

The background is a blue gradient with a red horizontal line. The top part of the image features a lighter blue gradient with wavy lines, transitioning into a darker blue gradient below. A solid red horizontal line is positioned in the upper middle section. The text "Normal Flora" is centered in the lower half of the image.

Normal Flora

A) What is Normal Flora ?

These are mixture of microorganisms regularly found at any anatomical site on /within the body of a healthy person.

Some of these microorganisms are found in association with humans / animals only.

Others are found in the environment as well.

Normal flora types

- Resident vs. Transient
- Resident populations
(normal flora, microbiota, indigenous microbial population, microflora, microbial flora)

Vast majority of normal flora are bacteria.

Internal tissues normally sterile



Resident flora

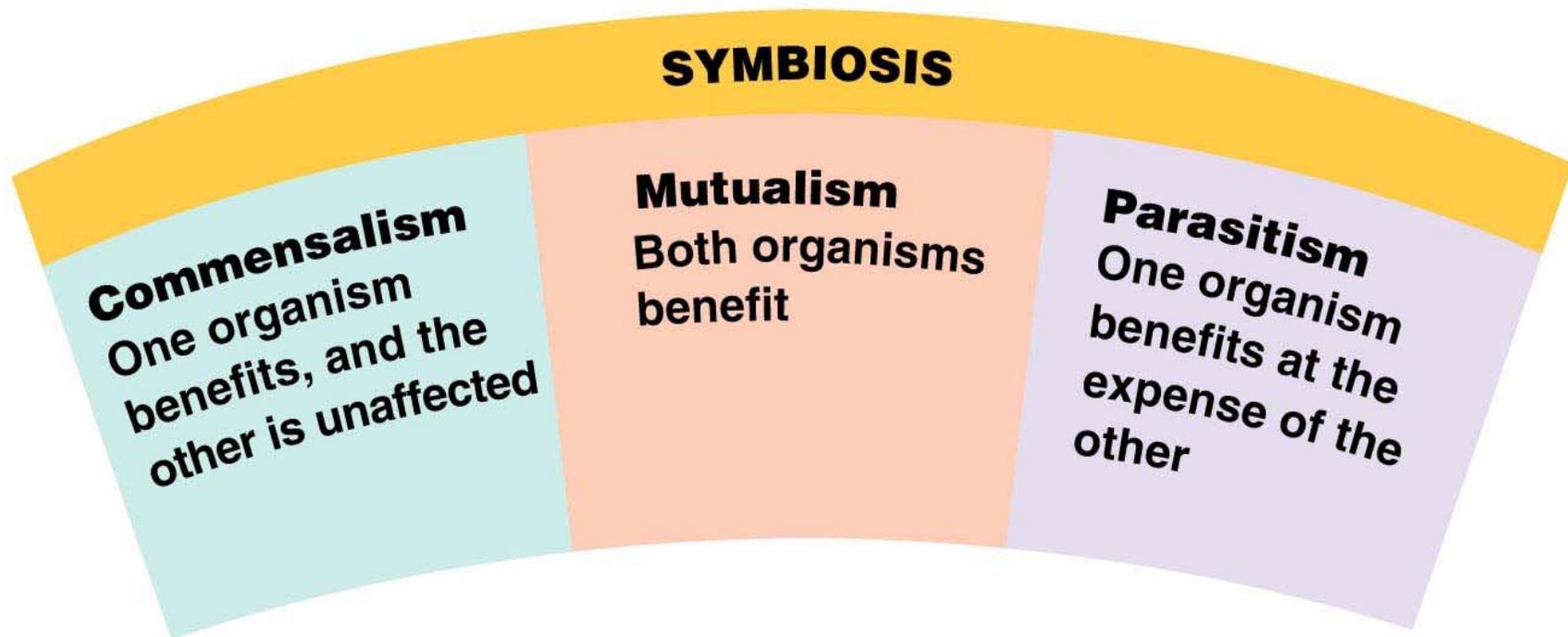
- Resident flora: If disturbed, it promptly reestablishes itself/ microorganisms may colonize, proliferate and produce disease
- More important



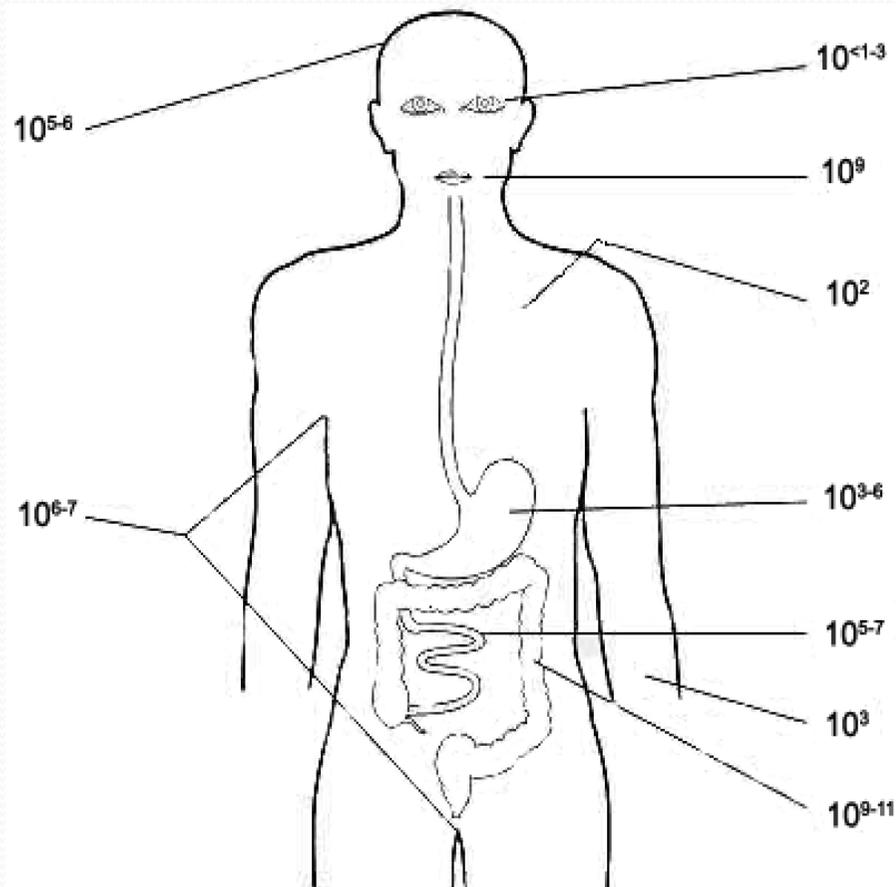
TRANSIENT FLORA

- Non-pathogenic or potentially pathogenic microorganisms that inhabit the skin or mucous membranes for hours, days, or weeks
- Derived from the environment, does not produce disease
- Does not establish itself permanently on the surface
- Little significance

Relationship between normal flora and host



Normal flora



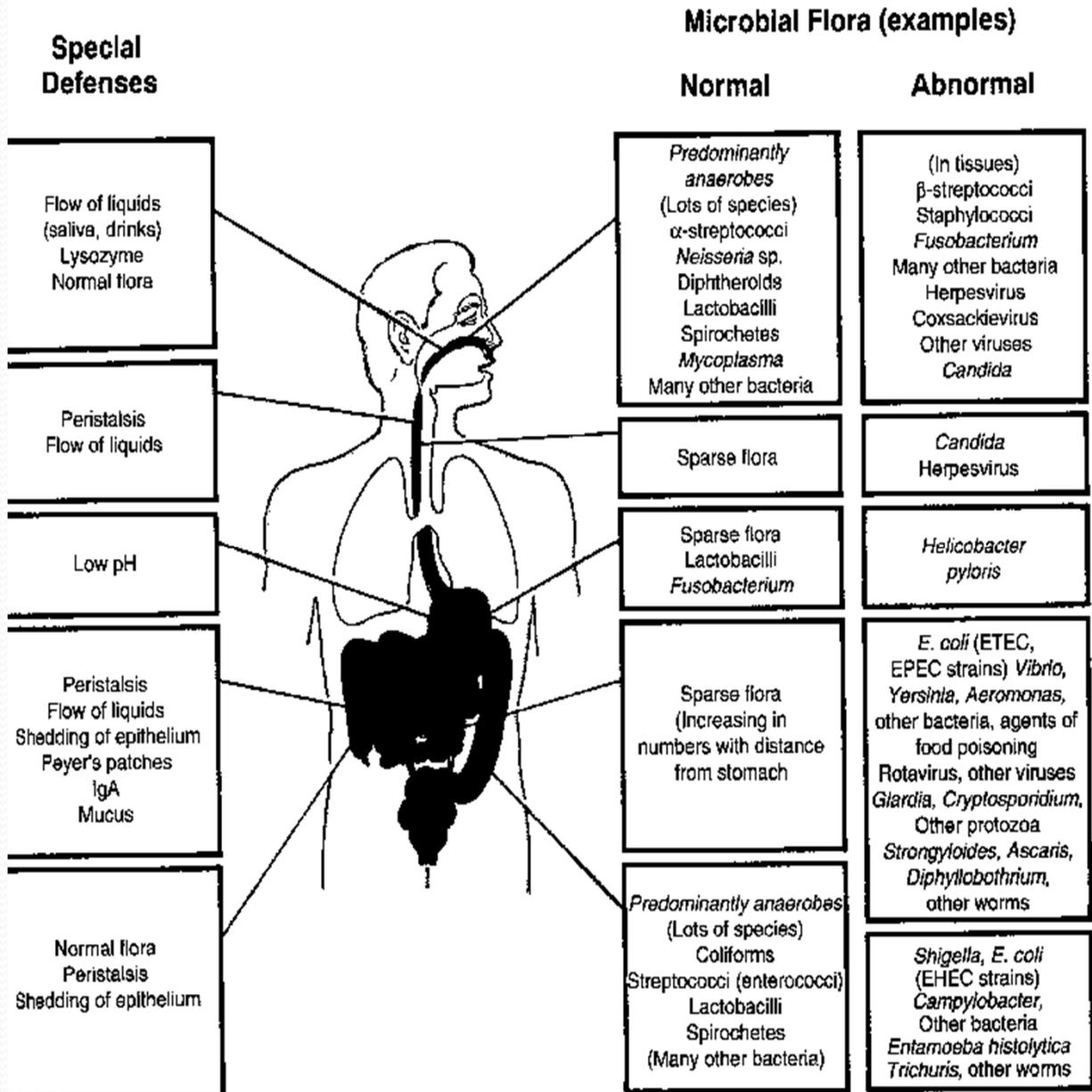
- Human body
 - 10^{13} cells
 - 10^{14} bacteria

Normal flora

- Some bacteria occupy more than one niche
- Some bacteria occupy only one niche: tissue tropism
- Tropism determined by bacterial ligand-host receptor interactions
- Variation in microflora at one site
- Combinations of microflora at same site

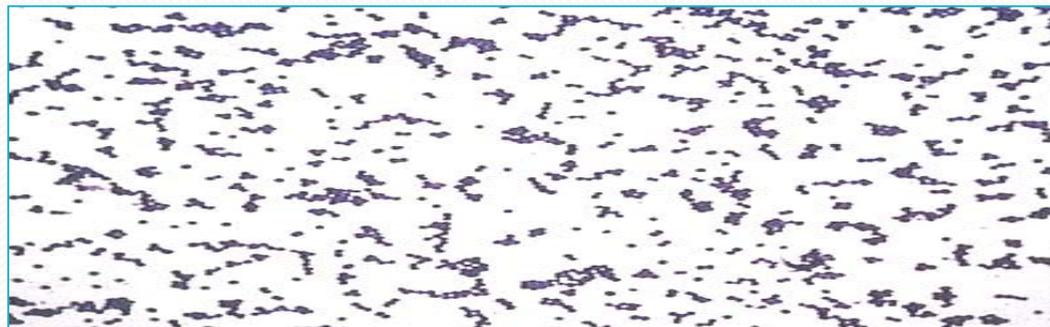
Where the Normal Flora Are Found

- Skin
- Conjunctiva
- Nasopharynx
- Oral cavity
- Gastrointestinal tract and rectum
- Urogenital tract



NORMAL FLORA- Skin

SITE	COMMON/ MEDICALLY IMPORTANT ORGANISMS	LESS COMMON BUT NOTABLE ORGANISMS
Cutaneous surfaces including urethra and outer ear	<i>Staphylococcus epidermidis</i>	<i>Staphylococcus aureus</i> , <i>Corynebacteria</i> (diphtheroids) <i>Streptococci</i> , Anaerobes e.g. <i>Peptostreptococci</i> , Yeast (<i>Candida</i> sp.)



Staphylococcus epidermidis, invariably
found on skin and nasal membranes.

Normal flora - Skin

- Human adult has 2 square meters of skin
 - Overall, a hostile environment toward bacteria
 - Periodic drying
 - Eccrine (simple sweat) glands
 - Apocrine glands: sweat and nutrients
 - Sebaceous glands: associated with hair follicles

Normal flora - Skin

- *S. epidermidis*: Major inhabitant making up more than 90% of the flora
- *S. aureus*: Nose, perineum, vulvar skin
 - Occurrence in nasal passages varies with age being greatest in newborns, less in adults
- Micrococci, Diphtheroids, Propionibacterium
 - Eg. *P. acnes* = children younger than 10 years are rarely colonized with it

- **Skin: 3 main microenvironments**

- Axilla, perineum, toe webs
- Hands, face and trunk
- Upper arms and legs

Factors that are Important in Eliminating Non-resident microorganism from the Skin

1. Low pH
2. Fatty acids (sebaceous secretions)
3. Lysozyme



Neither profuse sweating nor washing and bathing can eliminate or significantly modify the normal resident flora

Normal flora of the skin:

Benefit

- Inhibit fungal growth (athlete's foot)

Harm

- ▶ Body odor
- ▶ Acne
- ▶ Opportunistic infections

Normal flora - Conjunctiva

- Variety of bacteria: low numbers present
 - High moisture
 - Blinking mechanically removes bacteria
 - Lachrymal secretions include lysozyme

Normal flora – UPPER RESPIRATORY TRACT

SITE	COMMON/ MEDICALLY IMPORTANT ORGANISMS	LESS COMMON BUT NOTABLE ORGANISMS
NOSE	Staphylococcus aureus	Staphylococcus epidermidis, Corynebacteria (diphtheroids) Assorted Streptococci,
Oropharynx	Viridans streptococci including Streptococcus mutans	Assorted streptococci, nonpathogenic Neisseria, nontypeable Haemophilus influenzae

Normal flora - Oral cavity

- Ecology and developmental stages
 - Birth: sterile mouth within 4-12 hours (lactobacilli, streptococci)
 - Neonate (Streptococcus salivarius, staphylococci, Neisseriae, Moraxella catarrhalis)
 - Teeth appear (Streptococcus mutans, Streptococcus parasanguis)
 - Gingival crevice area (Anaerobic species, yeasts)
 - Puberty (Bacteroides, spirochetes)
- 10^8 bacteria/mL of saliva; potentially >700 species

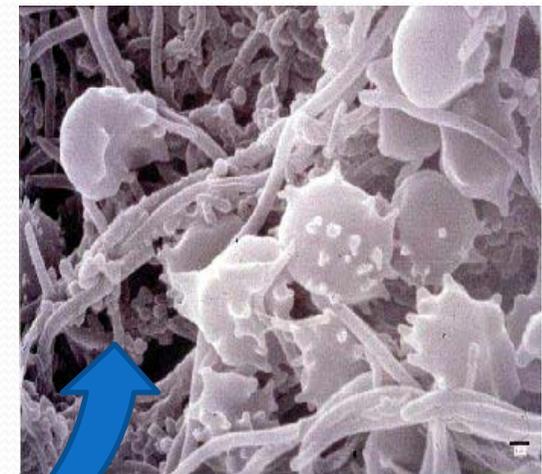
Normal flora of the oral cavity

Benefit

- Compete with pathogens for colonization sites
- Produce substances that inhibit pathogens
- Stimulate local immunity

Harm

- Plaque formation and dental disease



Normal flora- Oropharynx

- If large numbers are introduced into the bloodstream (following tooth extraction or tonsillectomy) they may settle on deformed/prosthetic heart valves and produce endocarditis
- Aspiration of saliva (containing 10^{12} of these organism and aerobes) may result in necrotizing pneumonia, lung abscess, and empyema

Normal flora - Respiratory tract

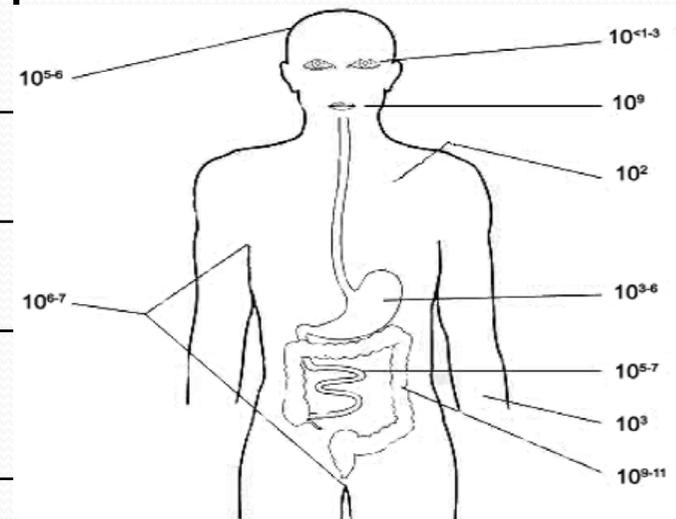
- Lower respiratory tract
(trachea, bronchi, pulmonary tissues)
 - Usually sterile
 - Ciliated epithelium
 - Mucus blanket: entrapment
 - Alveolar macrophages
 - If breached: opportunistic infections

Normal flora - Gastrointestinal tract

- GI ecology varies
- Esophagus saliva ,food
- Stomach harsh 10^2
- Small intestine (10^3 - 10^8)
 - Proximal small intestine (duodenum and jejunum)
 - Distal small intestine (ileum)
- Large intestine
 - 10^9 - 10^{11} /ml
 - >350 species
 - *E. coli* = 0.1% of total population
 - Primarily anaerobic
 - Facultative aerobes deplete oxygen
 - Adult excretes 3×10^{13} bacteria/day
 - 25%-35% of fecal mass = bacteria

Normal flora - Gastrointestinal tract

Location (adult)	Bacteria/gram contents
duodenum	10^3-10^6
jejunum and ileum	10^5-10^8
cecum and transverse colon	10^8-10^{10}
sigmoid colon and rectum	10^{11}



SITE

**COMMON/
MEDICALLY
IMPORTANT
ORGANISMS**

**LESS COMMON BUT
NOTABLE
ORGANISMS**

Gingival crevices

Anaerobes, Prevotella,
Fusobacterium,
Streptococcus,
Actinomyces

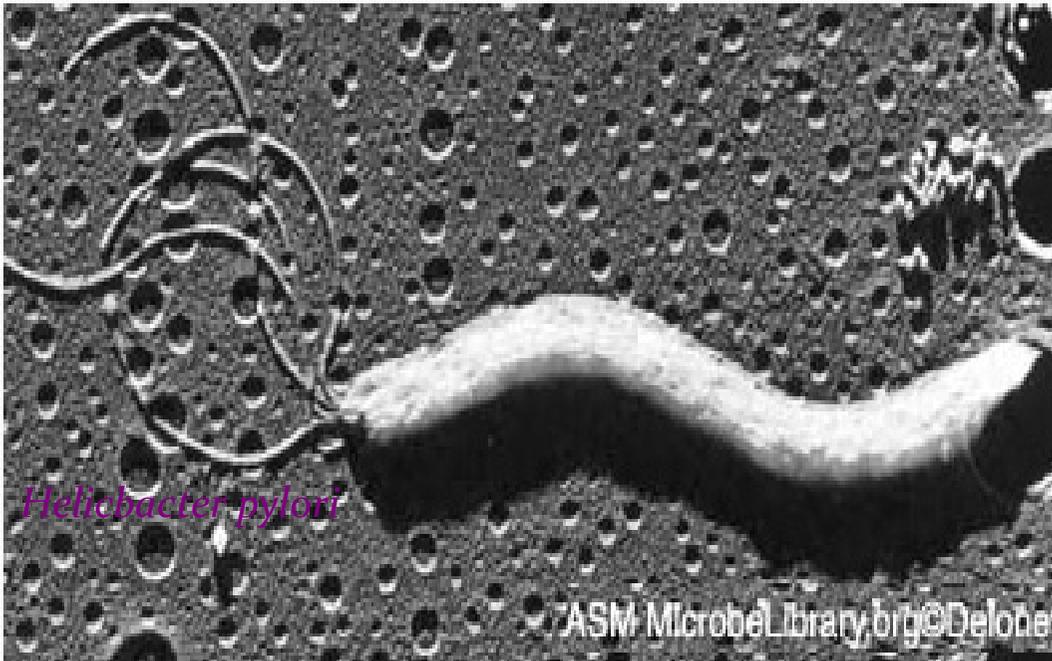
Stomach

NONE

Acidity keeps the
number of
microorganisms at
minimum 10^3 - 10^5
unless obstruction at
the pylorus favors the
proliferation of gram-
positive cocci and
bacilli

Normal flora of GI tract – stomach

Helicobacter pylori



Harm

- Causes gastric ulcers
- Probable association with duodenal ulcers

Normal flora of GI tract: SMALL INTESTINE

streptococci, lactobacilli, enterococci, enterics, anaerobic rods and cocci

Benefit

- Production of vitamins and nutrients
- Competition with pathogens for colonization sites
- Production of substances that inhibit pathogens

Harm

- Possible relationship with inflammatory conditions
- Transfer antibiotic resistance to pathogens

SITE	COMMON/ MEDICALLY IMPORTANT ORGANISMS	LESS COMMON BUT NOTABLE ORGANISMS
<p>Colon (microaerophilic/ anaerobic)</p> <p>**sterile at birth, but organisms are soon introduced with food</p>	<p><u>INFANTS</u> Breast-fed: Bifidobacterium Bottle-fed: mixed flora, less lactobacilli</p> <p><u>ADULTS</u> Bacteroides (predominant) Escherichia Bifidobacterium</p>	<p>Lactobacillus, Streptococci, Eubacterium, Fusobacterium, Lactobacillus, assorted gram-negative Anaerobic rods, Enterococcus faecalis and other streptococcus</p>

Normal flora of GI tract: LARGE INTESTINE

Bacteroids, clostridia, bifidobacteria, lactic acid bacteria, enterococci, enterics

Benefit

- Competition with pathogens for colonization sites
- Production of substances that inhibit pathogens
- Stimulate development and activity of immune system

Harm

- Relationship with inflammatory bowel diseases
- Production of carcinogens and relationship with colon cancer
- Methanogenesis

Normal flora - Urogenital tract

- Upper urinary tract (kidneys, ureters, bladder) usually sterile
- Male anterior urethra Same as skin : enteric and enterococcus
- Vagina: complex microbiota
 - At birth Same as mother (PH 5)
 - Neonate Same as skin+enteric+ strept (PH 7)
 - At puberty Lactobacillus+same as skin+anaerobes+strep (PH 5)
 - At menopause: return to prepuberty flora

Normal flora of the VAGINA - during child-bearing age lactobacilli and other lactic acid bacteria

Benefit

- Competition with pathogens for colonization sites
- Production of lactic acid that inhibits pathogenic bacteria and yeasts

Harm

- none

What are the roles of Normal Flora:

1. **May be source of opportunistic infections**
e.g. In-patients with impaired defense Mechanisms.

2. **Immunostimulation**
 - a) They produce antibodies which may contribute to host defenses.
 - b) Some of these antibodies may cross react with normal tissue components.



3) **Protection from External Invaders**

Because of the normal flora occupy body's epithelial surfaces, they are able to prevent other bacteria from establishing themselves by blocking receptors (attachment), competing for essential nutrients or producing anti-bacteria substances

e.g. Fatty acids, peroxides , Bacteriocins.



4) **Production of Carcinogens:** Some normal flora may modify, through their enzymes, some chemicals in our diets into carcinogens

e.g. Artificial sweeteners may be enzymatically modified into bladder carcinogens.

Predominant and important flora of various body sites in normal health.



5) **Nutrition**

Some of the normal intestinal flora e.g. *E. coli* & *Bacteroids* produce Vitamin K in the gut which is available for use by host.

6) Stimulate development of certain tissues: Caecum and lymphatic tissues (Peyer's patches) in GI tract and influence immunology of gut-associated lymphatics

Overall benefits of the normal flora

- ▶ Synthesis and excretion of vitamins used by the host
- ▶ Competition with pathogens for nutrients and colonization sites
- ▶ Direct antagonism against pathogens
- ▶ Stimulate the development of immunological tissues
- ▶ Stimulate the activity of the immune system by production of natural antibodies



Overall harmful effects of the normal flora

- Competition with host for nutrients
- Bacterial synergism between normal flora and potential pathogens
- Low grade toxemia produced in host
- Endogenous disease and opportunistic infection

Opportunistic flora

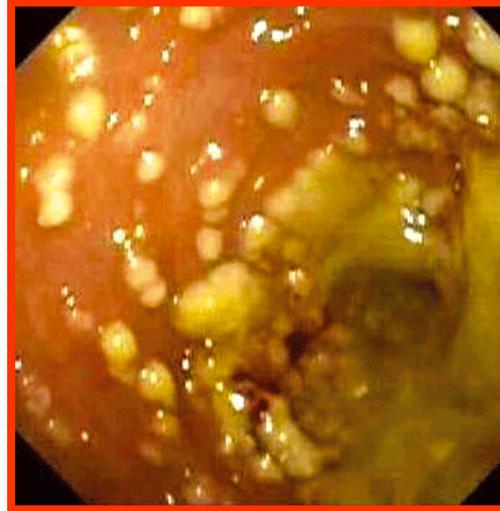
- Some normal flora become opportunistic pathogens
 - (*Staphylococcus aureus*, *Streptococcus mutans*, *Enterococcus faecalis*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, etc.)
- Breach of skin/mucosal barrier: trauma, surgery, burns
- Bacterium at one site may be commensal, but might be pathogenic at another site

Opportunistic flora

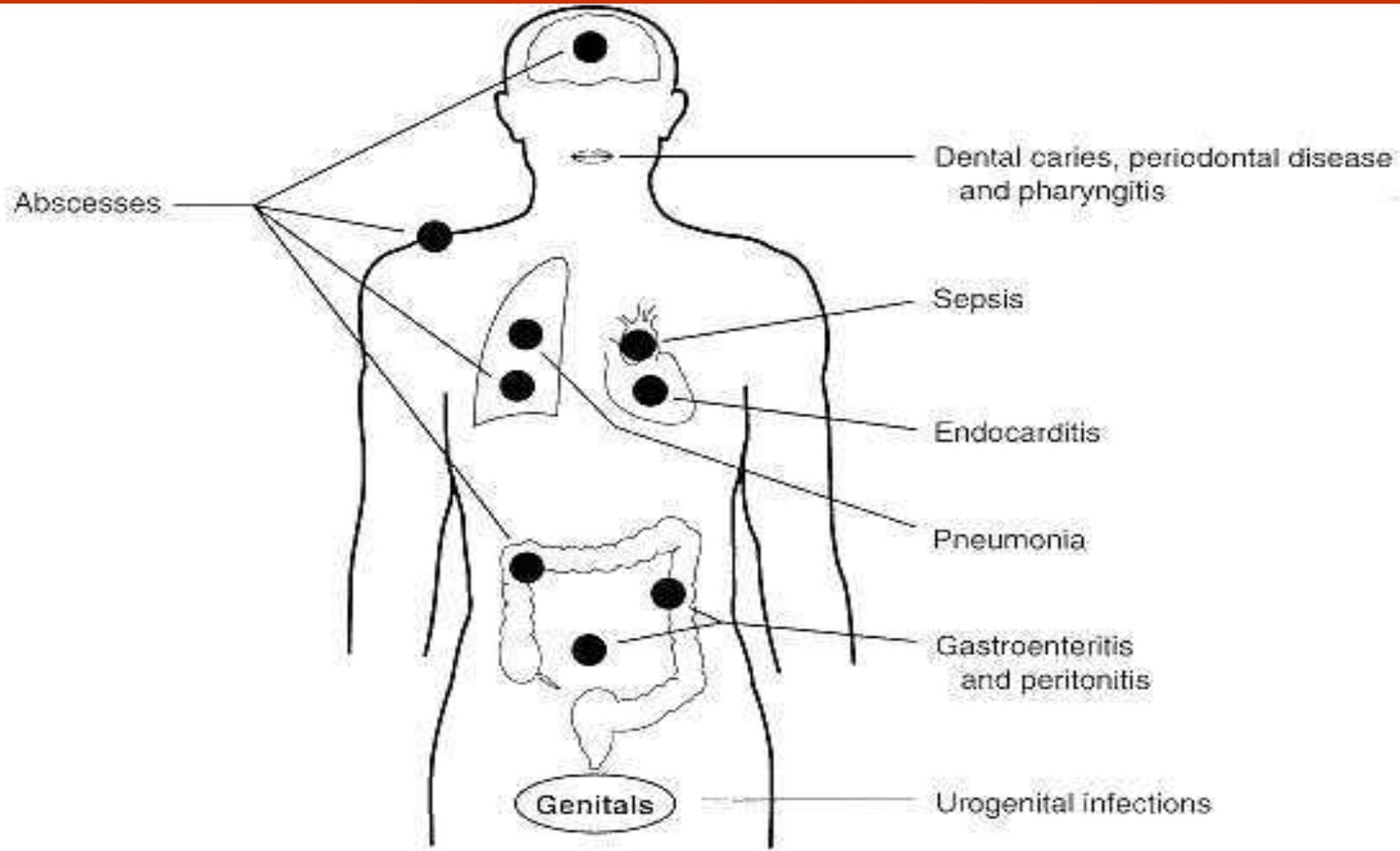
- Growth of commensals may put patient at risk: Broad-spectrum antibiotic therapy decreases total number of bacterial in gut
- During repopulation, faster-growing aerobic Enterobacteriaceae over slower-replicating anaerobes increases probability of gram-negative bacteremia
- Cross-reactive responses to host tissue: Superantigen
- Chronic, low-grade inflammation
- Perturbation of cytokine network

Gastrointestinal flora

- Antibiotics overuse
- Antibiotic associated diarrhea
- *C. difficile* -associated diarrhea (CDAD)
- Pseudomembranous colitis
 - toxic megacolon



Normal flora - Risks and Opportunistic



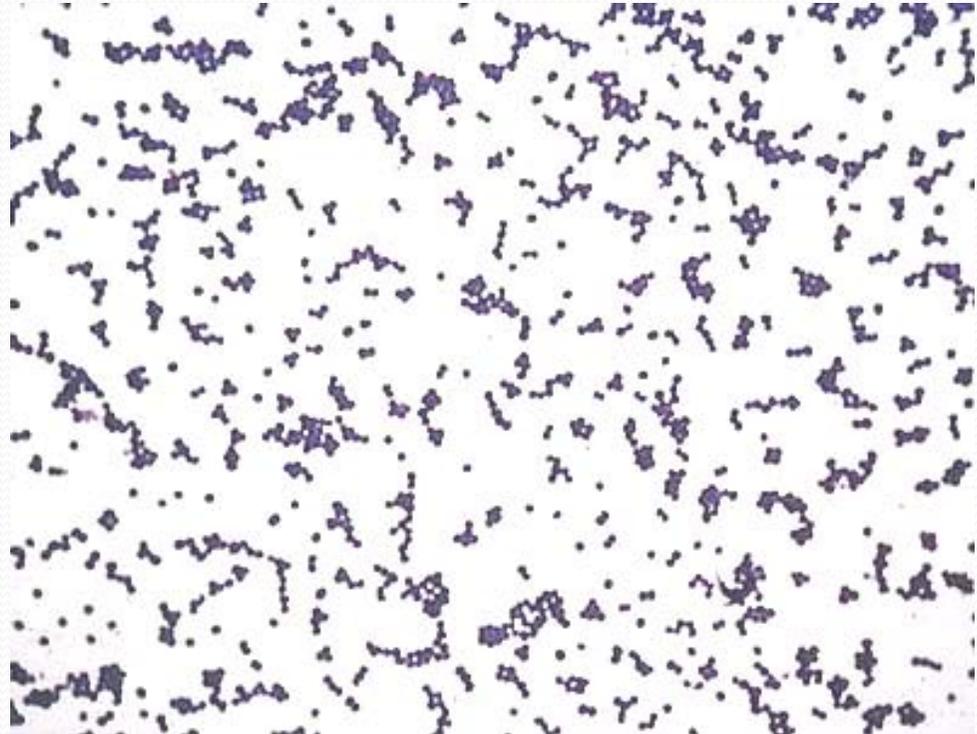
Probiotics/Prebiotics

- Probiotic
 - Oral administration of living organisms to promote health
 - Mechanism speculative: competition with other bacteria; stimulation of nonspecific immunity
 - Species specific: adherence and growth (tropism)
- Prebiotic
 - Non-digestible food that stimulates growth or activity of GI microbiota, especially bifidobacteria and lactobacillus bacteria (both of which are noninflammatory)
 - Typically a carbohydrate: soluble fiber

Guide to the Normal Bacterial Flora of Humans

Staphylococci

- Includes *Staphylococcus epidermidis* and *Staphylococcus aureus*
- Located on skin and most mucous membranes

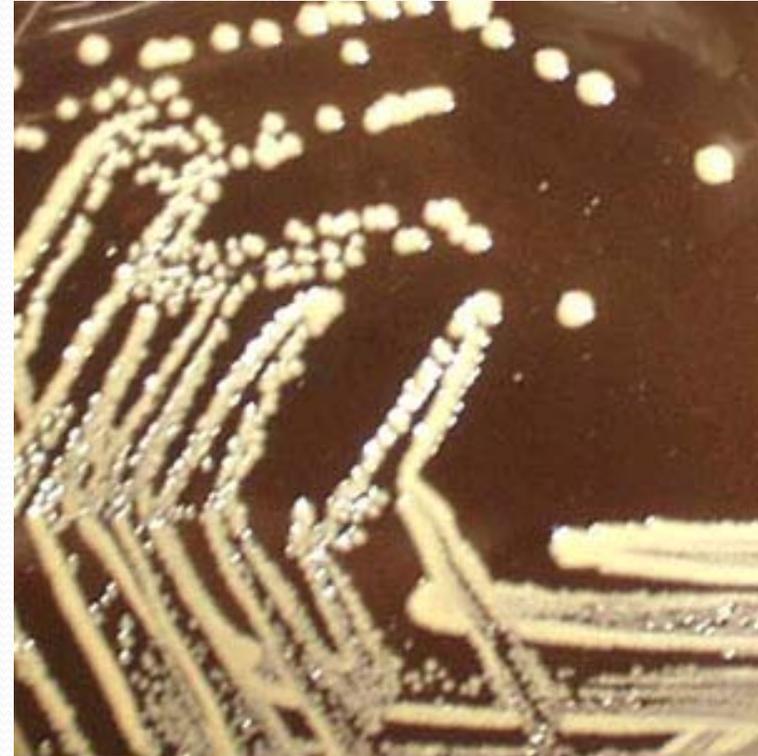


Staphylococcus epidermidis, invariably found on skin and nasal membranes.

Guide to the Normal Bacterial Flora of Humans

Corynebacteria

- Includes *Corynebacterium* and *Probionibacterium* species
- Located primarily on skin and upper respiratory tract



Propionibacterim acnes colonies. The bacterium is found on skin, nasal membranes and the conjunctiva of the eye.

Guide to the Normal Bacterial Flora of Humans

Streptococci

- Includes *Streptococcus salivarius*, *S. mitis* and *S. mutans*
- Located in oral cavity

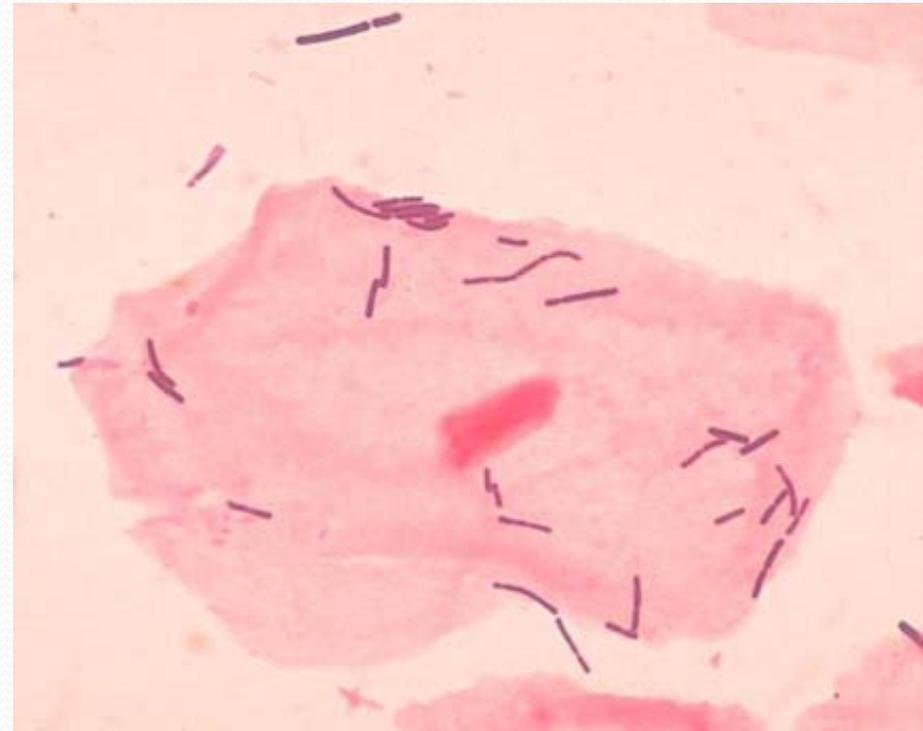


Streptococcus mutans, the main bacterium implicated in dental caries.

Guide to the Normal Bacterial Flora of Humans

Lactic acid bacteria

- Includes *Streptococcus* and *Lactobacillus* species
- Located in oral cavity, intestinal tract and vagina



Lactobacillus acidophilus and a vaginal squamous epithelial cell.

Guide to the Normal Bacterial Flora of Humans

Bifidobacteria

- Members of the genus *Bifidobacterium*
- Found in the the intestinal tract

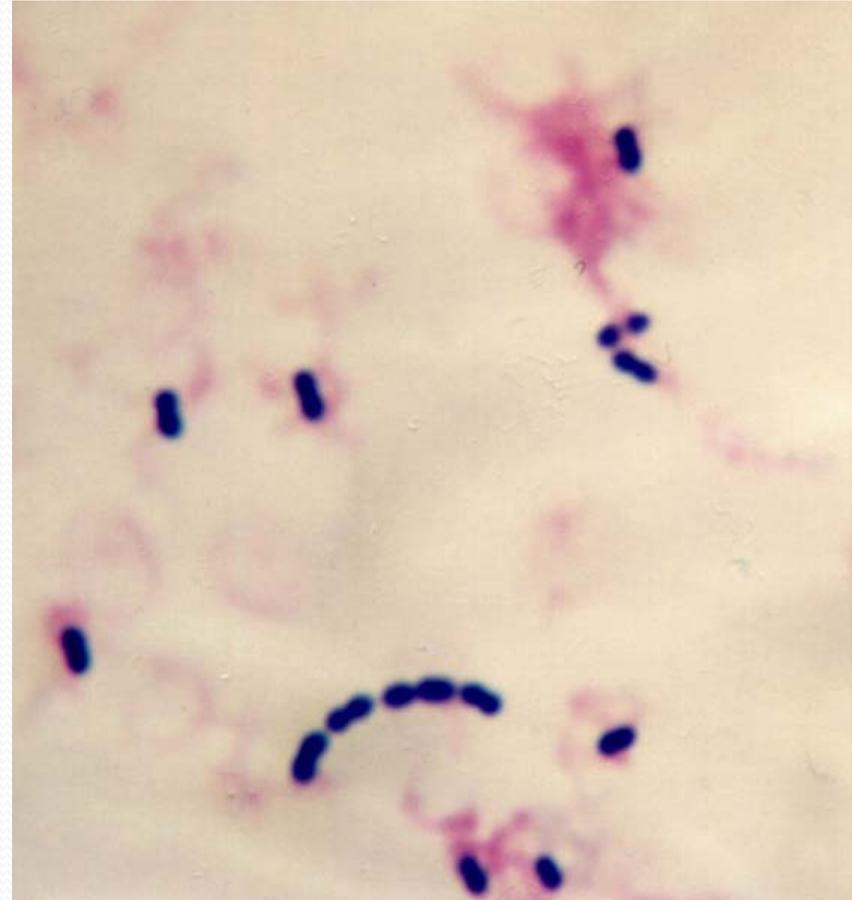


Bifidobacterium bifidus. Bifidobacteria make up over 90 percent of the bacteria in the intestine of breast-fed infants.

Guide to the Normal Bacterial Flora of Humans

Enterococci

- Includes *Enterococcus faecalis* and *Enterococcus faecium*
- Located in the intestinal tract



Enterococcus faecalis - so regularly found in the intestine that some countries use the bacterium as their indicator of fecal pollution of water.

Guide to the Normal Bacterial Flora of Humans

Clostridia

- Members of the genus *Clostridium*
- Found in the the intestinal tract

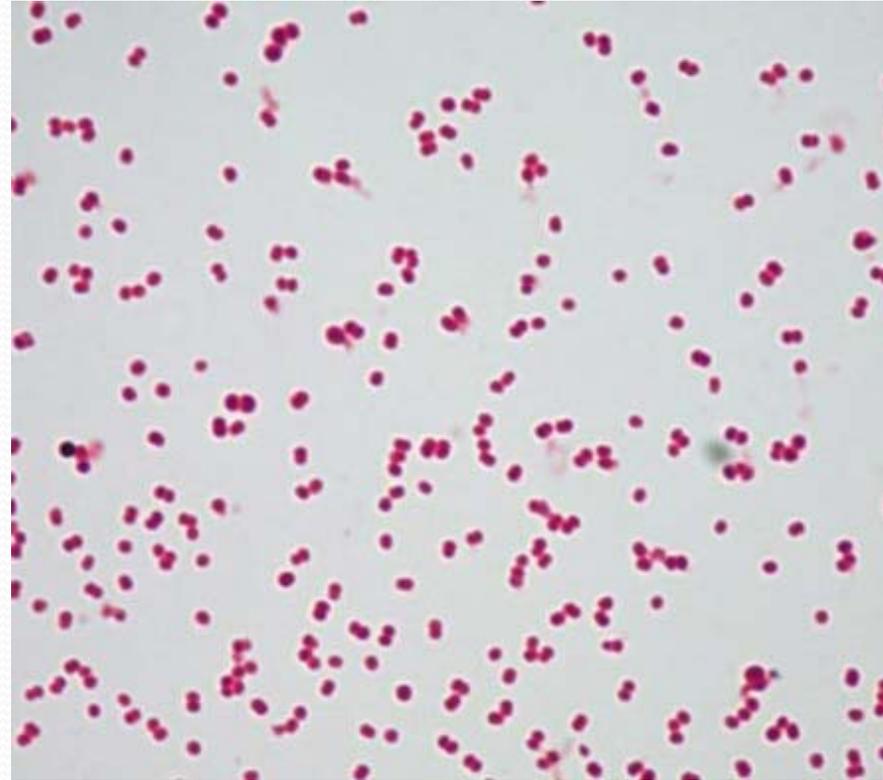


Clostridium difficile. Clostridia are anaerobic endospore-forming bacteria, found mainly in the large intestine.

Guide to the Normal Bacterial Flora of Humans

Gram-negative cocci

- Includes *Neisseria*, *Moraxella* and *Veillonella* species
- Located in the nasopharynx

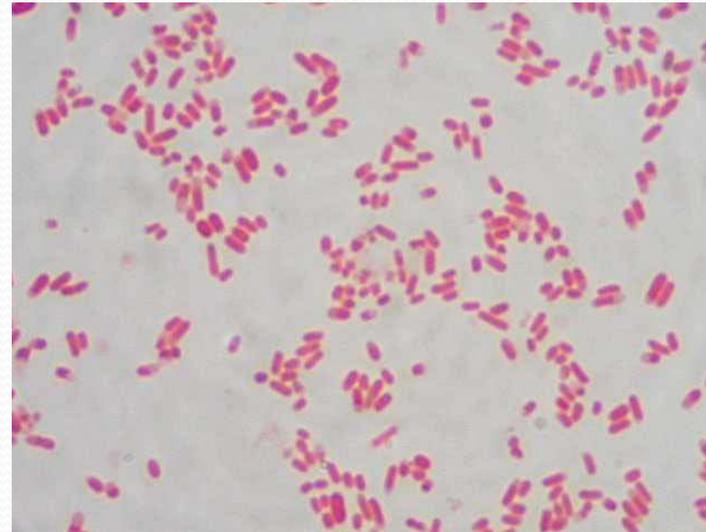


Neisseria species are found commonly in the throat.

Guide to the Normal Bacterial Flora of Humans

Enteric bacteria

- Gram-negative rod-shaped bacteria including *E. coli* and its relatives
- Located in the intestinal tract



Escherichia coli Gram stain and colonies on EMB agar.