Symbiotic Relationships

- Symbiosis means “to live together”
- Describes the relationship between microorganisms and their host
- Three types
  - Mutualism
  - Commensalism
  - Parasitism

The Three Types of Symbiotic Relationships

<table>
<thead>
<tr>
<th>Organism 1</th>
<th>Organism 2</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutualism</td>
<td>Benefits</td>
<td>Benefits</td>
</tr>
<tr>
<td>Commensalism</td>
<td>Benefits</td>
<td>Neither benefits nor is harmed</td>
</tr>
<tr>
<td>Parasitism</td>
<td>Benefits</td>
<td>Is harmed</td>
</tr>
</tbody>
</table>

Table 14.1
Normal Microbiota

- Also termed normal flora and indigenous microbiota (flora)
- Refers to the organisms that colonize the body’s surfaces without normally causing disease
- Two types
  - Resident microbiota
  - Transient microbiota

Resident Microbiota

- Are a part of the normal microbiota throughout life
- Most are commensal

<table>
<thead>
<tr>
<th>Table 14.2.1</th>
<th>Same Resident Microbiota</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper Respiratory Tract</strong></td>
<td><strong>Lower Respiratory Tract</strong></td>
</tr>
<tr>
<td>Pharynx</td>
<td>Lower Respiratory Tract</td>
</tr>
<tr>
<td>Larynx</td>
<td>Trachea</td>
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<tr>
<td>Esophagus</td>
<td>Bronchus</td>
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</tbody>
</table>

Table 14.2.1
Transient Microbiota

- Remain in the body for only hours to months before disappearing
- Found in the same regions as resident microbiota
- Cannot persist in the body
  - Competition from other microorganisms
  - Elimination by the body’s defenses cells
  - Chemical or physical changes in the body

Acquisition of Normal Microbiota

- Development in the womb is generally free of microorganisms (axenic)
- Microbiota begins to develop during the birthing process
- Much of one’s resident microbiota established during the first months of life
Opportunistic Pathogens

- Normal microbiota or other normally harmless microbes that can cause disease under certain circumstances
- Conditions that provide opportunities for pathogens
  - Immune suppression
  - Changes in the normal microbiota – changes in relative abundance of normal microbiota may allow opportunity for a member to thrive and cause disease
  - Introduction of normal microbiota into unusual site in the body

Contamination vs. Infection

- Contamination – the mere presence of microbes in or on the body
- Infection – results when the organism has evaded the body’s external defenses, multiplied, and become established in the body

Portals of Entry

- Sites through which pathogens enter the body
  - major types
    - Skin
    - Mucous membrane
Skin
- Outer layer of packed, dead, skin cells usually acts as a barrier to pathogens
- Some pathogens can enter through openings or cuts
- Others enter by burrowing into or digesting the outer layers of skin

Mucous Membranes
- Line the body cavities that are open to the environment
- Provides a moist, warm environment that is hospitable to pathogens
- Respiratory tract is the most commonly used site of entry – entry is through the nose, mouth or eyes
- Pathogens able to survive the acidic pH of the stomach may use the gastrointestinal tract as a route of entry

Infection vs. Disease
- Infection is the invasion of the host by a pathogen
- Disease results only if the invading pathogen alters the normal functions of the body
- Disease is also referred to as morbidity
Manifestations of Disease

- Symptoms – subjective characteristics of disease felt only by the patient
- Signs – objective manifestations of disease that can be observed or measured by others
- Syndrome – group of symptoms and signs that characterize a disease or abnormal condition
- Asymptomatic, or subclinical, infections lack symptoms but may still have signs of infection

Etiology

- Study of the cause of disease
- Germ theory of disease – disease caused by infections of pathogenic microorganisms
- Robert Koch developed a set of postulates one must satisfy to prove a particular pathogen causes a particular disease

Koch’s Postulates

Figure 14.7
Exceptions to Koch’s Postulates

- Using Koch’s postulates is not feasible in all cases
  - Some pathogens can’t be cultured in the laboratory
  - Some diseases are caused by a combination of pathogens and other cofactors
  - Ethical considerations prevent applying Koch’s postulates to pathogens that require a human host
- Difficulties in satisfying Koch’s postulates
  - Diseases that can be caused by more than one pathogen
  - Pathogens that are ignored as potential causes of disease

Virulence Factors of Infectious Disease

- Pathogenicity – ability of a microorganism to cause disease
- Virulence – degree of pathogenicity
  - Virulence factors contribute to an organism’s virulence
    - Adhesion factors
    - Biofilms
    - Extracellular enzymes
    - Toxins
    - Antiphagocytic factors

The Stages of Infectious Disease

- Following infection, sequence of events called the disease process occurs
- Many infectious diseases have five stages following infection
The Stages of Infectious Disease

- Incubation period (no signs or symptoms)
- Prodromal period (mild, general symptoms)
- Illness (most severe signs and symptoms)
- Decline (declining signs and symptoms)
- Convalescence (no signs or symptoms)

Movement of Pathogen Out of Host

- Pathogens leave host through portals of exit

- Eyes (tears)
- Nose (secretions)
- Mouth (saliva, sputum)
- In feaces:
  - Mammary glands (milk, secretions)
  - Vagina (secretions, blood)
- Armpit (feaces)
- Genital (semen and lubricating secretions)
- Urethra (urine)
Reservoirs of Infection

Most pathogens cannot survive long outside of their host.
Sites where pathogens are maintained as a source of infection are termed reservoirs of infection.

Three types of reservoirs:
- Animal reservoir
- Human carriers
- Nonliving reservoir

Animal Reservoirs

- Zoonoses – diseases that are naturally spread from their usual animal host to humans.
- Acquire zoonoses through various routes:
  - Direct contact with animal or its waste
  - Eating animals
  - Bloodsucking arthropods
- Humans are usually dead end host to zoonotic pathogens

Human Carriers

- Infected individuals who are asymptomatic but infective to others.
- Some individuals will eventually develop illness while others never get sick.
- Healthy carriers may have defensive systems that protect them from illness.
Nonliving Reservoirs

- Soil, water, and food can be reservoirs of infection
  - Presence of microorganisms is often due to contamination by feces or urine

Modes of Infectious Disease Transmission

- Transmission from either a reservoir or portal of exit
- Three groups
  - Contact transmission
  - Vehicle transmission
  - Vector transmission

Modes of Disease Transmission

<table>
<thead>
<tr>
<th>Mode of Transmission</th>
<th>Diseases Spread Include</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Transmission</td>
<td>Croup, scarlet fever, typhus, pertussis, meningitis, botulism, tetanus, diphtheria, whooping cough, leptospirosis, typhoid fever</td>
</tr>
<tr>
<td>Direct Contact e.g., hand, body, nose, mouth, skin</td>
<td></td>
</tr>
<tr>
<td>Indirect Contact e.g., drinking water, food, insects, flies</td>
<td></td>
</tr>
<tr>
<td>Droplet Contact e.g., sneezing, talking, coughing, etc. (water)</td>
<td></td>
</tr>
<tr>
<td>Vehicle Transmission</td>
<td>Cholera, smallpox, poliomyelitis, influenza, measles, Salmonella typhosa, tuberculosis</td>
</tr>
<tr>
<td>Vehicle Transmission e.g., streams, swimming pools,</td>
<td></td>
</tr>
<tr>
<td>Waterborne e.g.,</td>
<td></td>
</tr>
<tr>
<td>Foodborne e.g., prickly heat,</td>
<td></td>
</tr>
<tr>
<td>Vector Transmission</td>
<td>Yellow fever, dengue fever, malaria, Rocky Mountain spotted fever,</td>
</tr>
<tr>
<td>Mechanism e.g., bite,</td>
<td></td>
</tr>
<tr>
<td>Biological e.g.,</td>
<td></td>
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</tbody>
</table>

Table 14.10
Classification of Infectious Diseases

- Many different methods of classification
  - The body system they affect
  - The taxonomic groups of the causative agent
  - Their longevity and severity
  - How they are spread to their host

Epidemiology

- Study of where and when diseases occur and how they are transmitted within populations
- Track occurrence of diseases using two measures
  - Incidence – number of new cases of a disease in a given area during a given period of time
  - Prevalence – number of total cases of a disease in a given area during a given period of time
- Occurrence also evaluated in terms of frequency and geographic distribution

Figure 14.15a-d
Nosocomial Infections

- Infections acquired while in a health care facility
- Types of nosocomial infections
  - Exogenous – pathogen acquired from the health care environment
  - Endogenous – pathogen arise from normal microbiota due to factors within the health care setting
  - Iatrogenic – results from modern medical procedures

Control of Nosocomial Infections

- Involves precautions designed to reduce the factors that result in disease
- Hand washing is the most effective way to reduce nosocomial infections

Figure 14.19
Epidemiology and Public Health

- Agencies at the local, state, national, and global level share information concerning disease
  - The United States Public Health Service is the national public health agency
  - World Health Organization (WHO) coordinates public health services internationally
- Public health agencies work to limit disease transmission
  - Monitor water and food safety
- Public health agencies campaign to educate the public on healthful choices to limit disease

Epidemiology

- Epidemiology is the science dealing with when and where diseases occur in humans and how they are transmitted.

Factors which affect the occurrence and spread of disease may include:
- overcrowding
- lack of immunization
- poor nutritional status
- lack of sanitation
- contaminated areas or materials
- ways pathogens are transmitted

CDC

- The CDC (Center for Disease Control) is the central source of epidemiological information in the United States.
- They publish “Morbidity and Mortality Weekly Report” containing data on the incidence of specific notifiable diseases (morbidity) and on the deaths from these diseases (mortality). This is read by many health care professionals.
- Notifiable diseases are those required to be reported to the Public Health Service.
A pandemic disease is an epidemic that occurs in many countries at the same time. Which disease is expected to become a pandemic soon? At present, three diseases which are pandemics are:
- 1. HIV/AIDS
- 2. Tuberculosis
- 3. Malaria

The World Health Organization tracks diseases throughout the world. Read up on oral health and HIV at this website:
http://www.who.int/oral_health/action/communicable/en/

HIV facts from 2001
- Fourth leading cause of mortality in the world
- More than 60 million people had been infected; by 2000, 22 million had died of AIDS
- 28 million cases in Sub-Saharan Africa
- About 1 million in US in 2001
- In 2001, 3 million deaths from AIDS, approximately 46% of female deaths worldwide due to AIDS
- Most infected people do not know they are infected
Health Care Workers

- Primary Danger: needle sticks
- Only 0.3% of needle sticks lead to infection (99.7% of accidents do not lead to infection).
- Universal Precautions

CDC indicates 57 health care workers have Sera-converted to HIV following occupational exposures, including:

- 24 nurses
- 19 laboratory workers
- 6 physicians
- 2 surgical techs
- 2 housekeepers/maintenance workers
- 1 each dialysis and respiratory therapist, aide, and an embalmer

Health Care Workers With AIDS

- 23,951 people with AIDS have been employed in health care.
- Only one case of health care worker transmitting to patients (one dentist infected 6 patients).
- 73% of health care workers with AIDS, including 3,856 nurses, 1,384 physicians, 378 dental workers, 317 paramedics & 88 surgeons have died.
**Tuberculosis Facts:**
- Many strains of *Mycobacterium tuberculosis* are multi-drug resistant
- About 2 billion people have TB (1/3 of all people in world)
- 2 million people die of TB every year
- TB leading cause of people with AIDS
- 10 – 15 million Americans are infected with *Mycobacterium tuberculosis*
- Airborne droplet transmission

**Malaria facts:**
- *Plasmodium* (parasite) is transmitted by Anopheles mosquito
- Symptoms: fever, chills, sweating, headache and nausea
- Most common in tropics; 90% of cases in Africa
- **Endemic** (always present) in 101 countries
- 300 – 500 million cases per year
- 1.5 - 2.7 million deaths per year; one million are children

**Chain of Infection – The infectious disease process**
- 1. The pathogen
- 2. Reservoir – the source of the pathogen
- 3. Portal of exit - way pathogen escapes
- 4. Mode of transmission – way pathogen travels
- 5. Portal of entry – how pathogen infects host
Types of Reservoirs:

1. Humans
   - Person to person contact including kissing, touching, sexual intercourse, sneezing or coughing

2. Animals
   - Both wild and domestic animals can carry disease organisms (example: rabies, Rocky Mountain Spotted Fever, Cat Scratch Fever)

3. Nonliving
   - Air, water, food, soil, human and animal fecal matter, 
     Fomites (inanimate object or substance capable of carrying infectious organisms)

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Fomites

- Which fomites in found in a dental office?
- Examples:
  - Gloves
  - Syringes
  - Gowns
  - Dental tools
  - Needles
  - Tissues

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Modes of Transmission

- Direct or indirect contact
- Airborne
- Droplet
- Fomites, air, water, food
- Vectors (usually insects and other arthropods)

Which are of greatest concern in a dental office?
Contact, airborne, droplet and fomites
Normal Flora of the Human Oral Cavity

- Oral bacteria include:
  - streptococci
  - lactobacilli
  - staphylococci
  - corynebacteria

Bacteria Species

- **Streptococcus salivarius** is dominant and may make up 98% of the total oral flora until the appearance of the teeth (6 - 9 months in humans).
- The eruption of the teeth during the first year leads to colonization by **S. mutans** and **S. sanguis**.
  - These bacteria require a non-epithelial surface in order to colonize.
  - Persist as long as teeth remain

Various streptococci in a biofilm in the oral cavity.
Tooth Decay

- Oral bacteria are responsible for diseases of the oral cavity
  - gingivitis
  - periodontitis
- The oral bacteria can invade compromised tissues in their hosts and produce disease outside the oral cavity.
  - oral streptococci are introduced into wounds created by dental manipulation or treatment

Dental Plaque

- Material adhering to the teeth, consists of bacterial cells (60-70% the volume of the plaque), salivary polymers, and bacterial extra-cellular products.
  - Plaque is a naturally constructed biofilm, in which the consortia of bacteria may reach a thickness of 300-500 cells on the surfaces of the teeth
  - high concentrations of bacterial metabolites result in dental disease.

Common Oral Bacteria

- *Porphyromonas gingivalis*. A common bacterium found in periodontal infections.
- Dominant bacterial species in dental plaque are *Streptococcus sanguis* and *Streptococcus mutans*
**Dental Caries**

- **Dental Caries** is the destruction of the enamel, dentin or cementum of teeth due to bacterial activities.
  - Caries are initiated by direct demineralization of the enamel of teeth due to lactic acid and other organic acids which accumulate in dental plaque.
  - Lactic acid bacteria in the plaque produce lactic acid from the fermentation of sugars and other carbohydrates.
  - These organisms normally colonize the occlusal fissures and contact points between the teeth, and this correlates with the incidence of decay on these surfaces.

**Susceptible Regions**

- Cross section of a tooth illustrating the various structural regions susceptible to colonization or attack by microbes.

**Secondary Invaders**

- *Lactobacilli, Actinomyces,* and various proteolytic bacteria are commonly found in human carious dentin and cementum, suggesting that they are secondary invaders contributing to the progression of the lesions.
Periodontal Diseases

- **Periodontal Diseases** are bacterial infections that affect the supporting structures of the teeth (gingiva, cementum, periodontal membrane and alveolar bone).
  - **Gingivitis**, is an inflammatory condition of the gums.
  - **Actinomyces israelii** have been suggested as the cause.

Cause of Periodontal disease

- Mechanisms of tissue destruction in periodontal disease are not clearly defined but hydrolytic enzymes, endotoxins, and other toxic bacterial metabolites seem to be involved.