Marine Microbiology

- In general, microbiology is the study of microscopic (very small) organisms.
- This generally includes 3 categories:
  - Bacteria
  - Viruses
  - Fungi
- Marine Microbiology is the study of microscopic organisms which inhabit the marine environment.

Marine Microbiology

- Marine microorganisms face unique challenges:
  - The marine environment is very salty, sometimes reaching a salinity of up to 40 parts per thousand (ppt).
    - The Gulf of Mexico has an average salinity of 35 ppt.
    - The Dead Sea has a salinity of 300 ppt.
    - The Red Sea has a salinity of 370 ppt.
  - The marine environment is highly variable, subject to high and low tides, rainfall, and environmental contamination.

Marine Microbiology

- The ocean contains 10^5 - 10^7 bacteria per milliliter (mL) of water.
- A mL of water is about the size of the tip of your thumb.
- That's 100,000 - 10,000,000 bacteria per thumb.

Marine Microbiology

- Some marine organisms cause disease (are pathogenic), but most do not.
- Those which are pathogenic prefer warmer temperatures, such as those seen in the human body (98.6º F = 37º C).
- Therefore, the presence of harmful bacteria is influenced by the temperature of the water.

Marine Microbiology

- Marine bacteria survive in several places:
  - Free-floating
  - In the digestive tracts of shellfish (e.g., oysters) and finfish (e.g., grouper)
  - Attached to plankton (e.g., copepods)
  - In sediment

Marine Microbiology

- Therefore, it is possible to be exposed to these bacteria by:
  - Ingesting (swallowing or drinking) seawater
  - Eating raw or undercooked shellfish or finfish (or eating cooked fish which have been contaminated by raw fish)
  - Exposing open wounds to seawater

Marine Microbiology

- Not all contact with seawater or undercooked seafood results in illness; most contact is safe.
- Thousands of people safely visit beaches and eat raw or undercooked seafood every year.
- Beaches are kept safe by constant monitoring by agencies like the MS Department of Marine Resources.
- Seafood is kept safe by constant monitoring and establishment of guidelines by agencies like the U.S. Food and Drug Administration and the Environmental Protection Agency.
- There are many factors involved in exposure to harmful bacteria.

Marine Microbiology

- There are usually not enough bacteria in fish or water to cause disease. This threshold is called the infectious dose, the minimum number of bacteria necessary to establish an infection.
- Therefore, the chances of becoming sick depends on the actual number of bacteria present in the water or fish, and the number of bacteria present depends on other factors, such as temperature, salinity, and the presence of other organisms.
- The reason why agencies constantly monitor the marine environment is because of its variability and its health effects on consumers and beachgoers.

Marine Microbiology

- There are several marine bacteria which are pathogenic for humans.
- Waterborne diseases are the #1 killer of people worldwide, more than war and terrorism combined; most of these deaths are in developing countries with little access to clean water.
- Most waterborne disease is gastrointestinal in nature (diarrhea), and death usually results from dehydration as a result of the diarrhea plus the lack of clean water to rehydrate the individual.
- There are 900,000 infections and 900 deaths per year in the U.S. due to waterborne disease.

Marine Microbiology

- A major cause of waterborne disease is the bacterium *Vibrio cholerae*, which causes cholera.
- The two Bangladeshi children on the left are malnourished and suffer from diarrhea. The child on the right recovered after eating proper foods for three weeks in a research hospital:

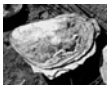
http://www.umich.edu/news/MT/04/Fall04/story.html?humanity

Marine Microbiology

- *Vibrio cholerae* is a gram-negative, curved rod-shaped bacterium found in seawater.
- It causes watery diarrhea, but no cramping, pain, or fever.
- A unique characteristic of cholera is mucus-flecked rice-water stools.
- Its incubation period (the time from contacting the bacterium to the time the symptoms start) is 1-5 days.
- Its infectious dose is 1,000,000 *V. cholerae* (i.e., ingesting 10,000 *V. cholerae* would probably not cause cholera).

V. cholerae
http://textbookofbacteriology.net/medical.html

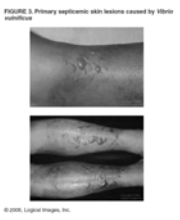
Marine Microbiology



- *Vibrio parahaemolyticus* is a "cousin" of *Vibrio cholerae*. It is the same genus ("family"), but different species ("parents").
- It causes watery diarrhea, nausea, vomiting, cramps, chills, and mild fever. It can also cause wound infections if enough bacteria are present in the water when an open wound is exposed to the water.
- Illness is often due to consumption of raw oysters.
- It is more common than *V. cholerae* in the U.S.
- Its incubation period is 4-30 hours (much shorter than *V. cholerae*).
- Its infectious dose in oysters is 100,000 bacteria per gram of oyster meat (i.e., oysters with 10,000 bacteria per gram or less are considered safe to eat).
- *V. parahaemolyticus* killed 2 people following Hurricane Katrina (see attached report "Vibrio Illnesses After Hurricane Katrina --- Multiple States, August--September 2005".)

Marine Microbiology

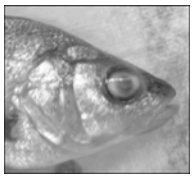
- *Vibrio vulnificus* is another "cousin" in the *Vibrio* genus which may cause diarrhea but is also associated with wound and blood infections.
- It is the most severe of the vibrios, with up to a 50% fatality rate in blood infections in predisposed individuals (such as those with liver disease or diabetes).
- Its infectious dose may be as low as 100 total bacterial cells for predisposed individuals.
- Incubation period: 12-72 hours.
- *V. vulnificus* killed 3 people following Hurricane Katrina (see attached report "Vibrio Illnesses After Hurricane Katrina --- Multiple States, August--September 2005".)



http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5437a5.htm

Marine Microbiology

- *Vibrio anguillarum* is often a pathogen of finfish, particularly salmon and trout.
- Infection is characterized by lethargy and skin inflammation, followed by bloody open sores and body fluids.
- It is particularly problematic in fish culture facilities, and can kill up to 50% of the fish population.



http://www.mdsg.umd.edu/news/wperch.html

Marine Microbiology

- *Salmonella typhi* is found in seawater usually as a result of land runoff, and sometimes in the guts of finfish
- *Salmonella* are not natural inhabitants of the ocean, but their cells are equipped for survival in marine environments, and they can cause disease if present in high enough amounts.
- *S. typhi* causes salmonellosis and typhoid fever.
- Salmonellosis
  - Characterized by diarrhea, anorexia, fever, headache, and cramps.
  - Incubation period is usually 7-14 days.
  - Infectious dose is 100,000 total bacterial cells.
- Typhoid Fever
  - Characterized by bloodstream infection, debilitating high fever and headache without diarrhea.
  - Incubation period is usually 10-20 days.
  - Infectious dose is 1,000 - 1,000,000 total bacterial cells.

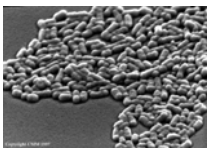
Marine Microbiology

See attached story, "Typhoid Mary".

www.pbs.org/wgbh/ nova/typhoid/mary.html

Marine Microbiology

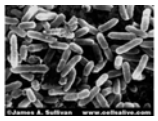
- *Escherichia coli* is found in seawater usually as a result of land runoff.
- *E. coli* causes diarrhea, urinary tract infections, bacteremia, and meningitis.
- It is ubiquitous in the gastrointestinal tracts of humans and animals.
- It is used as indicator organism for fecal contamination.
- *E. coli* was made famous in 1993 by Jack-in-the-Box.



http://science.nasa.gov/headlines/images/eclss-microbes/e-coli.jpg

Marine Microbiology

- *Pseudomonas aeruginosa*, causes eye and ear infections and is a major cause of nosocomial (hospital-acquired) respiratory tract infections (e.g., pneumonia), and can cause up to 50% mortality rates in ICU patients.
- *P. aeruginosa* is ubiquitous; it is found in moist soil, moist plants, hospital disinfectants, ointments, irrigation fluids, eye drops, dialysis fluids, respiratory therapy equipment
- It is a major cause of death among cystic fibrosis patients because of biofilm formation.
- See attached article, "Biofilms".



http://textbookofbacteriology.net/medical.html

Marine Microbiology

- *Dracunculus medinensis*, also known as the Guinea worm, is a marine parasite
- As larvae, it is eaten by marine zooplankton (the copepod), where it matures.
- When the copepod is ingested by drinking, the mature adult spreads in the human host where it reproduces just below the skin.
- The female migrates to the skin surface and forms a blister.
- This blister ruptures when in contact with water, usually on the foot or ankles of the host.
- The only method of removal from the blister is by gentle traction:

See attached paper, "Dracunculiasis (Guinea Worm Disease) and the Eradication Initiative"

http://pathmicro.med.sc.edu/parasitology/nematodes.htm

Marine Microbiology

- Historically, the serpents on the caduceus symbol are thought to be Guinea worms:

- The extruding larva was wrapped around a stick over the course of weeks to months, and the result was "worn" as an indicator of the doctor's competence.

Marine Microbiology

Questions?

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