens when mainstream media get convinced or influenced by poor science?

http://www.badscience.net/2009/10/aids-denialism-at-the-spectator/

Read this excellent article on dangerous AIDS denialism and campaigning against AZT drugs in South Africa:

http://www.badscience.net/2009/04/matthias-rath-steal-this-chapter/

What did Matthias Rath stand to gain by his actions?

Why can government policy makers be so selective in the medical and scientific advice they choose to act upon?

A virus walked into a bar and asked for a pint of beer.

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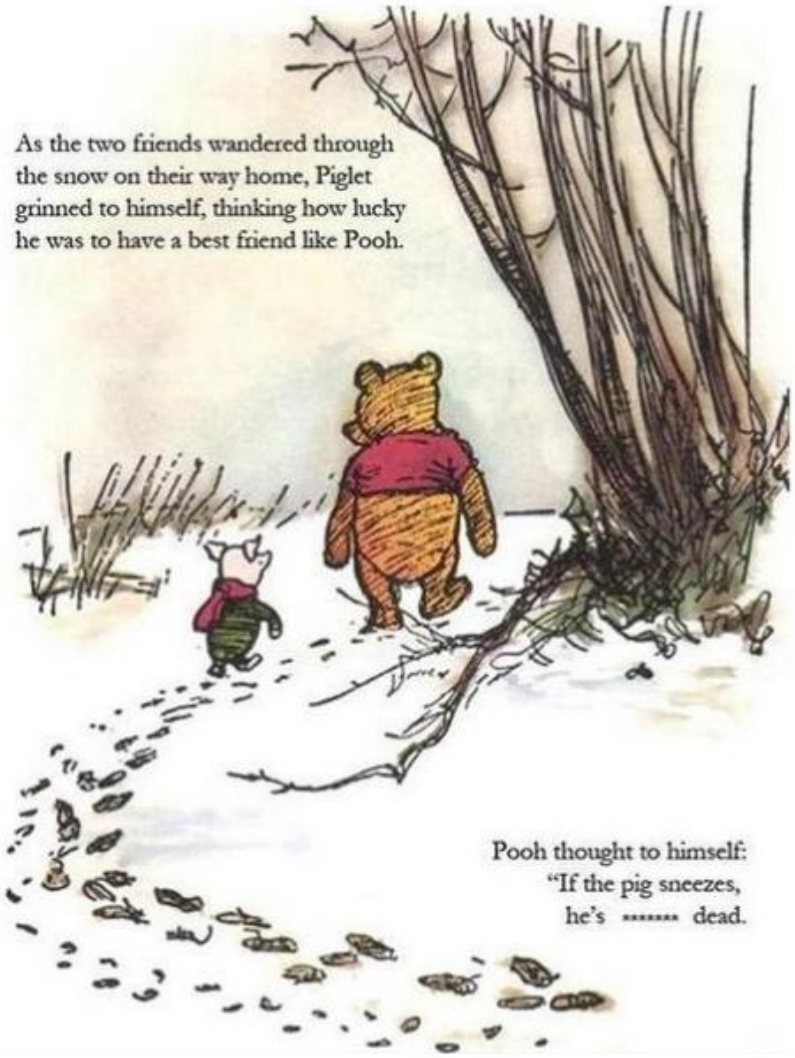
"I'm sorry, we don't serve viruses here," the barman said

A virus walked into a bar and asked for a pint of beer.

"I'm sorry, we don't serve viruses here," the barman said

So the virus crossed over the bar and replaced him.



for more IB Biology resources:

http://sciencevideos.wordpress.com