Yale-New Haven Teachers Institute®

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Microbiomes in and on Our Bodies

Curriculum Unit 14.04.09
by Deborah Johnson

Objective

In the curriculum unit, students will develop an understanding of ecosystems that exist in and on our bodies, called microbiomes and also learn how technology has evolved whereby scientists can build machines on the scale of nanometers in order to better immunize people and fight diseases, possibly finding a cure for cancer. In focusing on microbiomes in and on our bodies, students will learn proper oral and body hygiene, which becomes critically important for students to learn at this age of puberty.

Introduction

This unit will be taught to four sixth grade general science classes at Betsy Ross Arts Magnet School in New Haven, CT. Science is departmentalized at Betsy Ross and each class period is approximately fifty-two minutes long. The sixth grade curriculum has four science standards that must be taught throughout the year and these are Ecosystems, Simple Machines, How Technology Impacts Our Waters, and Weather. Two of the standards, Ecosystems and Simple Machines, will be able to be broadened through this proposed unit. Students will gain insight into ecosystems that that exist within their own bodies and to define themselves as being more symbiotic with microorganisms then they could imagine. They will also see that with the new knowledge of using nanotechnology, machines the size of molecules can help to fight diseases. They will learn to convert metric units of measurements to the nanoscale. They will come to understand that instead of taking something large, like a block of wood, and carving it down to the size of a table; they will build from something very small to a larger scale.

Overview

This curriculum unit will be presented to my students in order for them to learn about microbiomes within our bodies that will coincide with the unit Ecosystems and students will have a school wide impact because they will design posters and brochures to inform and educated the entire school population of what they learned in this unit. Currently, Betsy Ross is the only middle school left in the district. All other schools are kindergarten to eighth grade and then high school.

Betsy Ross is an inter-district magnet school with an emphasis on the arts. It is based on meeting the needs of diverse cultures, learning styles and academic skills. New Haven is a college town, home to Yale University. Despite a rich history, New Haven is victim to poverty in certain neighborhoods and violent crime was at an all time high in 1990, making it one of the highest crime rates per capita in the United States. Efforts have been made to decrease the crime rate in New Haven and with 2009 being its safest year on record. Since our school is an arts magnet school, we draw students from the surrounding suburbs. We therefore, have a school population of diverse ethnicities, races, and socioeconomics. The demographics of New Haven Public Schools are as followed: Asian American: 1.24%, African American: 54.82%, Hispanic: 30.95%, Indian American: 0.05%, White: 11.08%, and Other: 1.86%.

The sixth grade curriculum has four science standards that must be taught throughout the year and these are **Ecosystems, Weather, How Technology Impacts Our Waters,** and **Simple Machines.** The following are the content standards for sixth grade science in New Haven: 6.2 - An ecosystem is composed of all the populations that are living in a certain space and the physical factors with which they interact. 6.3 - Variations in the amount of the sun's energy hitting the Earth's surface affect daily and seasonal weather patterns. 6.4 - Water moving across and through earth materials carries with it the products of human activities. 7.1 - Energy provides the ability to do work and can exist in many forms. Support is given to sixth grade math by teaching students how to convert metric units, as well, and this will now include the nanoscale.

Background Information

All life forms require energy in order to carry out life functions such as eating, breathing, reproduction and growth. This energy comes from the surrounding environment. Life exists in three domains: **eukarya** , **bacteria** , and **archaea.** These eukaryotes include life such as fungi, animals, and plants. Then there are bacteria and archaea which make up most of the microorganisms. The major difference between bacteria and archaea is, not in their physical appearance or morphology, but in their DNA sequences. Bacteria and archaea are similar in that both do not have DNA encapsulated in a cell nucleus whereas eukarya do. (See Figure A)

Since all life forms require energy in order to carry out life functions, energy and electron flow are used interchangeably. Energy, on a chemical/cellular level, is referred to as electrons, which are part of all atoms that make up matter, and organisms need an electron source and an electron sink in order for electrons to flow. Organisms need this electron flow in order to produce ATP. ATP is adenosine triphosphate and is considered as the universal energy currency for metabolism. This allows organisms to reproduce, grow, and to carry out other life functions. Microorganisms, like macroorganisms, gain energy for life from their

environment. These are listed below:

- Photosynthesis is the conversion of light energy into chemical energy.
- Aerobic respiration is the process in which organic substrates are degraded completely to CO_2 and uses oxygen as the terminal electron acceptor.
- Anaerobic Respiration is a process in which organic substrates are degraded completely to CO_2, but using a substance other than oxygen as the terminal electron acceptor.
- Chemolithotrophy is the production of organic matter from inorganic materials (similar to photosynthesis). Examples: Sulfide Oxidation, Iron Oxidation, Nitrification
- Fermentation is a process in which organic compounds are degraded or oxidized incompletely.

The purpose of this unit is to provide information to fellow teachers of science that teach ecosystems that there are a vast array of organisms that exist in ecosystems that may be unfamiliar to what we think exists. There are ecosystems that do not rely on a "predator-prey" relationship, but rather a community of organisms existing on metabolic byproducts and chemicals released by neighboring organisms. They will come to realize that not all food chains begin from the energy source of the sun directly, but indirectly. Life forms would not exist without the existence of microorganisms. Scientists believe bacteria are what now exist in our cells as mitochondria. Microorganisms are everywhere and take up the largest population here on Earth. Microorganisms are found in soil, in the oceans, in the air, deep beneath the rocks, and frozen in glaciers. It is believed that microorganisms were the first life form on Earth. All of this information opens up the dynamic world of ecosystems within our bodies understanding that microorganisms inhabit our bodies.

These ecosystems within our bodies are called "microbiomes." These are the microbes that live on and inside our bodies. Scientists have recently discovered that the human body hosts about ten trillion bacteria, mostly not harmful. Bacteria alone outnumber our own cells ten to one. That is about five pounds of body weight due to microbial biomass. Microbes are bacteria, fungi, viruses, yeast, and other little creatures that live in and on us. These microbes and their genes make up our microbiome. New research has found that these benign microbes' aid in boosting the immune system, regulate digestion, prevent infection and can also influence mood. A lot more research is being made in studying people's biomass and differences in the type of bacteria found in different individuals has led researchers to better understand why obesity exist for some people, why certain people that have autism, why people suffer from irritable bowels such as colitis and Crohn's disease. In studying people's microbiomes, also known as our microflora, scientists are hopeful that this research could cure and prevent diseases. The terms microbes and bacteria will be used interchangeably, but for the sake of antibiotics that only kill bacteria, not viruses or fungi, bacteria will be the term most referred to in this unit.

This new study called the Human Microbiome Project is a way for scientists to study the role microbes play in the functioning of our bodies. The largest storehouse of bacteria in the body resides in the gut and scientists call this gut flora. It is known that the bacteria in our guts produce enzymes that help us digest our food. They give us nutrients like vitamin K and B. They also crowd out harmful bacteria. [1] Your gut contains more than 100 million neurons-around the same order of magnitude as the number of brain cells-that operate more or

less independently from the brain in your skull. [2] A rich network of nerve endings in your intestinal wall sends signals directly to your brain via the vagus nerve. Another recent group of research papers, again using models in rodents, shows that this signaling from bottom (gut) up (to the brain) can affect cognitive development and mood.

Without microbes, we would not survive. These bacteria need us and we need them, as well. We share mutuality. Unfortunately, some of these helpful microbes are disappearing due to the over prescribed use of antibiotics, modern sanitation and the increase of C-section births. Many microbes are passed on to an infant at birth when it passes through the mother's womb. The overuse of antibiotics has also led to a rise in antibiotic-resistant bacteria such as MRSA and the loss of "good" bacteria, it appears, could be linked to several immune and metabolic disorders such as asthma, allergies, celiac disease, acid reflux disease, to name just a few.

This may be a reason why there has been such an increase of food allergies such as peanuts and gluten, just to name a few. Having a diet high in processed foods has also led to the decline of bacteria in our bodies because these foods are stripped of all bacteria, the good and the bad. This may be the reason why we have to supplement our diets with probiotics, particularly when we have to take antibiotics. Some scientists are skeptical about probiotics claiming that most of the products out there for consumption may not contain the microbes needed to promote good health in humans. What is suggested is to eat fermented food such as yogurt, kimchi, and sauerkraut. Probiotics are found in the mouth, as well, and help in digestion.

A call to alarm has been sounded by the scientific community that the overuse of antibiotics is causing havoc on our health and a lot of research has been in force to find a way to get around this dilemma. Just the amount of antibiotics used on our livestock alone is over 20 million pounds per year. This will come in the meat we eat, milk we drink, and eggs we consume that gives us additional antibiotics into our systems indirectly. If you are a vegetarian, you will still be victim to these antibiotics in water runoff from farms which will affect groundwater, rivers, and reservoirs.

We need not abandon antibiotics all together, but to use less is best and to focus on making a "smarter" antibiotic. Since bacteria can reproduce at a rate by several million within a few hours, there's no wonder how they can adapt and mutate once introduced to a "hostile" environment, such as the introduction of an antibiotic. That is the reason why there are more antibiotic-resistant bacteria arising every day and the antibiotics are losing. That is why scientists have to think of new ways to combat this phenomenon. We, as humans, live in their world and are just passing through. Therefore we have to trick the pathenogenic bacteria and not harm the helpful bacteria. Studies are presently being done to use helpful bacteria to fight off the harmful bacteria.

Scientists have discovered drugs that can destroy any leftover antibiotics before it harms the "good" bacteria. Scientists are also hopeful that by gene-to-gene basis, they may wipe out resistant bacteria. Scientists are also discovering "natural" bacteria killers. Antimicrobial peptides consist of tiny chains of amino acids-like proteins only smaller. [3] They discovered these AMP's in sleeping pupae of giant silk moth and in the African-clawed frog. How these AMP's destroy is by emitting a slight positive electric charge which allows it to stick to the negatively charged outer surface of the bacterial cell membrane, pierces it and fluids rush into the cell destroying it. Another approach is to find a way to turn off a bacterium's call to arms. Scientists call this approach "defanging." For instance, Staphylococcus aureus can stay dormant in the body one day, and then wreak havoc the next. The Staph germ knows when it has reached the right number in order to attack and the immune system is defenseless against the number. If scientist can figure out a way to block these signals, the

immune system can take care of the pathogen.

Research has also included looking at genetically modifying vaccines by looking at the genomes of different strains of bacteria, MRSA and targeting them. They call this reverse vaccinology. And the most exciting discovery is prescription probiotics. Scientists looked at the vaginal cavities of women that had no vaginal infections to see if they could isolate "good" bacteria. They identified and gave the specimen to women that had chronic vaginal infections and it proved to be successful. Other studies included isolating bacteria in the gut to help with Crohn's disease, ear infections, streptoccocci which can affect the skin, as well as the throat, those people that kept getting , they lacked the harmless bacteria alpha-streptoccocci. This method has also aided in the field of dental hygiene when a dental microbiologist discovered a genetically engineered Strep. mutans bacteria that could attack harmful Strep.mutans which causes tooth decay bythe secretion of its wastes which is an acid.

When discussing oral hygiene, scientists have discovered over seven hundred different varieties of bacteria. Most people house around thirty to seventy different strains. The two most harmful bacteria to teeth are *streptococcus mutans which causes tooth decay and porphyromonas gingivitis which causes gingivitis which could lead to* periodontitis resulting in tooth loss. Diet is a key factor to healthy teeth and gums. There are foods that are recommended to promote a healthy mouth such as raisins which has phytochemicals that help to kill off bad bacteria in your mouth. They also provide good sugars, fructose and glucose, rather than sucrose which can lead to tooth decay. Milk is another food that promotes a healthy mouth. Not only does it provide calcium for strong teeth and bones, it also provides proteins that prevent tooth-decaying bacteria from sticking to our teeth. Of course brushing and flossing regularly and visits to the dentist all help in having a healthy mouth. We should end the war against our microbiological environment and look to harness in what good that community can offer to us instead.

From the Cell Science Systems, Corp. – Alcat Worldwide, numerous studies have been conducted to test foods that are making us sick. [4] Inflammation and chronic activation of the immune system due to food intolerance have been linked to: digestive disorders, migraines, obesity, chronic fatigue, ADD/ADHD, aching joints, skin disorders, arthritis, and many more. Since it has been pointed out previously that there is communication with the gut and the brain, there is an urgency to see how much our micro flora affects theses illnesses.

Alcat Worldwide is a profit organization which suggests all people should be tested to see which foods their bodies cannot tolerate, but they also suggest that "variety is the spice of life." They call this the Rotational Diet. [5] History has shown that variety in the human diet is very important to health and wellbeing. [6] By eating foods in a particular family one day and then omitting them for at least the next three days, a cumulative sensitizing effect is avoided. [7] This time allows the food molecules to "clear" the system, avoiding overload. Having a balanced microbiome will balance our weight, as well according to Raphael Kellman, MD. By giving his patients probiotics, which aide in the recovery of healthy bacteria, he had amazing results with his patients losing and maintaining their weight. When their microbiome in their gut was balanced, everything else improved, including their mood. Refer to Figure G for a more explicit list and locations of micro flora of the human body.

Activities

This unit will begin with a brainstorming session where students will write what they know about microorganisms, what questions they have about microorganisms. This KWL chart will be kept in their interactive notebook, as well as displayed in the classroom. As new information is given through hands-on activities, students will continuously add what they know and generate additional questions.

An interactive notebook is a notebook that contains all information that is given in the lesson. Hand outs are glued into the book and pages are based on the Cornell note taking strategy which is a two column page where questions are on the left and notes are on the right. An objective for the day is always at the top. This will always be on the right side of the notebook. Depending on the activity, the teacher will give questions whereby the students will answer those questions on the note side. Or the teacher will give notes and the students will generate questions based on the notes. At the end of the page, students will summarize the notes and questions of that day. All pages are numbered and a Table of Contents will reflect the new page entries daily. Students will be introduced to new vocabulary terms and a foldable activity called a matchbook will be assigned.

A matchbook foldable is a 5×15 centimeter piece of colored construction paper will be given for each new vocabulary term. Students will fold almost half-way down leaving a lip to be folded up resembling a matchbook. On the front, a picture is drawn depicting the vocabulary term. On the inside top half will have the phonetic spelling. The bottom half will have the meaning of the term, in the students own words, and on the flap will appear the term itself. This can be given as a homework assignment. These matchbooks will be glued to the left side of the notebook opposite to the questions and notes of the day.

Since there is an increase in news coverage and scientific developments in the field of nanotechnology, students will be introduced to the nanoscale and realize that objects on this scale are smaller than microorganisms. Nano- is a prefix from the Greek word meaning "dwarf" and means one billionth. Thus, a nanometer is means one billionth of a meter. They will also learn about the prefix micro- which means one millionth of a particular unit. In science the metric units are used because it is the universal measuring unit called the International System of Units. Scientists measure mass in grams, volume/capacity in liters or cubic centimeters, length/ depth/ width in meters, temperature in degrees Celsius, and time in seconds. A new mnemonic will be created to add these two prefixes on. It will be **K** ings **H** ave **D** iamonds **B** ut **D** iamonds **C** ost **M** ore **M** oney **N** ow, symbolizing kilo, hecto, deka, base, deci, centi, milli, micro, nano.

Students will be able to learn to convert metric units down to the nano-unit and develop a scale helping to reinforce the concept of decimals and exponents. A visual scale will be made that they will glue into their interactive notebook that they can refer to on a daily basis since metric conversions will be part of their daily "Do Now's." Currently students are taught the metric prefixes kilo-, hecto-, deka-, base, deci-,centi-, milli-. One learning strategy that is taught in order for students to remember this order is " **K** ings **H** ave **D** iamonds **B** ut Diamonds **C** ost **M** oney." Students will now learn two additional smaller units and that is micro- and nano-.

Students will learn that "nanotechnologist" rely on nature and mimic many things such as the iridescent colors in a cicada's wings and the suction in tree frogs feet. They will then relate these two parts of the curriculum, nanotechnology and microbiomes, and see how scientists are using this new technology to come up with better alternatives to antibiotics, since more bacteria are developing to be resistant to antibiotics.

Nanotechnology is not new to the modern world. People just didn't know that they were using it in earlier times. The people that made stained-glassed windows in churches for centuries, unbeknownst to them, were using nanotechnology.

Lessons

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1. Introduction to Micro-organisms (Five lessons)

Day1 : Students will complete a "K-W-L" graphic organizer of what they know about germs/micro-organisms, what they want to know about micro-organisms, and what they learned about micro-organisms. (See Figure B in appendix)

Note: The last column will remain blank the first day and as students read and discover more about micro-organisms, they will revisit this graphic organizer to add new knowledge.

Day 2: Students will work in teams of four to research micro-organisms and categorize them into four categories: bacteria, viruses, protozoa, and fungi. They will need to list a minimum of four for each group. Students will make matchbooks for the four new terms introduced for homework.

Day3 : Students will label by putting and X on the part of the body they believe has the most micro-organisms. Students will research to discover where they would find micro-organisms in and on our bodies and which of these micro-organisms are hurtful to us, we call these pathogens, and which are helpful to us. They will answer the question: Why do micro-organisms live in and on us? (See Figure D)

Day 4 : Students will report their findings on chart paper, illustrations included.

Day 5 : Students will present their reports to the rest of the class. Students will be assessed on their presentations using a three point rubric guide showing content, creativity, and presentation skills.

2. Why Should I Brush and Floss My Teeth?

- Students view a video on the proper way to brush and floss provided by Colgate Oral and Health Resource Center

- The school nurse will come to talk to students and demonstrate proper oral care. She will provide students with toothbrushes and floss

- Students will write in their notebooks the proper procedure of brushing and flossing, how often to do it, the duration, and how often to visit their dentist

- Students will be taught that bacteria that live in our mouths feed off the sugars and starches that we eat and it is their waste products that are acidic leading to tooth decay. They will learn that diet plays a key role in the health of their teeth and gums. They will complete a chart listing foods that are good for teeth and foods that are not.

- Students will be given a study guide for proper dental hygiene in which they will be assessed.

3. Why Do I Need to Bathe?

- Students will be given a hygiene worksheet created by the teacher to ask how often they think they should bathe, shower, wash their hair, and wash their hands. (See Figure C)

- Students will be given a myth and fact worksheet provided by the teacher to compare their results. They will be surprised that less bathing is better, but do wash hands often for twenty seconds paying attention to all the nooks and crannies on their hands and under their nails.

- Use soap and water rather than using antibacterial soaps which can result in dryness of the skin and setting themselves up for killing the "good" bacteria needed to keep skin moisturized and protected from pathenogenic bacteria. Being too clean is not healthy.

- Make sure the clothes you put on are clean and that the bed linens, towels and wash cloths are clean.

- Do use deodorant and mouthwash. Air-dry shoes at night.

4. What does my diet look like?

- Students will keep a journal of all the foods they ate for one week

- Students will come together in a thin-pair-share activity where they will share with another student the amount of variety of foods they ate that week by filling out the form found in the Appendix (Figure E)

5. Ongoing lessons on converting metric units which will be done daily for the "Do Now" part of every lesson. (See Figure F)

- Students will be given a strip of paper (6 x 42 centimeters)

- Divide the strip into seven parts (42÷7=6 centimeters)

- At the top of each box going across, they will write the words: Kings Have Diamonds But Diamonds Cost More Money Now

- Under each first letter of every word going vertically, students will write the prefixes: kilo, hecto-, deka-, base, deci-, centi-, milli-, micro-, nano-

- In each of the boxes students will write the number of what the prefix represents: 1,000; 100; 10; 1; 1/10 and 0.1; 1/100 and 0.01; 1/1,000 and 0.001; 1/1,000,000 and 0.000001 (10^{-6}); 1/1,000,000,000 and 0.000000001 (10^{-9})

Students will glue the metric strip into their interactive notebooks and use it daily as the teacher puts various problems on the board. *Example:* 40 meters = ____ centimeters.

For students to understand the abstract thought of such a tiny particle, they will research how small a nanometer is, for instance a strand of human hair's diameter is 80,000 to 100,000 nanometers wide.

Notes

[1] Michael J. Blaser, MD., *Missing Microbes: How the Overuse of Antibiotics is Fueling Our Modern Plagues,* New York: Henry Holt and Company, LLC 181.

[2] Blaser, 181

[3] Jessica Snyder Sachs, *Good Germs, Bad Germs: Health and Survival in a Bacterial World* , New York: Hill and Wang,176-177.

[4] Cell Science Systems, Corp. – Alcat Worldwide Pamphlet from *Are Foods Making You Sick?*

[5] Cell Science Systems, Corp. – Alcat Worldwide Pamphlet

[6] Cordain diet health implications for the 21 st century American Journal of Clinical Nutrition, 81 from "Are Foods Making You Sick?" 341-354.

[7] Cessna R. (2003) The Four-Day Rotation Diet. Original Internist, 9(2), 11-18 from Are Foods Making You Sick?

Sources

Blaser, Michael, MD. *Missing Microbes: How the Overuse of Antibiotics is Fueling Our Modern Plagues,* New York: Henry Holt and Company, LLC, 2014

Cell Science Systems, Corp. – Alcat Worldwide: Deerfield Beach, FL www.Alcat.com from *Are Foods Making You Sick?*

Crawford, Dorothy H. *Deadly Companions: How Microbes Shape Our History,* Oxford: University Press, 2009

Johnson, Rebecca L. *Nanotechnology (Cool Science),* Minneapolis: Lerner Publication Company, 2006

Kellman, Raphael, MD. *The Microbiome Diet,* Boston: Da Capo Press, March 2008

Leach, Jeff D. *Honor thy Symbionts* , December 2012

Morgan, David, Gregory K. Folkers and Anthony S. Fauci. *The challenge of emerging and re-emerging infectious diseases* , Nature *Volume 430* . July 8, 2004

Ratner, Mark A. and Daniel Ratner. *Nanotechnology: A Gentle Introduction to the Next Big Idea* , Upper Saddle, NJ: Prentice Hall, 2003

Rhodes, Rosamond. *The Human Microbiome: Ethical, Legal and Social Concerns* , Oxford: University Press, May 2013

Scott-Mumby, Keith. *Fire in the Belly: The Surprising Cause of Most Diseases, States of Mind and Aging Processes* , Reno: Mother Whale, Inc, February 2013

Snyder-Sachs, Jessica. *Good Germs, Bad Germs: Health and Survival in a Bacterial World* , New York: Hill and Wang, 2007

Staley, James T., Robert P. Gunsalus, Stephen Lory, Jerome J. Perry. *Microbial Life,* Massachusetts: Sinaur Associates, Inc., 2007

Sources for Students

Biddle, Wayne. Microbes-Kids Discover, Harpswell. Anchor Books, 2002.

The author introduces to children that microbes are everywhere, including on your skin, in your mouth, and inside your organs, but don't fear, most microbes are harmless and some are beneficial to us.

Farrell, Jeanette. Invisible Allies: Microbes That Shape Our Lives, Canada: Douglas & Mcintyre Publishing Group, 2005.

The author informs students about how microbes help us in preserving our foods by digesting foods and transforming it by decomposition in order for the cycle to repeat itself. The author provides illustrations and amusing anecdotes.

Padilla, Michael; Ioannis Miaoulis; Martha Cyr. From Bacteria to Plants, Upper Saddle River: Pearson Prentice Hall, 2007.

The authors provide a juvenile textbook written for children/young adults in grades seven to nine.

Ricciuti, Edward R. Microorganisms: The Unseen World (our Living World), Library Binding: 1994

This is written for 4-8th graders with colorful illustrations explaining our place in the ecology of the world. It explains our metabolism, senses, and characteristics unique to each of us.

Learn.Genetics: made by the University of Utah is an interactive learning website for students.

http://www.youtube.com/watch?v=LfeNTQxxn0w&feature=youtu.be

http://dentaleducation.crest.com/lesson_plan_creator.php

http://www.biology4kids.com/files/micro_modern.html

http://education.nationalgeographic.com/education/activity/properties-matter-macro-nano-scale/?ar_a=1

National Library of Medicine. Medical Subject Heading

Appendix

Figure A

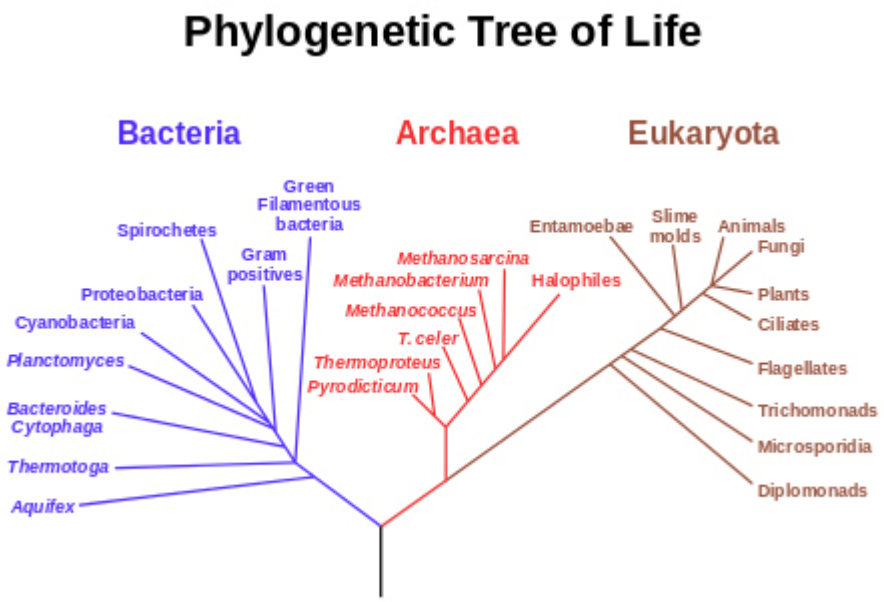


Figure B

Worksheets:

Microbes

What I Know	What I Want to Know	What I Learned

Figure C

Myths and Facts about Washing

Myths	Facts
• You should bathe every day • You should always used antibacterial soap • You should use hot water to bathe • You can use a mesh bath pouf for 6 months • When drying off with a towel, be vigorous	• Bathing every day will leave your skin dry and washes off the good bacteria on your skin that helps to protect you from harmful bacteria • Plain soap and water are fine. Make sure it's at least 20 seconds of hand-washing. Use a paper towel to turn off faucet • Warm water showers are the best in maintaining a healthy flora and fauna for your skin • Throw out your mesh bath pouf after 8 weeks of use • Dry off gently n order to not damage your skin

Figure D

The Human Body

Figure E

Food Chart

On the chart below, place tally marks in each column of how many foods you ate this past week. Please be sure you tally everything you ate on a daily basis and be honest. There is nothing to be ashamed about.

Day of the week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Meat such as chicken, fish, beef, etc.							
Starches/Carbohydrates such as bread, pasta, rice, potatoes, etc.							
Vegetables (this includes salad)							
Fruits (fresh, canned, or frozen). Do not include fruit roll ups. That goes under miscellaneous.							
Miscellaneous such as candy, chocolate							
Beverages such as soda, juice, water, etc.							
Dairy Products such as milk, eggs, yogurt, etc.							

Figure F

Metric Conversion Strip

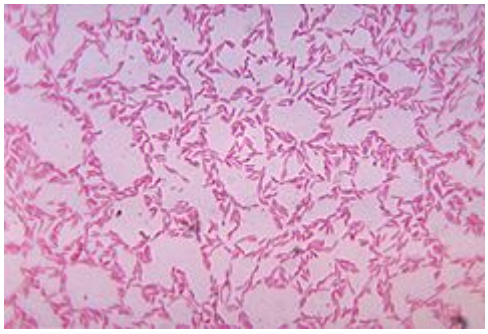
Kings	Have	Diamonds	But	Diamonds	Cost	More	Money	Now
I	E	E	A	E	E	I	I	A
L	C	K	S	C	N	L	C	N
L	T	A	E	I	T	L	R	O
O	O				I	I	O	
				1/10	1/100	1/1,000		
1,000	100	10	1	0.1	0.01	0.001	10^{-6}	10^{-9}

Figure G

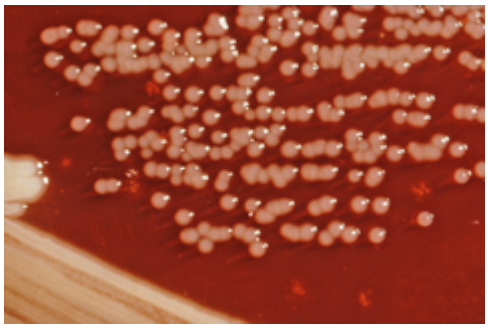
List of Micro Flora of the Human Body

Retrieved from "http://en.wikipedia.org/w/index.php?title=List_of_human_flora&oldid=593879642"

Categories: Bacteria



Bacteroides spp. anaerobically cultured in blood agar medium



Yersinia enterocolitica colonies growing on XLD agar plates

This article lists some of the species recognized as human flora in humans.

Contents

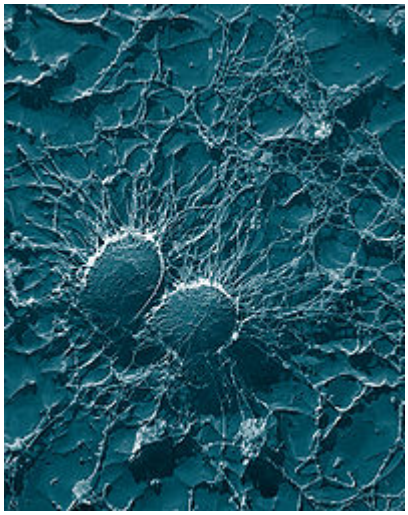
Whole-body distributed

- Acinetobacter calcoaceticus
- Burkholderia cepacia
- Pseudomonas pseudoalcaligenes
- Peptostreptococcus spp

Natural cavities

- Fusobacterium necrophorum
- Eubacterium spp
- Microbacterium spp

Skin



Staphylococcus aureus

- Acinetobacter spp
- Bacillus spp
- Candida albicans
- Corynebacterium spp
- Corynebacterium parvum

- Demodex folliculorum
- Enterobacter cloacae
- Epidermophyton floccosum
- Micrococcus spp
- Micrococcus luteus
- Mycobacterium spp
- Neisseria spp
- Peptostreptococcus spp
- Malassezia ovale
- Propionibacterium spp
- Propionibacterium acnes
- Pseudomonas aeruginosa
- Sarcina spp
- Staphylococcus aureus
- Staphylococcus epidermidis
- Staphylococcus haemolyticus
- Streptococcus viridans
- Trichophyton spp

- Staphylococcus aureus

External ear

- Corynebacterium spp
- Staphylococcus aureus
- Staphylococcus epidermidis

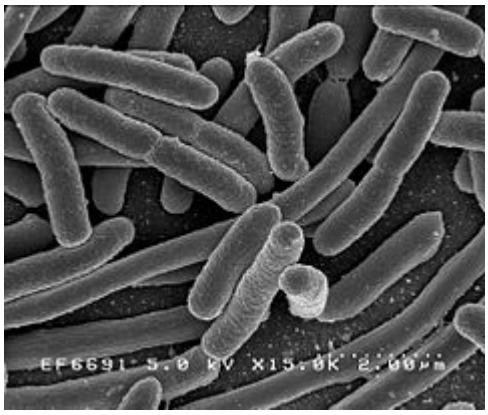
Mucous membranes

- Chlamydia trachomatis
- Hemophilus influenzae
- Staphylococcus aureus
- Staphylococcus epidermidis

Eye

Conjunctiva

- Chlamydia trachomatis
- Chlamydophila pneumoniae
- Haemophilus aegyptius
- Haemophilus influenzae
- Moraxella spp
- Neisseria spp
- Staphylococcus aureus
- Staphylococcus epidermidis
- Streptococcus viridians



Escherichia coli

Binomial name	Location
Achromobacter spp	Large intestine, small intestine (Ileon)
Acidaminococcus fermentans	Large intestine
Acinetobacter calcoaceticus	Large intestine
Actinomyces spp	Amygdala[citation needed]
Actinomyces viscosus	Mouth
Actinomyces naeslundii	Mouth
Aeromonas spp	Large intestine, small intestine (Ileon)
Aggregatibacter actinomycetemcomitans	Mouth
Anaerobiospirillum spp	Feces
Alcaligenes faecalis	Large intestine, small intestine (Ileon)
Arachnia propionica	Mouth
Bacillus spp	Large intestine
Bacteroides spp	Mouth, amygdala
Bacteroides gingivalis	Mouth
Bacteroides fragilis	General distribution
Bacteroides intermedius	Mouth
Bacteroides melaninogenicus	Mouth, feces
Bacteroides pneumosintes	Pharynx

Binomial name	Location
Bacterionema matruchotii (Corynebacterium matruchotii, new combination 1983 IJSB 33:438)	Gingiva
Bifidobacterium spp	Large intestine, feces
Buchnera aphidicola	Mouth
Butyriviberio fibrosolvens	Large intestine
Campylobacter spp	Large intestine
Campylobacter coli	General distribution
Campylobacter sputorum	Mouth
Campylobacter upsaliensis	Mouth
Candida albicans	Mouth
Capnocytophaga spp	Mouth
Clostridium spp	Large intestine, small intestine (Ileon)
Citrobacter freundii	Sputum
Clostridium difficile	Large intestine
Clostridium sordellii	Stomach, small intestine, large intestine, rectus, anus channel
Corynebacterium spp	Mouth
Eikenella corrodens	General distribution, mouth
Enterobacter cloacae	General distribution
Enterococcus spp	Mouth, amygdala
Enterococcus faecalis	General distribution
Enterococcus faecium	General distribution
Escherichia coli	General distribution
Eubacterium spp	Mouth
Flavobacterium spp	Large intestine, small intestine (Ileon)
Fusobacterium spp	Mouth, amygdala
Fusobacterium nucleatum	Mouth
Gordonia Bacterium spp	Sputum
Haemophilus parainfluenzae	Mouth
Haemophilus paraphrophilus	Mouth
Lactobacillus spp	Mouth, Saliva
Leptotrichia buccalis	Mouth
Methanobrevibacter smithii	Intestines
Morganella morganii	Feces
Mycobacteria spp	Large intestine, small intestine (Ileon)
Mycoplasma spp	Large intestine, small intestine (Ileon)
Micrococcus spp	Mouth, Amygdala

Binomial name	Location
Mycoplasma spp	Mouth
Mycobacterium chelonae	Sputum
Neisseria spp	Mouth
Neisseria sicca	Saliva, sputum
Peptococcus spp	Mouth, large intestine
Peptostreptococcus spp	Mouth, amygdala
Plesiomonas shigelloides	General distribution
Porphyromonas gingivalis	Mouth
Propionibacterium spp	Large intestine
Propionibacterium acnes	General distribution
Providencia spp	Feces
Pseudomonas aeruginosa	Large intestine, small intestine (Ileon)
Ruminococcus bromii	Large intestine
Rothia dentocariosa	Mouth
Ruminococcus spp	Cecum, large intestine
Sarcina spp	Large intestine
Staphylococcus aureus	Mouth, large intestine, small intestine (Ileon)
Staphylococcus epidermidis	Mouth
Streptococcus anginosus	General distribution
Streptococcus mutans	Teeth: Dental plaque
Streptococcus oralis	Teeth: Dental plaque
Streptococcus pneumoniae	Nasopharynx
Streptococcus sobrinus	Teeth: Dental plaque
Streptococcus viridans	Mouth, large intestine, small intestine (Ileon)
Torulopsis glabrata	Mouth
Treponema denticola	Mouth
Treponema refringens	Mouth
Veillonella spp	Mouth, amygdala, large Intestine
Vibrio spp	Large intestine, Small intestine (Ileon)
Vibrio sputorum	Mouth
Wolinella succinogenes	Mouth
Yersinia enterocolitica	Large intestine

Respiratory tract

Color-enhanced scanning electron micrograph showing *Salmonella typhimurium* (red) invading cultured human cells

Binomial name	Location
Acinetobacter spp	Nasopharynx
Burkholderia cepacia complex	Lung
Campylobacter sputorum	Nasopharynx
Candida albicans	Pharynx
Cardiobacterium spp	Nose
Chlamydophila pneumoniae	Lung
Citrobacter freundii	Throat
Eikenella corrodens	General distribution
Haemophilus spp	Nasopharynx
Haemophilus parainfluenzae	Pharynx
Haemophilus paraphrophilus	Pharynx
Kingella spp	Upper respiratory Tract
Kingella kingae	Upper respiratory Tract
Moraxella spp	Nasopharynx
Moraxella catarrhalis	Nasopharynx
Mycoplasma orale	Oropharynx
Mycoplasma pneumoniae	Respiratory epithelium
Neisseria spp	Nasopharynx
Neisseria cinerea	Nasopharynx
Neisseria elongata	Pharynx
Neisseria gonorrhoeae	Pharynx[citation needed]
Neisseria lactamica	Nasopharynx
Neisseria meningitidis	Nasopharynx

Binomial name	Location
Neisseria mucosa	Nasopharynx
Neisseria sicca	Nasopharynx
Peptococcus spp	Upper respiratory tract
Peptostreptococcus spp	Pharynx
Pseudomonas aeruginosa	Lung
Selenomonas sputigena	Nasopharynx
Staphylococcus aureus	Nose
Streptobacillus spp	Throat, nasopharynx
Streptococcus constellatus	Oropharynx
Streptococcus intermedius	Oropharynx
Streptococcus mitis	General distribution
Streptococcus pyogenes	Upper respiratory tract
Streptococcus viridans	Pharynx

Urogenital tract

Binomial name	Location
Acinetobacter spp	Anterior urethra, vagina
Bacteroides spp	External genitalia
Bifidobacterium spp	Vagina
Candida albicans	Anterior urethra, external genitalia, vagina
Chlamydia trachomatis	Urethra, vagina, fallopian tubes, prostate gland
Clostridium spp	Vagina
Corynebacterium spp	Anterior urethra, external genitalia, vagina
Enterobacteriaceae	Anterior urethra, external genitalia, vagina
Neisseria gonorrhoeae	Urethra, vagina, prostate gland
Streptococcus viridans	Anterior urethra, external genitalia, vagina
Eikenella corrodens	General distribution
Streptococcus anginosus	General distribution
Staphylococcus aureus	Perineum
Gardnerella vaginalis	Female reproductive system
Mycoplasma hominis	Cervix, vagina
Mobiluncus curtisii	Vagina
Mobiluncus mulieris	Vagina