

Health

- What is an arms race? What sort of adaptations would you expect to be produced by an arms race?
- What is senescence and why is it unlikely that we will find a “cure” for aging?
- List examples of psychological disorders for the different categories of causes of disease.
- What sort of novel environmental conditions have been posited to cause psychological diseases? What empirical evidence exists?
- What is the smoke-detector principle?
- What evidence would be needed to determine whether depression is an adaptation? Has any of this evidence been collected since Nesse's 2000 paper was published?

What is Pathology?

- Pathology is a dysfunctional state of an organism or a part thereof, compromising normal, adaptive, evolved functioning.
- The prototype is a *fracture*: a structure is broken, and it therefore cannot do what it was designed by selection to do.



Whose adaptations may harm us?

- Predators
- Pathogens & Parasites
- Infectious agents like TB, syphilis
- Other people
 - Allies with imperfectly consonant interests
 - maternal-fetal “conflict”
 - mates who shirk
 - Antagonists with no shared interests
 - competitors
 - psychopaths
 - exploiters, e.g. thieves and rapists

Causes of Disease

- Defenses
- Infection
- Novel Environments
- Genes
- Design Compromises
- Evolutionary Legacies

Defenses

- Coughing
- Sneezing
- Fever
- Iron “deficiency”
- Pregnancy sickness
- Some pathogens exploit defenses in order to spread

Fever



- When lizards are infected with pathogens, they will move along a temperature gradient to keep their body temperature about 2 degrees Celsius warmer than normal.
- Body temperature is still regulated during fever, rats placed in a too-warm room will use cooling mechanisms to lower their body temperature to fever level.

Iron Deficiency

- Doctors used to give iron supplements to patients with infection because they had anemia.
- Human milk protein is 20% lactoferrin, an iron-binding molecule. Cow milk has only 2%. Breast-fed babies have fewer infections than bottle-fed babies.
- Lactoferrin is concentrated in tears, saliva and at wounds.
- Leukocyte endogenous mediator sequesters iron during infection. Iron absorption by the gut decreases. Even food preferences may change.

More Evidence

- Zulu men drink beer from iron pots and have frequent amoebic infections.
- Masai seldom (<10%) have amoebic infections, but when given iron supplements, 88% of Masai soon developed an amoebic infection.
- A group of Somali nomads given iron supplements had a 38% infection rate, compared to 8% in a non-supplemented group.

Defenses Against Infection

- Hygiene to prevent contact
- Skin as a barrier
- Pain and malaise
- Expulsion
 - Sneezing, coughing, urination, diarrhea, vomiting, menstruation?
- Immune system
- Repair mechanisms
 - selection has caused repair according to how useful it would have been in the EEA

Pathogens' Counter-Defenses

- Pathogens in sheep's clothing
 - Rabies mimics neurotransmitters
 - Cowpox mimics hormones
- Changing disguises
 - The trypanosome that causes African sleeping sickness has over 1000 different antigenic coats and changes every 9 days. It takes about 10 days to build up antibodies.
- Disguise as the host



Other Pathogen Adaptations

- Attack host defenses (HIV)
- Manipulate host behaviour



- Dispersal and virulence

The Evolution of Virulence

- Virulence is the harmfulness of a pathogen.
- Some pathogens have very severe effects (smallpox, AIDS, malaria) whereas others only produce mild effects (common cold virus).
- Ewald (1993) argued that there are 3 main evolutionary reasons for these differing levels of virulence.
 - Mode of transmission
 - Survivability
 - Human behaviours

Mode of Transmission

- If a host's illness impairs transmission, then the parasite should evolve to have milder effects so that the host can move around.
- If the host's disability does not inhibit transmission then pathogens could evolve greater virulence.
- For example, rhinoviruses that cause the common cold are easily spread by sneezing and so they do not disable their hosts.
- When a pathogen is transported by a vector (an organism that transmits an infectious agent like a mosquito) it can disable the host and still spread easily.
- It thus can be highly virulent to the victim but not to the vector (e.g. malaria, yellow fever, typhus).
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Survivability

- There are exceptions to the previous rule when a pathogen can survive for long periods outside of the host.
- For example the smallpox virus can live for 10 years in the environment and is particularly virile.

Human Behaviours

- Human activities influence virulence. When drinking water systems were created this enabled pathogens to spread more easily.
- They could increase in virulence as the immobility of their host had little importance to their survival.
- Cholera epidemics in India in the 1950's and 1960's were drastically reduced when the water supplies were purified - a less virulent form of cholera overtook the more virulent type.
- In nearby Bangladesh where water supplies were not purified, the most virulent form of cholera out-reproduced the less virulent form.

Human Behaviours

- Hospitals may create cultural vectors by adopting poor hygiene.
- Such vectors create increasing virulence in the form of antibiotic-resistant bacteria.
- Around 1 in 20 hospitalised patients in the USA acquire an infection before leaving hospital, and this leads to 4 million infections and thousands of deaths.
- Increasing sexual partners created highly virulent forms of HIV but as sexual practices became safer, HIV has become less virulent.

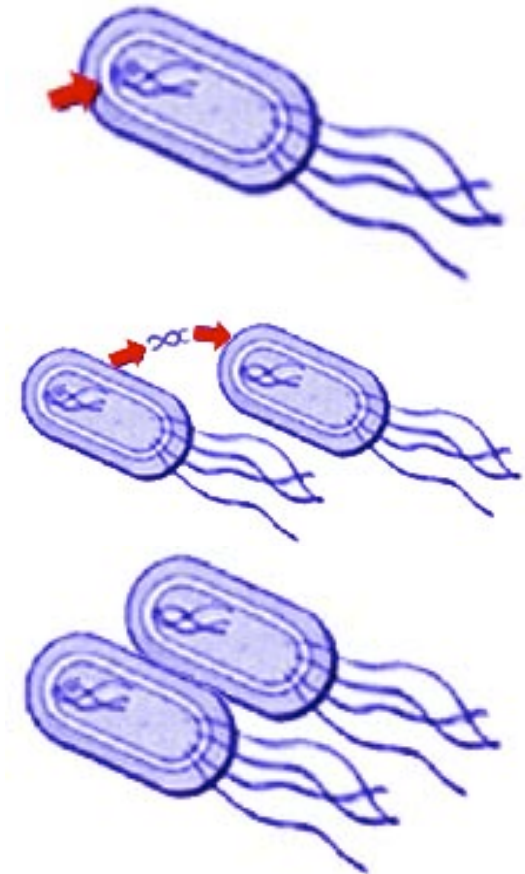
Antibiotic Resistant Bacteria

Bacteria can acquire genes for resistance in three ways:

Mutation - drug-resistant tuberculosis

Transformation - penicillin-resistant gonorrhea

Plasmids - Shigella in Guatemala



How to Stop Antibiotic-Resistance

- Take ALL of your antibiotics
- Use “narrow-spectrum” antibiotics
- Use common antibiotics first
- Improve infection control in hospitals
- Use new drugs with different anti-microbial mechanisms
- Reduce widespread use in farm animals and agriculture
- Reduce unnecessary household use

Vocabulary

- Pathology
- Pathogen
- Lactoferrin
- Defenses
- Virulence