“Nurses play an important role in controlling and stopping the growth of microorganism in providing quality and safe nursing care.”

Microbial Control

Unit 3

Domino B. Puson, R.N., M.N.
Controlling Microbial growth is necessary

Micro-organisms (microbes) are present in almost every environment found on the surface of the earth.

In buildings, micro-organisms are normally present in low concentrations and are found on surfaces (such as carpet, tiles) or as floating dust/aerosol particles.

The primary objective of this policy is to assist in the control of micro-organisms in building systems, particularly those associated with bacterial genus Legionella such as Legionnaires' disease, humidifier fever, and pontiac fever.

To a lesser extent control is sought of other micro-organisms sources, such as Pseudomonas (eg causing skin rashes or ear infections), amoebic meningitis, herpes, chlamydia and gastro-intestinal infections.

Today's control measures are more sophisticated and include a wide array of methods but not all methods do not kill microbes eg filtration = removal.
**MAIN SOURCES OF COMMUNITY WATER SUPPLY**

Surface water

Ground water

**Water resources** are sources of water that are useful or potentially useful. Uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water.

97% of the water on the Earth is salt water. However, only three percent is fresh water; slightly over two thirds of this is frozen in glaciers and polar ice caps. The remaining unfrozen freshwater is found mainly as groundwater, with only a small fraction present above ground or in the air.

Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world and as the world population continues to rise, so too does the water demand.

One of the most important natural resources in the world is water. Tremendous amounts of resources and efforts have been invested in keeping our water clean and safe. But in spite of these efforts and advances in water treatment technologies, waterborne disease outbreaks still occur and continue to threaten drinking water quality and safety in developed and developing countries.
Sources of water contamination

Rainwater
falling over a large area, collects in lakes and rivers

Floods and storms
contaminate local drinking water with sewage

Soil microbes and raw fecal materials
contaminate water sources

Ground water
sewage seeped into the ground water

First stage: Filtration
remove large debris, twigs and leaves

Second stage: sedimentation or settling
water remains in holding tank, where additional debris settles into the bottom of the tank

Third stage: coagulase or flocculation
alum added to coagulate smaller pieces of debris which then settles to the bottom

Fourth stage: sand filtration or diatomaceous earth filtration
water filtered to remove remaining bacteria, protozoan cyst and oocyst, and other small particles
alternative: charcoal filters, membrane filters (remove giardia lambdia cysts and cryptosporidium parvum oocysts)

Fifth stage: Chlorination
Cl gas or NaHCl added to kill most
remaining bacteria
alternative: ozone (O3); UV light

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The infectious process cycle

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Waterborne diseases are caused by pathogenic microorganisms that most commonly are transmitted in contaminated fresh water. Infection commonly results during bathing, washing, drinking, in the preparation of food, or the consumption of food thus infected. Various forms of waterborne diarrheal disease probably are the most prominent examples, and affect mainly children in developing countries; according to the World Health Organization, such disease account for an estimated 4.1% of the total DALY global burden of disease, and cause about 1.8 million human
deaths annually. The World Health Organization estimates that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene.

The term "waterborne disease" is reserved largely for infections that predominantly are transmitted through contact with or consumption of infected water.

http://en.wikipedia.org/wiki/Waterborne_diseases

Giardia lamblia (synonymous with Giardia intestinalis, Lamblia intestinalis and Giardia duodenalis) is a flagellated protozoan parasite that colonizes and reproduces in the small intestine, causing giardiasis.

remains confined to the lumen of the small intestine

Giardia trophozoites absorb their nutrients from the lumen of the small intestine, and are anaerobes. If the organism is split and stained, it has a
very characteristic pattern that resembles a familiar "smiley face" symbol.

Chief pathways of human infection include ingestion of untreated sewage.

*Giardia* infection can occur through ingestion of dormant *microbial cysts* in contaminated water, food, or by the faecal-oral route (through poor hygiene practices).

Cysts are resistant to conventional water treatment methods such as *chlorination* and *ozonolysis*.

Colonization of the gut results in inflammation and villous atrophy, reducing the gut’s absorptive capability, diarrhea, *malaise*, excessive gas (often flatulence or a foul or sulphuric-tasting belch, which has been known to be so nauseating in taste that it can cause the infected person to vomit), *steatorrhoea* (pale, foul smelling, greasy stools), epigastric pain, bloating, nausea, diminished interest in food, possible (but rare) vomiting which is often violent, and weight loss. Pus, mucus and blood are occasionally present in the stool. It usually causes "explosive diarrhea" and while unpleasant, is not fatal. In healthy individuals, the condition is usually self-limiting, although the infection can be prolonged in patients who are immunocompromised, or who have decreased gastric acid secretion.

Boiling suspect water for one minute is the surest method to make water safe to drink and kill disease-causing microorganisms like *Giardia lamblia* if
in doubt about whether water is infected with the *Giardia* parasite.

- Metronidazole 5–7 days
- Nitazoxanide 3 days
- Tinidazole Single dose
- Albendazole 5 days

Under a normal compound light microscope, *Giardia* often looks like a "clown face," with two nuclei outlined by adhesive discs above dark median bodies that form the "mouth." Cysts are oval, have four nuclei, and have clearly visible axostyles. In spite of the common belief that all Eukaryotes have mitochondria, *Giardia* is one of the few that lack these organelles.

Cryptosporidium parvum is one of several protozoal species that cause cryptosporidiosis, a parasitic disease of the mammalian intestinal tract.

Primary symptoms of C. parvum infection are acute, watery, and non-bloody diarrhoea. C. parvum infection is of particular concern in immunocompromised patients, where diarrhoea can reach 10–15L per day.

Other symptoms may include anorexia, nausea/vomiting and abdominal pain. Extra-intestinal sites include the lung, liver and gall bladder where it causes respiratory cryptosporidiosis, hepatitis and cholecystitis.

Infection is caused by ingestion of sporulated oocysts transmitted by the faecal-oral route. In healthy human hosts, the median infective dose is 132 oocysts.

Infection is generally self-limiting in immunocompetent people.

C. parvum is considered to be the most important waterborne pathogen in developed countries.

Supportive therapy such as IV fluids is the primary for C. parvum infection. Paromomycin and Nitazoxanide may alleviate some of the diarrhoeal symptoms, however the latter is contraindicated for AIDS patients. Continuing antiretroviral drugs to boost the immune system may
also control infection.

http://en.wikipedia.org/wiki/Cryptosporidium_parvum

The pathogenic nature of \( E. \) histolytica was first reported by Lösch in 1875, but it was not given its Latin name until Fritz Schaudinn described it in 1903

**Entamoeba histolytica** is an anaerobic parasitic protozoan, part of the genus*Entamoeba*.\(^1\) Predominantly infecting humans and other primates, \( E. \) histolytica is estimated to infect about 50 million people worldwide.

The active (trophozoite) stage exists only in the host and in fresh loose feces; cysts survive outside the host in water, in soils, and on foods, especially under moist conditions on the latter.

The cysts are readily killed by heat and by freezing temperatures, and survive for only a few months outside of the host.

Symptoms can include fulminating dysentery, bloody diarrhea, weight loss, fatigue, abdominal pain, and amoeboma (also known as an
amebic granuloma, is a rare complication of *Entamoeba histolytica*, where in response to the infecting amoeba there is formation of annular colonic granulation, which results in a large local lesion of the bowel.

Metronidazole for the invasive trophozoites PLUS a lumenal amoebicide for those still in the intestine.

Definitive Host - Human
Portal of Entry - Mouth
Mode of Transmission - Ingestion of mature cyst through contaminated food or water

What is the difference?

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**Bacterial Waterborne Disease**

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**Campylobacter**
- Enteritis and occasional systemic infection
- Self-limiting: 5 – 8 days
- Acute onset of crampy abdominal pain, copious diarrhea may be grossly bloody, foul-smelling feces, headache, malaise, fever
- Sources: milk, undercooked food, contact with infected animals or humans and excreta
- Dx: fresh stool specimen

is a genus of bacteria that are Gram-negative, spiral, and microaerophilic, characteristic spiral/corkscrew appearance

*Campylobacter jejuni* is now recognized as one of the main causes of bacterial foodborne disease in many developed countries

with *C. jejuni* and *C. coli* the most common

The common routes of transmission are fecal-oral, ingestion of contaminated food or water, and the eating of raw
meat.

It produces an inflammatory, sometimes bloody, diarrhea, periodontitis\[8\] or dysentery syndrome, mostly including cramps, fever and pain. The infection is usually self-limiting and in most cases, symptomatic treatment by liquid and electrolyte replacement is enough in human infections. Symptoms typically last for five to seven days.

The sites of tissue injury include the jejunum, the ileum, and the colon.

Diagnosis of the illness is made by testing a specimen of faeces (bowel motion).

Quinolone antibiotics, as ciprofloxacin or levofloxacin. Dehydrated children may require intravenous (by vein) fluid treatment in a hospital. The illness is contagious and children must be kept at home until they have been clear of symptoms for at least two days. Good hygiene is important. Increased abdominal pain and collapse require immediate medical attention.
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**Escherichia coli**

- EPEC (enteropathogenic E. coli) - Infant’s diarrhea
- ETEC (enterotoxigenic E. coli) - Traveler’s diarrhea
- EIEC (Enteroinvasive E. coli) - Traveler’s diarrhea
- EHEC (enterohemorrhagic E. coli) - Outbreaks in diarrheal diseases
- SX: Gastroenteritis, diarrhea
- MOT: Ingestion of infected material/substances

*E. coli* is **Gram-negative, facultative anaerobic and non-sporulating**

Optimal growth of *E. coli* occurs at 37°C (98.6°F)

*E. coli* normally colonizes an infant's gastrointestinal tract within 40 hours of birth, arriving with food or water or with the individuals handling the child. In the bowel, it adheres to the mucus of the large intestine. It is the primary facultative anaerobe of the human gastrointestinal tract.1

As long as these bacteria do not acquire genetic elements encoding for virulence factors, they remain benign commensals.

Virulent strains of *E. coli* can cause gastroenteritis, urinary tract infections, and neonatal meningitis. In rarer cases, virulent strains are also responsible for hemolytic-uremic syndrome, peritonitis, mastitis, septicemia and Gram-negative pneumonia.

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*Salmonella*

- Salmonellosis
- Enterocolitis: S and L intestine
- Incubation period: 1 – 10 days
- Onset: 8 – 48 hrs; lasts 1 – 4 days (healthy adults) and self-limiting
- Resolves in 2 – 3 days
- SX: nausea, headache, vomiting, profuse diarrhea with blood and mucus, low grade fever and chills lasting 1 – 3 wks
- Dx: stool culture

*Salmonella* /ˈsælməˌnɛlə/ is a genus of rod-shaped, Gram-negative, non-spore-forming, predominantly motile

*Salmonella* infections are zoonotic and can be transferred between humans and non-human animals. Many infections are due to ingestion of contaminated food.

The organism enters through the digestive tract and must be ingested in large numbers to cause disease in healthy adults. Gastric acidity is
responsible for the destruction of the majority of ingested bacteria.

However, infants and young children are much more susceptible to infection, easily achieved by ingesting a small number of bacteria.

A short incubation period of a few hours to one day, the germ multiplies in the intestinal lumen causing an intestinal inflammation with diarrhea that is often muco-purulent and bloody.

In infants, dehydration can cause a state of severe toxicosis.

In Germany, *Salmonella* infections must be reported. Between 1990 and 2005, the number of officially recorded cases decreased from approximately 200,000 cases to approximately 50,000. It is estimated that every fifth person in Germany is a carrier of *Salmonella*.

In the USA, there are approximately 40,000 cases of *Salmonella* infection reported each year.
Shigella is a genus of Gram-negative, nonspore forming, non-motile, rod-shaped bacteria closely related to *Escherichia coli* and *Salmonella*.

*Shigella* is one of the leading bacterial causes of diarrhea worldwide.

The genus is named after Kiyoshi Shiga, who first discovered it in 1898.

*Shigella* infection is typically via ingestion (fecal–oral contamination); depending on age and condition of the host, less than 100 bacterial cells can be enough to cause an infection.

*Shigella* causes dysentery that results in the destruction of the epithelial cells of the intestinal mucosa in the *cecum* and *rectum*.

Hand washing before handling food and thoroughly cooking all food before eating decreases the risk of getting *Shigella*.

Severe dysentery can be treated with ampicillin, TMP-SMX, or fluoroquinolones, such as ciprofloxacin, and of course rehydration.
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The main reservoirs of *V. cholerae* are people and aquatic sources such as brackish water and estuaries, often in association with copepods or other zooplankton, shellfish, and aquatic plants. Recent studies indicate that global warming creates a favourable environment for the bacteria.

Cholera infections are most commonly acquired from drinking water in which *V. cholerae* is found naturally or into which it has been introduced from the feces of an infected person.

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What struck me most about this article were the mummies of Guanajuato in Mexico. These people were buried due to a cholera epidemic outbreak in 1833. And there bodies were mummified naturally—due to the air and weather in the area.

http://reahguevarra.com/buried-alive-premature-burial/
“Today, no one should die of cholera,”

Philippines' Health Secretary Francisco Q. Duque

http://www.time.com/time/magazine/article/0,9171,895844,00.html

Mycobacterium is a genus of Actinobacteria, given its own family, the Mycobacteriaceae.

including tuberculosis (Mycobacterium tuberculosis)
and leprosy (Mycobacterium leprae)

All Mycobacterium species share a characteristic cell wall, thicker than in many other bacteria, which is hydrophobic, waxy, and rich in mycolic acids/mycolates.

Mycobacteria are widespread organisms, typically living in water (including tap water treated with chlorine) and food sources. Some, however, including the tuberculosis and the leprosy organisms, appear to be obligate parasites and are not found as free-living members of the genus.

Mycobacteria can colonize their hosts without the hosts showing any adverse signs. For example, billions of people around the world have asymptomatic infections of M. tuberculosis.
Mycobacterial infections are notoriously difficult to treat. The organisms are hardy due to their cell wall

In addition, they are naturally resistant to a number of antibiotics that disrupt cell-wall biosynthesis, such as penicillin.

Due to their unique cell wall, they can survive long exposure to acids, alkalis, detergents, oxidative bursts, lysis by complement, and many antibiotics.

*M. tuberculosis* complex, which can cause tuberculosis: *M. tuberculosis, M. bovis, M. africanum, and M. microti; M. leprae*, which causes Hansen's disease or leprosy; Nontuberculous mycobacteria (NTM) are all the other mycobacteria, which can cause pulmonary disease resembling tuberculosis, lymphadenitis, skin disease, or disseminated disease.
HEPATITIS A
• Infectious Hepatitis
• Fecal-oral route through close personal contact
• Sx: abrupt onset of fever (>38 °C), fever, night sweats, abdominal pain, diarrhea, weight loss
• Sources: Fecal contamination of single source: drinking water, food or milk
• Dx: blood: HAV (2 wks before or <1 wk after jaundice)
• Stool: HAV (2 wks before or after jaundice)

IgM levels
Electron microscopy
Sensitive serologic assay
polymerase chain reaction (PCR)

Hepatitis A (formerly known as infectious hepatitis and epidemic viral) is an acute infectious disease of the liver caused by the hepatitis A virus (Hep A), an RNA virus, usually spread the fecal-oral route; transmitted person-to-person by ingestion of contaminated food or water or through direct contact with an infectious person.

In developing countries, and in regions with poor hygiene standards, the incidence of infection with this virus is high and the illness is usually contracted in early childhood.

Early symptoms of hepatitis A infection can be mistaken for influenza, but some sufferers, especially children, exhibit no symptoms at all. Symptoms typically appear 2 to 6 weeks, (the incubation period), after the initial infection

Symptoms usually last less than 2 months, although some people can be ill for as long as 6 months.

Fatigue
Fever
Abdominal pain
Nausea
Appetite loss
Jaundice, a yellowing of the skin or whites of the eyes
Bile is removed from blood stream and
excreted in urine, giving it a dark amber colour
Clay-coloured feces

The virus spreads by the fecal-oral route and infections often occur in conditions of poor sanitation and overcrowding. Hepatitis A can be transmitted by the parenteral route but very rarely by blood and blood products. Food-borne outbreaks are not uncommon,[15] and ingestion of shellfish cultivated in polluted water is associated with a high risk of infection.

It is detectable from one to two weeks after the initial infection and persists for up to 14 weeks

Hepatitis A can be prevented by vaccination, good hygiene and sanitation

The vaccine was introduced in 1992 and was initially recommended for persons at high risk. Since then Bahrain and Israel have embarked on eradication programmes

There is no specific treatment for hepatitis A. Sufferers are advised to rest, avoid fatty foods and alcohol (these may be poorly tolerated for some additional months during the recovery phase and cause minor relapses), eat a well-balanced diet, and stay hydrated
The most widespread hepatitis A outbreak in the 2003 United States hepatitis outbreak afflicted at least 640 people (killing four) in north-eastern Ohio and south-western Pennsylvania in late 2003.

Noroviruses are a genetically diverse group of single-stranded RNA.

This genus name norovirus is derived from Norwalk virus which causes approximately 90% of epidemic nonbacterial outbreaks of gastroenteritis around the world, and may be responsible for 50% of all foodborne outbreaks of gastroenteritis in the United States. Noroviruses are the most common cause of viral gastroenteritis in humans. Norovirus affects people of all ages.

After infection, immunity to norovirus is usually incomplete and temporary.

Outbreaks of norovirus infection often occur in closed or semiclosed communities, such as long-term care.
facilities, overnight camps, hospitals, prisons, dormitories, and cruise ships, where the infection spreads very rapidly either by person-to-person transmission or through contaminated food.

Hand washing with soap and water is an effective method for reducing the transmission of norovirus pathogens.

Thirty elementary school children died and another 105 were hospitalized after eating a native delicacy made from cassava — a root that could be poisonous if not prepared correctly — at the San Jose Elementary School in Mabini, Bohol.
FOOD POISONING

Causative agents:
- Microbes and products
- Poisonous plants and animal tissues
- Food contaminated by pesticides
- Other poisonous substances

Foodborne illness (also foodborne disease and colloquially referred to as food poisoning)

is any illness resulting from the consumption of contaminated food, pathogenic bacteria, viruses, or parasites that contaminate food, as well as chemical or natural toxins such as poisonous mushrooms.

Foodborne illness usually arises from improper handling, preparation, or food storage.

Bacteria are a common cause of foodborne illness.

This ranges from hours to days (and rarely months or even years, such as in the case of Listeriosis or Creutzfeldt-Jacob disease), depending on the agent, and on how much was consumed.

If symptoms occur within 1–6 hours after eating the food, it suggests that it is caused by a bacterial toxin or a chemical rather than live bacteria.

http://en.wikipedia.org/wiki/Food_poisoning
Common Bacteria
Campylobacter jejuni
Clostridium perfringens,
Salmonella spp.
Escherichia coli O157:H7

Exotoxins
Clostridium botulinum
Clostridium perfringens
Staphylococcus aureus
Bacillus cereus
For example Staphylococcus aureus produces a toxin that causes intense vomiting. The rare but potentially deadly disease botulism occurs when the anaerobic bacterium Clostridium botulinum grows in improperly canned low-acid foods and produces botulin, a powerful paralytic toxin.

Viruses
Parasites
Natural toxins - Shellfish toxin
Other pathogenic agents - Prions, resulting in Creutzfeldt-Jakob disease
Preventing bacterial food poisoning
• strict rules of hygiene and a public services of veterinary surveying of animal products in the food chain
• At home, prevention mainly consists of good food safety practices

Prevention is mainly the role of the state, through the definition of strict rules of hygiene and a public services of veterinary surveying of animal products in the food chain, from farming to the transformation industry and delivery (shops and restaurants)

<table>
<thead>
<tr>
<th>General Category</th>
<th>Cause</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food intoxication</td>
<td>ingestion of exotoxin</td>
<td>diarrea and vomiting</td>
</tr>
<tr>
<td></td>
<td>• enterotoxin: intestine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• neurotoxin: nervous</td>
<td></td>
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<tr>
<td>Food infection</td>
<td>ingestion of whole, intact microbial cells that target the intestines and other body structures</td>
<td>diarrea, abdominal distress</td>
</tr>
</tbody>
</table>

Prevention Measures for Foodborne Disease
Prevent contamination of microbes into food
– Vigorous washing
– Aseptic extraction from source: meat, eggs, milk
– Hand washing and proper hygiene
– Cover food and eliminate pests
– Same cutting board for meat and veggies
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Prevention Measures for Foodborne Disease

- Prevent survival or multiplication of microbes in food
- Preserve food by physical or chemical method
- Heating: 60 – 120 ºC x 20 – 115 mins.
- Commercial sterilization
- Cooking: boiling; center of meat heated @ 80 ºC x 30 mins; roasting or frying @ 200 ºC
- Pasteurization

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Prevention Measures for Foodborne Disease

- Prevent survival or multiplication of microbes in food
- Temperature manipulation
- Regular refrigeration
- Freezing
- Slow frozen: 3 – 72 hours @ -15 to -23 ºC
- Rapid freeze: 30 mins. @ -17 to -34 ºC
- Radiation: UV (nonionizing)

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Prevention Measures for Foodborne Disease

- Other forms of preservation
- Chemical preservation: salting, table sugar, artificial subs (ethylene oxide)
- Desiccation

Ethylene oxide: at room temperature it is a flammable, carcinogenic, mutagenic, irritating, and anaesthetic gas with a misleadingly pleasant aroma used industrially for making many consumer products as well as non-consumer chemicals and intermediates used industrially for making many consumer products as well as non-consumer chemicals and intermediates

* a poison gas that leaves no residue on items it contacts, pure ethylene oxide is a disinfectant that is
widely used in hospitals and the medical equipment industry to replace steam in the sterilization of heat-sensitive tools and equipment, such as disposable plastic syringes

used for spices, nuts and dried fruits

Desiccation: drying food by exposing it to warm, dry air

Microorganisms are widespread and, once present, they can compromise product functionality, performance and aesthetics. Exposure to microorganisms can also affect human health.
**Brucella** is a genus of Gram-negative bacteria.

*Brucella* is the cause of brucellosis, which is a zoonosis. It is transmitted by ingesting infected food, direct contact with an infected animal, or inhalation of aerosols. Transmission from human to human, for example through sexual intercourse or from mother to child, is exceedingly rare, but possible.

The disease is characterized by acute undulating fever, headache, night sweats, fatigue and anorexia. Human brucellosis is not considered a contagious disease and people become infected by contact with fluids from infected animals (sheep, cattle or pigs) or derived food products like unpasteurized milk and cheese.

**Symptoms**

Acute stage: insidious onset; malaise, fever (rise in afternoon, fall during the night), weakness, aches, sweets (drenching sweat with fall in fever), GI symptoms, nervous symptoms, lymph node enlargement, palpable spleen, hepatitis with jaundice, deep pain and disturbances in motion esp. in vertebral bodies, osteomyelitis; subsides in weeks or months with localized lesions and symptoms may continue.

Chronic stage: weakness, aches, pains, low grade fever, nervousness.
**Mycobacterium tuberculosis** (MTB) is a pathogenic bacterial species in the genus *Mycobacterium* and the causative agent of most cases of *tuberculosis* (TB).\(^1\) First discovered in 1882 by Robert Koch

*M. tuberculosis* requires oxygen to grow.

*Mycobacterium bovis* is a slow-growing (16 to 20 hour generation time), aerobic bacterium and the causative agent of *tuberculosis* in cattle (known as bovine TB). Related to *M. tuberculosis*—the bacterium which causes tuberculosis in humans—*M. bovis* can also jump the species barrier and cause tuberculosis in humans.\(^2\)

**Coxiella burnetii** is an obligate intracellular bacterial pathogen, and is the causative agent of *Q fever*.

While most infections clear up...
spontaneously, treatment with tetracycline or doxycycline appears to reduce the symptomatic duration and reduce the likelihood of chronic infection.

The United States ended its biological warfare program in 1969. When it did, C. burnetii was one of seven agents it had standardized as biological weapons.

Sources: Sheep, cattle, goats, domestic mammals (cats, dogs)
Listeria monocytogenes, a facultative anaerobe, intracellular bacterium, is the causative agent of listeriosis.

Invasive infection by L. monocytogenes causes the disease listeriosis.

Listeriosis is a bacterial infection caused by a Gram-positive, motile bacterium, Listeria monocytogenes. Listeriosis occurs primarily in newborn infants, elderly patients, and patients who are immunocompromised. Listeriosis kills at least 1 in 5 persons it infects. Its wide range of temperature tolerance necessitates extra care in food processing and storage. Milk does not need to be homogenized to prevent listeriosis, but pasteurization of milk is definitely necessary. Vegetables and fruit that have contacted the soil must be carefully washed before refrigeration.

The symptoms of listeriosis usually last 7–10 days, with the most common symptoms being fever, muscle aches, and vomiting. Diarrhea is another, but less common symptom. If the infection spreads to the nervous system it can cause meningitis, an infection of the covering of the brain and spinal cord.

symptoms usually last 7-10 days
Sx: fever, muscle aches, vomiting
If the infection spreads to the nervous system it can cause meningitis:
headache, stiff neck, confusion, loss of balance, and convulsions
Infected pregnant women: mild flu – like symptoms, early delivery, newborn infection or death of the baby
Sources: Wild animals

In infections during pregnancy, the mother usually survives. Reports of successful treatment with parenteral penicillinor ampicillin exist. Trimethoprim-sulfamethoxazole has been shown effective in patients allergic to penicillin.

The process of heating wine for preservation purposes has been known in China since 1117

**Pasteurization** (or pasteurisation, see spelling differences) is a process of heating a food, which is usually a liquid, to a specific temperature for a predefined length of time and then immediately cooling it after it is removed from the heat. This process slows spoilage due to microbial growth in the food.

pasteurization is not intended to kill all micro-organisms in the food. Instead, it aims to reduce the number of viable pathogens so they are unlikely to cause disease (assuming the pasteurized product is stored as indicated and is consumed before its expiration date)
Milk pasteurization has been scientifically proven to be at least 90% effective in eliminating harmful bacteria in milk.

**Prevention Measure for Milk borne Disease**

**PASTEURIZATION**
- **BATCH METHOD**: 63 – 66 ºC x 30 min
- **Advantages**
  - Inactivate most viruses and destroy vegetative stages of 97 – 98% of bacteria and fungi but do not kill endospores or thermoduric spp
  - Prevent transmission of milk-borne diseases from infected cows and milk handlers
  - Extend milk storage time
  - Can be used by some wineries, breweries to stop fermentation and destroy contaminants

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**PASTEURIZATION**
- **UHT (Ultra High Temperature)**: 110 - 134 ºC x 1 sec.
- **Advantage**: produce sterile milk with storage life of 3 months
Food irradiation is a method of treating food in order to make it safer to eat and have a longer shelf life.

Food irradiated by exposing it to the gamma rays of a radioisotope -- one that is widely used is cobalt-60.

Irradiation of certain foods also have additional benefits. Since the energy passing through the food can disrupt cellular processes (this is the mechanism for destroying microorganisms) it also can halt the cellular processes that lead to the sprouting or ripening of foods.
The nurse plays a critical role in preventing and controlling infectious disease. The beginning nursing student participates significantly in the prevention process from the initial introduction to nursing care.

An important component in preparing for clinical nursing practice is an understanding of the infection process and prevention techniques. Microbiology and other science courses provide background information about pathogenic organisms.

The transfer of these scientific principles to the applied art and science of nursing involves an awareness of the dynamics of the infectious process.

In nursing, measures to prevent the transmission of infectious microorganisms from patient to patient become a significant component of care. This prevention is achieved through the practice of medical asepsis and standard precautions. Standard precautions include universal precautions and nosocomial infection.
Infection control

- Measures taken to prevent the spread of infection or infection to occur in the health care setting.
Principles of Basic Infection Control

3. Microorganisms are transferred by gravity when one item is held above the other.
4. Microorganisms are released into the air on droplet nuclei whenever a person breathes or speaks.

5. Microorganisms move very slowly on dry surface but quickly through moisture.
6. Proper hand washing removes most organisms that would be transferred by hands from one item to another.

Asepsis is the state of being free from disease-causing contaminants (such as bacteria, viruses, fungi, and parasites) or, preventing contact with microorganisms.

The term asepsis often refers to those practices used to promote or induce asepsis in an operative field of surgery or medicine to prevent infection.

Ideally, a surgical field is "sterile," meaning it is free of all biological contaminants, not just those that can cause disease, putrefaction, or...
fermentation, but that is a situation that is difficult to attain, especially given the patient is often a source of infectious agents.

Asepsis: without infection
• any action (aseptic technique) taken to prevent or break the chain of infection
Medical asepsis: clean technique
Surgical asepsis: sterile technique

The modern concept of asepsis evolved in the 19th century.

Ignaz Semmelweis showed that washing the hands prior to delivery reduced puerperal fever.

After the suggestion by Louis Pasteur, Joseph Lister, 1st Baron Lister introduced the use of carbolic acid as an antisepic and reduced surgical infections rates.

Lawson Tait went from antisepsis to asepsis, introducing principles and practices that have remained valid to this day.

Ernst von Bergmann introduced the autoclave, a device used for the practice of the sterilization of surgical instruments.
**Medical Asepsis**

**Goals**
- Reduce number and transmission of pathogens
- Prevent transfer of infection, direct or indirect

**Techniques**
- Frequent and thorough hand washing
- Personal grooming
- Proper cleaning of supplies and equipments
- Disinfection
- Proper disposal of needles, contaminated materials, infectious wastes
- Sterilization

**Cornerstone of Medical Asepsis**
- Know what is dirty
- Know what is clean
- Know what is sterile
- Keep all conditions separate
- Remedy contamination immediately

**Principles of Medical Asepsis**
- When body is penetrated and natural barrier is bypassed, the person is susceptible to any microbe that might enter
- Even if skin is intact, a person can become colonized by microbes if appropriate precaution is not observed
- All body fluids from patient is considered contaminated
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**Principles of Medical Asepsis**
- Health care team and the environment can be the source of contamination
- Assess each patient for infectious process
- Choose the barrier appropriate for the infectious process
- ISOLATE THE DISEASE NOT THE PATIENT
- The chain is as strong as the weakest link

Health care team and the environment can be the source of contamination
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ISOLATE THE DISEASE NOT THE PATIENT
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**Surgical Asepsis**
- Goal: Scrubbing and decontamination, entry sterile (free of microorganisms)

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**Surgical Techniques**
- Scrubbing hands and fingernails before entering the OR.
- Use of sterile gloves, masks, gowns, shoe covers and caps.
- Using sterile solutions and dressings.
- Using sterile drapes and creating a sterile field.

Scrubbing hands and fingernails before entering the OR.
Use of sterile gloves, masks, gowns, shoe covers and caps.
Using sterile solutions and dressings.
Using sterile drapes and creating a sterile field.
Surgical Techniques

- Using heat-sterilized instruments.
- Patients skin: thoroughly shaved and cleansed with soap and antiseptic.
- Floors, walls and all equipment's thoroughly cleaned and disinfected before and after each use.
- Proper ventilation maintained, fresh, filtered air is circulated throughout the room at all times.

Standard Precautions

- are standard operating procedures that apply to the care and treatment of all patients, regardless of their perceived infectious risk.

Standard precautions are work practices required to achieve a basic level of infection control and are recommended for the treatment and care of all Patients.

These precautions include aseptic technique, handwashing, use of personal protective equipment, appropriate reprocessing of instruments and equipment and implementation of environmental controls. Standard precautions should incorporate safe systems for handling blood (including dried blood), other
body fluids, secretions and excretions (excluding sweat), nonintact skin and mucous membranes.

Universal precautions were typically practiced in any environment where workers were exposed to bodily fluids, such as:
- Blood
- Semen
- Vaginal secretions
- Synovial fluid
- Amniotic fluid
- Cerebrospinal fluid
- Pleural fluid
- Peritoneal fluid
- Pericardial fluid

Bodily fluids that did not require such precautions included:
- Feces
- Nasal secretions
- Urine
- Vomitus
- Perspiration
- Sputum
- Saliva
According to Centers for Disease Control, STANDARD PRECAUTION is the outgrowth of UNIVERSAL PRECAUTION (UP). Universal Precaution was first introduced on 1987 to prevent the spread or the transmission of blood borne pathogens to the health care providers.

However, on 1996 the concept of STANDARD PRECAUTION (SP) was established to expand the course of UP. STANDARD PRECAUTION now constitutes the primary strategy to prevent the transmission of infectious agents not only to the health care personnel but also to patients and hospital visitors.

Hence, gowing, wearing of mask, gloving, and the use of protective barriers are just components of the popular Standard Precaution.

Universal Precaution and Body Substance Isolation
Apply to
- Blood
- All body fluids, secretions and excretions, except sweat
- Non intact skin
- Mucous membrane
- All patients regardless of infection status
The work practices listed in Table 2.1 should be considered minimum requirements for infection control. Implementing standard precautions minimises the risk of transmission of infection from person to person even in high-risk situations. Standard precautions should be implemented at all times, particularly when patients are undergoing invasive procedures, including catheterisation, cannulation or intubation.

Health care establishments that offer these procedures should provide detailed protocols for patient management in their infection control procedures manuals.
The use of standard precautions is essential as the primary strategy for the successful minimization of transmission of health care associated infection.

This is because:

- infectious patients may not show any signs or symptoms of infection that may be detected in a routine history and medical assessment;
- a patient’s infectious status is often determined by laboratory tests that may not be completed in time to provide emergency care;
- patients may be infectious before laboratory tests are positive or symptoms of disease are recognised (the window period of disease); or
- people may be placed at risk of infection from those who are asymptomatic but infectious.
UNIVERSAL PRECAUTION
Goal: REDUCE THE RISK OF TRANSMISSION OF BLOODBORNE PATHOGENS

- PPE: gloves, gowns, mask and/or goggles

Blood and body fluid precautions
- Applied universally to all patients regardless of presumed infection status

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**BODY SUBSTANCE ISOLATION**

- **Goals**
  - Protect against bacterial organisms that may exist in body substances
  - Prevent contamination of healthcare worker and patient
  - Reduce risk of transmission of pathogen from moist body substances

Applied to moist and potentially infectious body substances
Applied to all patients regardless of presumed infection status

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**ISOLATION OR PRECAUTION TECHNIQUES**

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**TRANSMISSION – BASED PRECAUTION**

- Airborne Precaution (droplet nuclei: 5um or less in diameter)
  - Patient placement: Private room with negative air pressure
  - Visitors: wear respiratory protection (N95 respirator)
  - Washing: After handling oral and respiratory secretions
  - Patient transport: mask on patient

Transmission – based precaution patients known or suspected to be infected with highly transmissible or epidemiologically important pathogens for which additional precautions beyond standard precautions are required to interrupt transmission within the hospital

Airborne precaution: airborne droplet nuclei dust particles containing suspected pathogen applied to patients known or suspected to be infected with epidemiologically important pathogens that can be transmitted by the airborne route
Example: M. tb; rubeola virus, varicella virus Patient placement: air is discharged outdoors or pass through HEPA (high efficiency particulate air) filter if circulated; in a room with a patient having active infection of same pathogen but with no other infection (cohorted)

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Patient care equipment: Concurrent and terminal disinfection

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TRANSMISSION – BASED PRECAUTION

Droplet precaution (droplet: >5um in diameter)

• Patient placement: Private room or same room with a patient having active infection of same pathogen but no other infection
• Others: mask when working within 3 ft
• Wash: After handling oral and respiratory secretions

Droplet infection droplet do not remain suspended in the air expel through sneezing, coughing, talking, suctioning, bronchoscopy

Droplet precaution used for patients known or suspected to be infected with microorganisms transmitted by droplets that can be generated in ways mentioned

Examples: meningococcal meningitis, multidrug resistant pneumococcal meningitis, pneumonia, whooping cough, strep throat, streptococcal pneumonia, influenza
CONTACT PRECAUTIONS

- Direct contact transmission
- Indirect contact transmission
- Patient placement: Private room or same room with a patient having active infection of same pathogen but no other infection (cohorting)
- Gloves: used when handling the patient and secretions/discharges
- Wash: Immediately after removing gloves (antiseptic or antimicrobial agent)

Contact precaution

Nosocomial infection patients known or suspected to be infected or colonized with epidemiologically important pathogens that can be transmitted through direct and indirect contact

Example: multidrug resistant bacteria, clostridium difficile-associated disease, respiratory syncytial virus (RSV) infection in children, shingles or chicken pox, scabies, impetigo, viral hemorrhagic fever

Direct contact transmission: transmission by body surface to body surface contact

Indirect contact: transfer via contaminated intermediate object
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**CONTACT PRECAUTIONS**
- Gowns: used when doing bedside care
- Patient transport: Limit for essential purpose
- Patient care equipment: Non-critical equipment dedicated to single patient Terminal disinfection

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**SOURCE ISOLATION**
- Patient placement: Private room, prevent room air from entering hallway (negative air pressure)
- Air from room passes through filters
- Glove: when handling oro-nasal secretions
- Wash: Before and after patient care
- Patient transport: mask on patient
- Patient care equipment: Concurrent and terminal disinfection

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**PROTECTIVE ISOLATION**
- Reverse or Neutropenic Isolation
- Patient placement: Private room where air passes through filters
- Prevent hallway air from entering the room (positive pressure)
- Gloves and gowns, sterile gloves, gowns and shoe cover
- Wash: surgical handwashing

Source isolation with contagious disease (Tb and others) placed in isolation to protect others from becoming infected.

Protective isolation protect patient from infection
Example: with severe burns, leukemia, transplant, immunosuppressed, on radiation, leukopenic, premature infants
Patient placement: total protected environment (TPE)
Patient transport: No transport if possible
Patient care equipment: Wash and disinfect or sterilize items in contact with the patient
Enteric precaution prevent spread of diarrheal diseases
Example: shigella, salmonella, E. coli, cholera, Hep A, rotavirus, giardiasis
Strict isolation most highly virulent or contagious microbes

STERILIZATION

- Patient placement: Private with closed door
- Gloves and gowns: By all persons include mask
- Wash: By all persons
- Patient transport: Surgical mask
- Patient care equipment: Contaminated items wrapped and sent to central supply for decontamination

METHODS OF MICROBIAL CONTROL

TERMS RELATED TO MICROBIAL CONTROL

- Sterilization
- Disinfection
- Antiseptic
- Antiseptic
- Degermation
- Sanitation

Sterilization: zero microbial life
Disinfection: destruction of vegetative form of microbe
Antiseptic: destruction of vegetative form on living tissues
Antiseptic: Chemical for antiseptic
Degermation: mechanical removal of most microbes in a limited area
Sanitation: decrease microbial population to safe public level

“CIDE” – kill
“STAT or STATIC or STASIS” – inhibit growth and multiplication
FACTORS INFLUENCING EFFECTIVENESS OF ANTIMICROBIAL TREATMENT

- Number of microbes
- Environment: organic materials, temperature
- Time of exposure
- Microbial characteristics

METHODS OF MICROBIAL CONTROL

- Destruction of Microbes
- Preservative additives
- Prevention of Growth
- Maintenance temperature
- Dosage
FORMS OF HEAT

Moist Heat

Boiling: free flowing steam
Action: Protein coagulation
Effective on: Vegetative forms of bacterial pathogen, almost all viruses, fungi and spores (10 mins application)
Less effective on: Hepatitis virus, Clostridium difficile bacillus
Application: Dishes, Basins, pitchers, various equipments

Autoclaving: steam under pressure
Action: Protein coagulation
Effective on: All vegetative cells (15 mins application @ 15 psi or 121 °C)
Application: Microbial media, solutions, linens, utensils, dressings

Pasteurization

• Classic: 63°C x 30 mins
• HTST (high temperature short time): 72 °C x 15 mins
• UHT (ultra high temp): 140 °C x <1 sec
• Application: Milk, cream, wine, beer
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**FORMS OF HEAT**

**Dry Heat**
- **Action:** Kill by oxidation

**Forms**
- **Direct flaming:** Burning contaminant to ashes
  - **Application:** Inoculation loop
- **Incineration:** Burning materials to ashes
  - **Application:** Paper cups, dressings, animal carcasses, wipes, bags

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**FORMS OF HEAT**

**Dry Heat**

**Forms**
- **Hot air sterilization:** Oven temperature 170°C x 2 hours
  - **Application:** Empty glassware, instruments, needles, glass syringe

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**FILTRATION**

**Mechanism of Action:** Separate bacteria from suspending liquid

**Material**
- Cellulose acetate or nitrocellulose

**HEPA (organism: > 0.3 μm diameter)**

**Application:**
- Heat sensitive materials, culture media, vaccine, enzymes, antibiotic solution
LOW TEMPERATURE

- Refrigeration: T 0 – 7 °C
- Deep freezing: T -50°C to -95°C
  - Indication: Prevention of microbial growth
  - MOA: ↓ chemical reaction with protein change
  - Application: Food, drug, culture preservation

LOW TEMPERATURE

- Lyophilization (rapid freeze):
  - Indication: Long term preservation of microbial culture
  - MOA: Water removed by high vacuum at low temp. then material rapidly freeze, cellular chemical reaction suspended
  - Application: Food, drug, vaccine, culture preservation, plasma

DESSICATION

- MOA: dehydrate organism but organism cannot grow and remain viable for indefinite number of years
- Application: Food preservation; Beddings (dust), clothing, dressing, urine, pus, feces
**OSMOTIC PRESSURE**

- **Action:** Plasmolysis
- **Materials:** Salt and sugar
- **Application:** Food preservation

**RADIATION**

- **Passage of energy through space**

**Forms**

- **Ionizing radiation**
  - MOA: DNA destruction
  - Materials: Gamma rays (cobalt); X-ray; HEEB (high energy electron beams)
  - Application: Pharmaceutical sterilization, disposable dental and medical supplies, plastic syringes, suturing materials, surgical gloves, catheters

- **Nonionizing radiation**
  - MOA: Destroy DNA of exposed cells
  - Materials: UV light; Germicidal soap
  - Application: Hospital rooms, NR, OR, cafeteria, vaccines, medicinal products
MICROWAVE

- MOA: moisture is absorbed killing the organism

CHEMICAL METHODS OF DISINFECTION

CHARACTERISTICS OF IDEAL DISINFECTANT
- Broad or wide antimicrobial spectrum
- Fast acting
- Not affected by presence of organic material
- Nontoxic to human tissues, noncorrosive and nondestructive to materials
- Leave a residual antimicrobial film on treated surface
- Soluble in water and easy to apply
- Inexpensive and easy to prepare
- Stable as concentrate and working solution
- Odorless

CHEMICAL METHODS OF DISINFECTION
application of chemicals on tissues and inanimate objects

CHARACTERISTICS OF IDEAL DISINFECTANT
Broad or wide antimicrobial spectrum
Fast acting
Not affected by presence of organic material
Nontoxic to human tissues, noncorrosive and nondestructive to materials
Leave a residual antimicrobial film on treated surface
Soluble in water and easy to apply
Inexpensive and easy to prepare
Stable as concentrate and working solution
Odorless
Phenols (carbolic acid)

- Advantage: odor control
- Disadvantage: Skin irritant; Disagreeable odor

Phenolics (Ex, Lysol)

- Effect/Advantage: Plasma membrane lipid destruction; Active in presence of organic material; Stable for long period
- Application: Pus, saliva, feces sterilization

Bisphenols (Ex. Phisohex)

- Effective on: Gm+ staph and strep
- Disadvantage: Neurological damage
- Application: Surgical and hospital microbial control
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**Biguanides**
- Effect: Broad spectrum
  - Injury to plasma membrane
  - Strong binding to skin and MM, low toxicity
  - Biocidal (bacteria and fungi)

Disadvantage: Damage to eyes
Resistance: mycobacteria, endospores, protozoa, virus
Application: Microbial control on skin and mucous membrane

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**Halogen**
- Iodine
  - Oldest most effective antiseptic
  - Effective on: All kinds of bacteria, endospores, virus, fungi
  - Combine with enzymes and cellular components

Iodine: oldest most effective antiseptic
Ex: tincture, povidone – iodine
Effective on: All kinds of bacteria, endospores, virus, fungi
Combine with enzymes and cellular components
Application: Skin disinfection

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**Halogen**
- Chlorine
  - Action: Oxidizing agent
  - Application: Material disinfection
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**Alcohol**
- Kill bacteria and fungi; Protein denaturation
- Material disinfection (70% or 60 to 90%); Intact skin disinfection

(Ex: ethanol, isopropanol)

**Effect:** Kill bacteria and fungi; Protein denaturation

**Disadvantage:** Endospores and nonenveloped virus; Cannot be applied to wound

**Application:** Material disinfection (70% or 60 to 90%); Intact skin disinfection

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**Heavy metals and compounds**
- Effect:
  - Oligodynamic (small amount with effective antimicrobial effect)
  - Denature cellular protein

**Application:**
- AgNO₃ – gonorrheal ophthalmia
- HgCl – organic material bacteriostasis
- CuSO₄ – green algae
- ZnCl – mouthwash
- ZnO – wound treatment

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**Surface active agents**
- Action: ↓ surface tension of molecules

**Forms**
- Soap
  - Action: Breaks oily film (emulsification)
  - Application: Bathing, washing, laundry
- Quarter nary ammonium compounds (Quats)
  - Ex. Zephiran, cepacol
  - Action: Cationic detergents; Bactericidal, fungicidal, amebicidal, virucidal
  - Application: Surgical handwashing and disinfection; Cord care
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**Aldehydes**

- **Formaldehyde (Formalin)**
  - Action: Inactivate bacteria and virus
  - Application: Biological specimen preservation
- **Glutaraldehyde (Cidex)**
  - Action: Tuberculocidal, bactericidal, virucidal, sporicidal
  - Application: Instrument disinfection

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**Gasses**

- **Ethylene oxide**
- **Propylene oxide**
- **Beta–propiolactone**
  - Indication: Closed chamber sterilization
  - Action: Kills microbes and endospores
  - Disadvantage: Suspected carcinogenic
  - Application: Sensitive materials

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**Gasses**

- **Plasma gas sterilizer**
  - Nontoxic; Effective sterilizer
  - Action: Free radicals destroy cells (water vapors + microwave radiation)
  - Application: Water resistant, sensitive materials
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**Peroxygens**

- **Forms**
  - Ozone
    - Effect: Reactive O$_2$ produced
    - Application: Supplement CI in water disinfection; Neutralize taste and odor
  - H$_2$O$_2$
    - Effect: Inhibit growth of anaerobic organism
    - Disadvantage: Slow healing
    - Application: Wound disinfection and cleansing

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**Peroxygens**

- Benzyl peroxide
  - Effect: Inhibit growth of anaerobic organism
  - Application: OTC meds for acne
- Peracetic acid (PAA): Acetic acid +peroxide
  - Effect: Liquid chemical sporicide
  - Application: Materials resistant to acid

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**CHEMOTHERAPY**

- Antibiotics
- Types of Antibiotics
  - Narrow spectrum
    - affect small range of microbial types
  - Broad spectrum
    - broad range of Gm+ and Gm- bacteria
MECHANISM OF ACTION FOR ANTIBIOTICS

- Inhibit cell wall synthesis
  - Peptidoglycan synthesis
    - Ex. Ampicillin (BS, bactericidal); penicillin (NS, bactericidal); methicillin (NS penicillin – resistant organisms)

- Inhibit protein synthesis
  - Chloramphenicol: peptide bonds
  - Erythromycin: penetrate cell wall
  - Tetracycline: tRNA attachment
  - Aminoglycoside: protein synthesis

- Injury to plasma membrane
  - Change plasma membrane permeability
    - Ex. Polymyxin B; Amphotericin B; miconazole, ketoconazole

- Inhibit nucleic acid synthesis
  - DNA replication and transcription
    - Ex. Rifampicin, quinolone

- Inhibit synthesis of essential metabolites
  - PABA and folic acid for growth of microorganism
    - Ex. Sulfonamide, trimethoprim