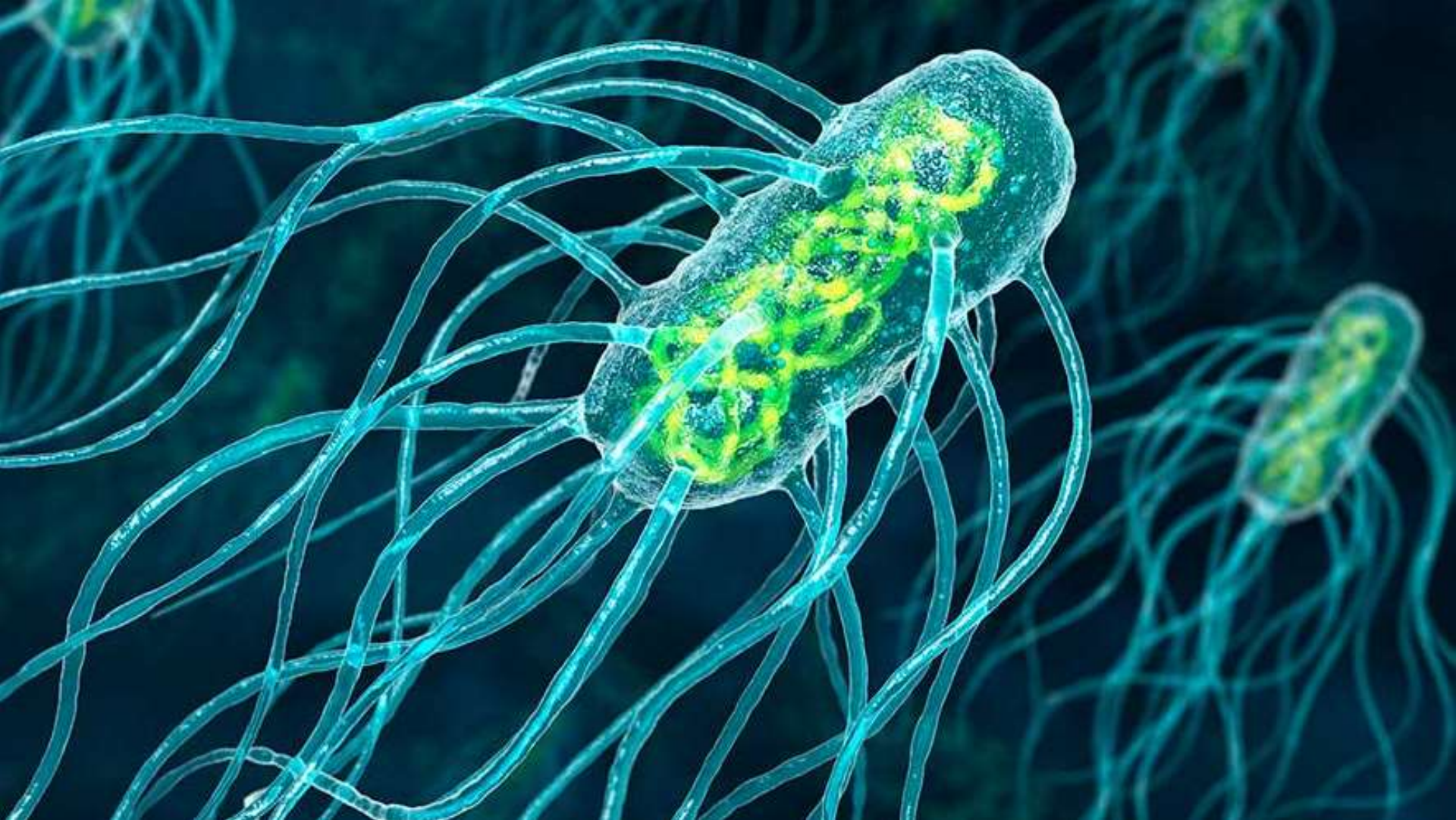


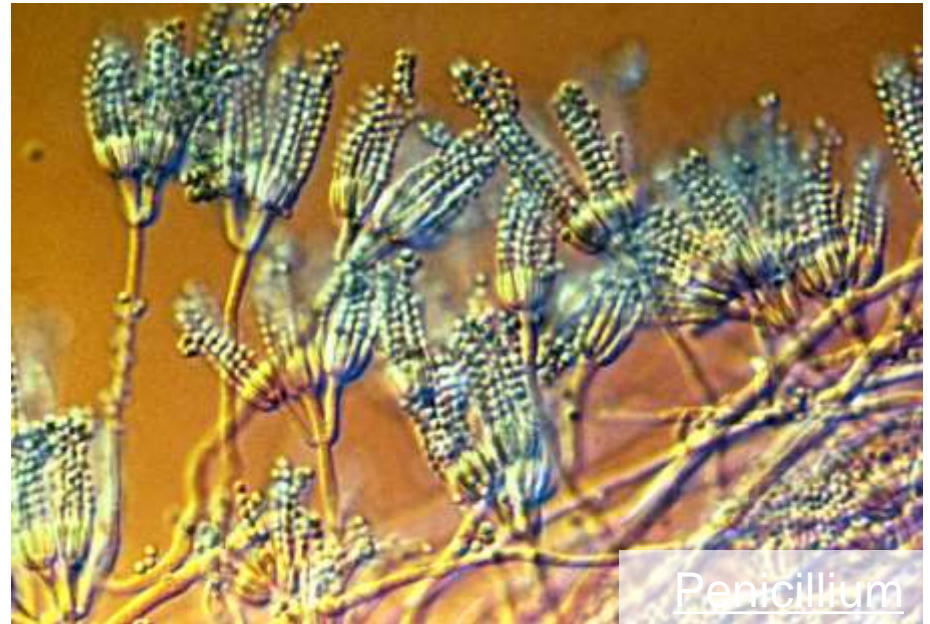
-
- *How your body decides if bacteria are friends or foes*

-
- How would you feel about:
 - A child eating food that dropped on the ground?
 - A child sucking their thumbs?
 - Take antibiotics without knowing the true reason you are feeling sick?

Antibiotic Resistance



The First Antibiotic



The first antibiotic was discovered by Alexander Fleming in 1928 when he noticed that the fungus penicillium killed disease causing bacteria.

Antibiotic Classes

Penicillins

penicillin

amoxicillin

Cephalosporins

cephalexin(Keflex)

Sulfonamides

co-trimoxazole (Bactrim)

Fluoroquinolones

ciprofloxacin (Cipro)

levofloxacin (Levaquin)

ofloxacin (Floxin)

Prevents
bacteria from
making cell
walls

Inhibits
Folate
synthesis

Inhibits
DNA
replication

Tetracyclines

Tetracycline(Sumycin)

doxycycline (Vibramycin)

Aminoglycosides

gentamicin (Garamycin)

kanamycin

tobramycin(Tobrex)

Macrolides

erythromycin (E-Mycin)

azithromycin (Zithromax)

Inhibits
protein
synthesis

Antibiotic Usage

Not simply used to fight primary infections... antibiotics are the backbone of modern medicine

Transplants



Dialysis



Suppressed Immune Systems

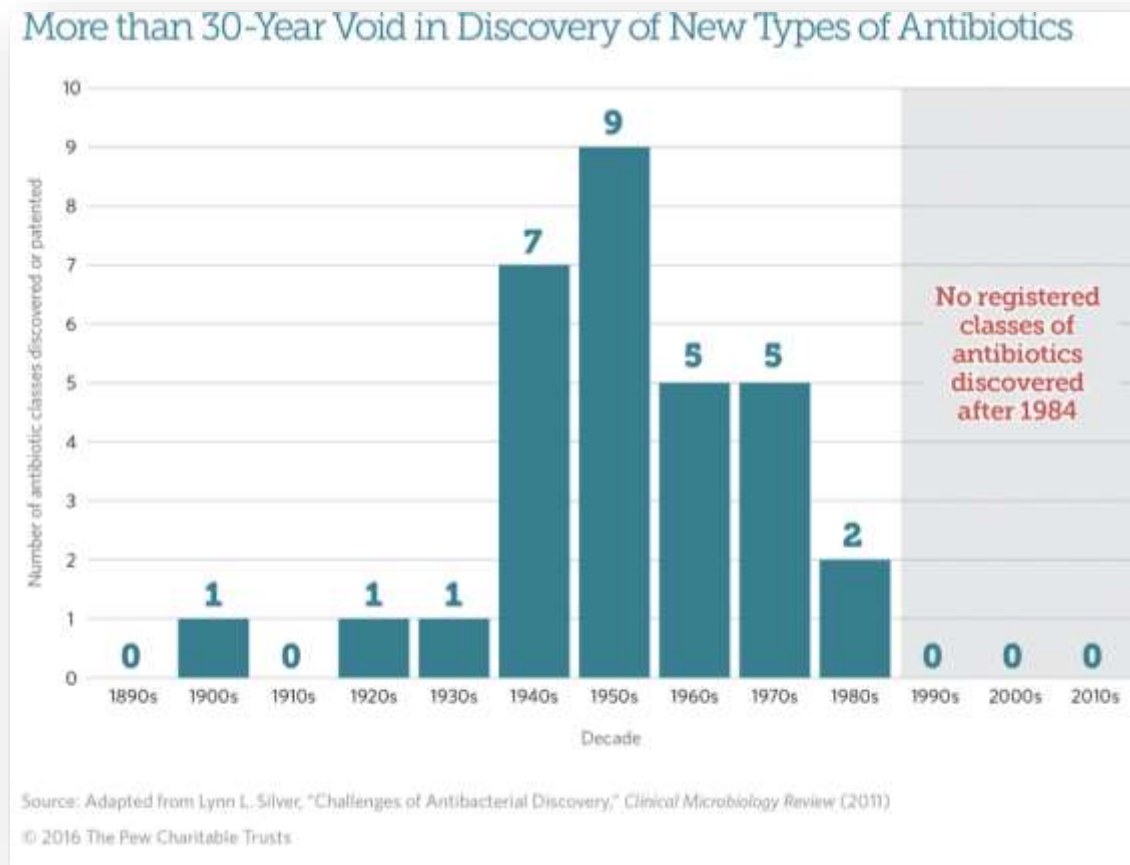


Invasive surgeries



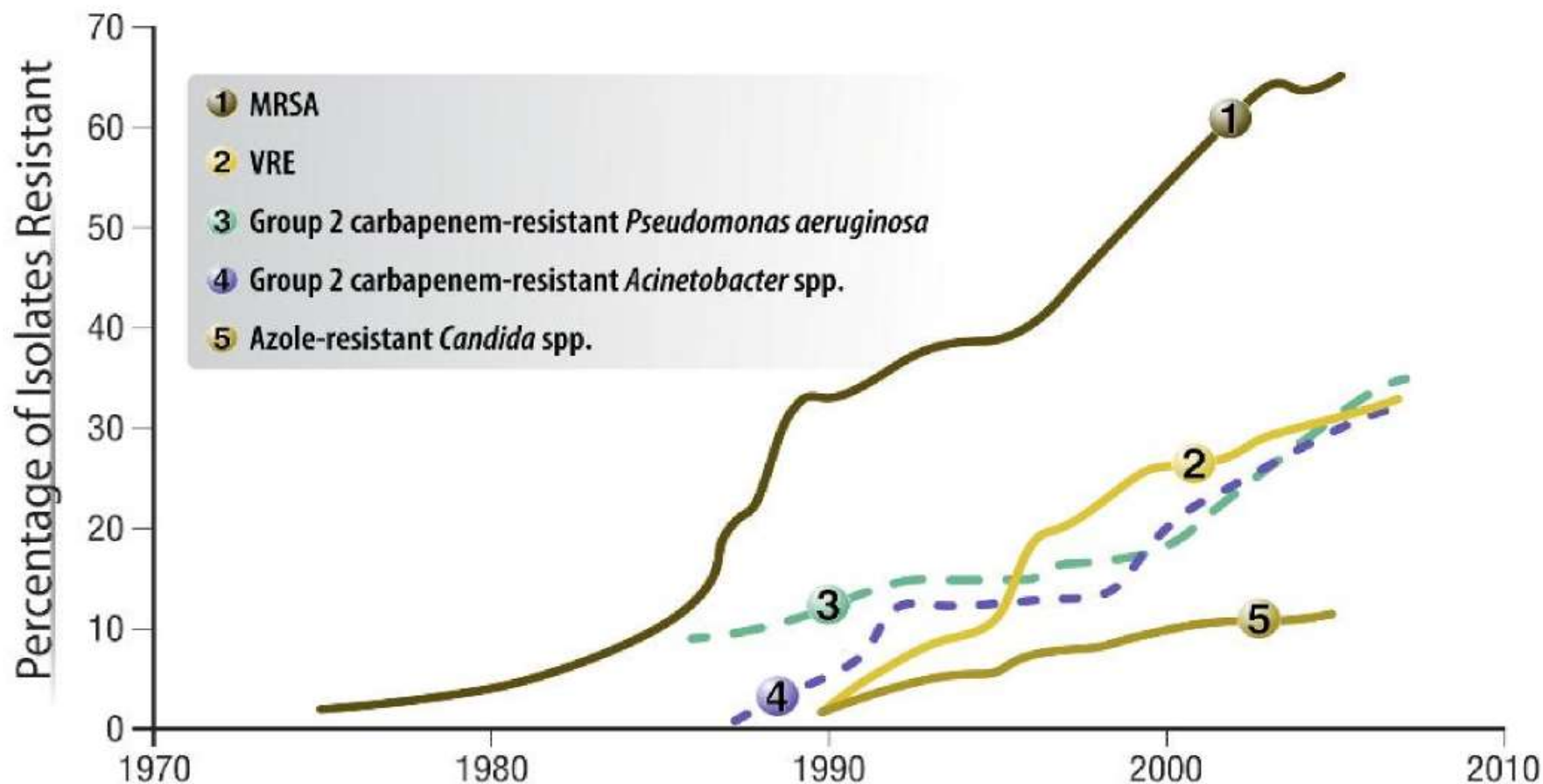
Lack of New Antibiotics

Despite the fact that they are essential for modern medicine, few new antibiotics have been discovered and developed in the last several decades



Why? It is much more profitable for pharmaceutical companies to pursue lifestyle type therapies (drugs that patients need for years/decades)

Trends in Antimicrobial Resistance



Adapted from Wenzel RP, et al. *Infect Control Hosp Epidemiol.* 2008;29:1012-1018.

NATIONAL SUMMARY DATA

Estimated minimum number of illnesses and deaths caused by antibiotic resistance*:

At least  **2,049,442** illnesses,
 **23,000** deaths

*bacteria and fungus included in this report

Estimated minimum number of illnesses and death due to *Clostridium difficile* (*C. difficile*), a unique bacterial infection that, although not significantly resistant to the drugs used to treat it, is directly related to antibiotic use and resistance:

At least  **250,000** illnesses,
 **14,000** deaths

WHERE DO INFECTIONS HAPPEN?

Antibiotic-resistant infections can happen anywhere. Data show that most happen in the general community; however, most deaths related to antibiotic resistance happen in healthcare settings, such as hospitals and nursing homes.



U.S. Department of
Health and Human Services
Centers for Disease
Control and Prevention

- \$20 billion in excess direct healthcare costs
- Costs to society for lost productivity as high as \$35 billion a year (2008 dollars)
- The use of antibiotics is the single most important factor leading to antibiotic resistance
- ↑ *C. difficile* infections¹
 - **453,000 cases 2011**
 - **29,000 deaths 2011**

Lessa FC et al. *N Engl J Med.* 2015; 372:825-34.

Death Toll of Antimicrobial Resistance

2015

2050



50,000

700,000

10,000,000

North America

317,000

“A Post-Antibiotic Future”

“Things as common as strep throat or a child’s scratched knee could once again kill.”

Dr. Margaret Chan
Director-General



Humans and Microbes

- Leeuwenhoek's discovery of microorganisms in 17th century led people to suspect they might cause diseases
- Robert Koch (1876) offered proof of what is now considered germ theory of disease; showed *Bacillus anthracis* causes anthrax
- Today, we now know that most of the bacteria we associate with are not pathogens, and many are critical for our health.

Bacteria Are Ubiquitous

- We contact numerous microorganisms daily
 - Every surface on earth is covered!
 - Even clouds have microbes
 - Could play a role in seeding rain..
 - Some have tremendous commercial value
 - Yogurts, wine, cheese, vinegar, pickles, etc.
 - Our bodies:
 - Breathe in, ingest, pick up on skin
 - Vast majority do not make us sick, or cause infections
 - Some colonize body surfaces; or slough off with dead epithelial cells
 - Most that are swallowed die in stomach or are eliminated in feces
 - Relatively few are pathogens that cause damage



Microbes, Health, and Disease

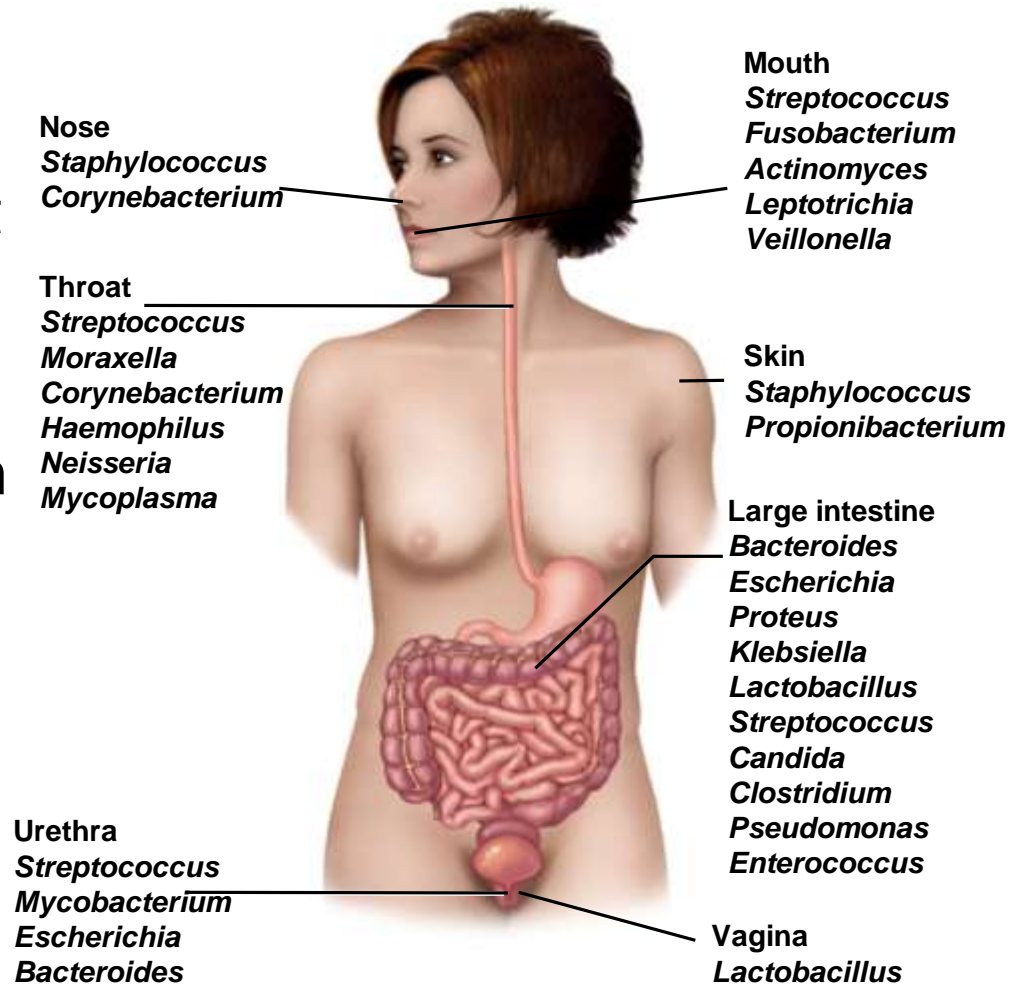
- Most microbes are harmless
 - Many are beneficial
 - Normal microbiota (normal flora) are organisms that routinely reside on body's surfaces
 - Relationship is a balance, and some can cause disease under certain conditions-- opportunistic infections
 - Weaknesses in innate or adaptive defenses can leave individuals vulnerable to invasion
 - malnutrition, cancer, AIDS or other disease, surgery, wounds, genetic defects, alcohol or drug abuse, and immunosuppressive therapy

Human commensals and mutualistic microbes

Resident microbiota inhabit sites for extended periods

Transient microbiota inhabit temporarily

- Important to human health
- Relatively little is known
- Human Microbiome Project aimed at studying http://en.wikipedia.org/wiki/Human_Microbiome_Project



The Normal Microbiota

The Protective Role of the Normal Microbiota

- Significant contribution is protection against pathogens
 - Covering of binding sites prevents attachment
 - Consumption of available nutrients
 - Production of compounds toxic to other bacteria
- When killed or suppressed (e.g., during antibiotic treatment), pathogens may colonize, cause disease
 - Some antibiotics inhibit *Lactobacillus*
 - Oral antibiotics can inhibit intestinal microbiota, allow overgrowth of toxin-producing *Clostridium difficile*

The Normal Microbiota

- The Dynamic Nature of the Normal Microbiota
 - Healthy human fetus sterile until just before birth
 - Exposure during birth and through contact with people, food, and environment lead to microbes becoming established on
 - Find that families often share similar microbial populations, and important gut microbes are acquired from the mother
 - Critical for proper gut development—first colonizers from mom
 - Composition of normal microbiota is dynamic
 - Changes occur over the life of a person. Younger people tend to have different compositions than older people.
 - Responses to physiological changes (e.g., hormonal changes), activities and diet (e.g., consuming food)

Microbiota alter the chemistry of your gut

-Obese mice had 50% fewer Bacteroidetes and 50% more Firmicutes in their bowels than their lean counterparts.

The link between the microbiota and obesity became even clearer when Gordon looked at a special strain of mice with no microbiota of their own.

When the team transplanted the microbiota from fat and lean mice into the germ-free strains, those colonized by microbiota from fat donors packed on far more weight than those paired with lean donors.



Fat Bacteria
More Firmicutes

Thin bacteria
More Bacteroidetes

--break down
carbohydrates better


--trigger biochemical
pathways to store fat

PROBIOTICS, ADHD, AND AUTISM



www.tetroots.com

CAN BACTERIA Talk To Your YOUR BRAIN?



YOUR MICROBES AND MENTAL HEALTH

Our brain and our digestive system are intricately linked. So closely linked, in fact, that some experts say it should be viewed as one system, with the gut often being referred to by scientists as "the second brain"....and the contents of this second brain can profoundly affect our first!



**Your Gut Bacteria
Linked to Anxiety and
Depression.
Here's What to Do to
Stay Mentally Healthy**

 PurifiedMe

Gut Bacteria May Play Role in Crohn's Disease



CHEMOTHERAPY AND THE MICROBIOME



**NEWBORN GUT MICROBIOME
LINKED TO ALLERGY & ASTHMA
RISK IN LATER LIFE**

- Gut microbes in infancy increase the risk of asthma and allergies in childhood
- Avoid situations or substances that trigger attacks of asthma.
- Monitor lung functions closely

Microbiome

- So far... more questions than answers

- But there are major indications that the microbiome (the combination of all microbes living in and on us) may be thought of as an organ

Principles of Infectious Disease

Colonization--microbe establishes on body surface

- Infection usually refers to pathogen
 - subclinical: no or mild symptoms
 - Infectious disease shows noticeable impairment
 - Symptoms are subjective effects experienced by patient (e.g., pain and nausea)
 - Signs are objective evidence (e.g., rash, pus formation, swelling)
- Initial infection is **primary infection**

Principles of Infectious Disease

■ Pathogenicity

- Primary pathogen is microbe or virus that causes disease in otherwise healthy individual
 - Diseases such as plague, malaria, measles, influenza, diphtheria, tetanus, tuberculosis, etc.
- Opportunistic pathogen (opportunist) causes disease only when body's innate or adaptive defenses are compromised or when introduced into unusual location
- Virulence refers to degree of pathogenicity
- Virulence factors are traits that allow microorganism to cause disease

Invasion—Breaching the Anatomical Barriers

■ Penetrating the Skin

Borrelia burgdorferi
(Lyme's disease)



- Difficult barrier to penetrate; bacteria rely on injuries
 - *Staphylococcus aureus* enters via cut or wound; *Yersinia pestis* is injected by fleas, Lyme's disease by tick bite

■ Penetrating Mucous Membranes-respiratory and gut tracts

- Common Entry point pathogens
- Directed Uptake by Cells
 - Pathogen induces cells to engulf via endocytosis

