10.5005/jp-journals-10015-1242
REVIEW ARTICLE

Oral Microbial Flora in Health

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ABSTRACT

The oral flora comprises of plethora of microorganisms with a predominance of bacteria. These organisms are beneficial when present in right numbers. The oral cavity harbors a variety of habitats with varying environmental conditions, making the study of oral microbiology complex and difficult. Hence, a sound knowledge of the normal commensals of the oral cavity is an essential tool for accurate laboratory diagnosis. The objective of this article is to benefit the student population as the concept of oral microbial flora has been put forward in a simplified format.

Keywords: Oral flora, Acquisition, Neonates, Adults.

How to cite this article: Patil S, Rao RS, Amrutha N, Sanketh DS. Oral Microbial Flora in Health. World J Dent 2013;4(4): 262-266.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Oral flora has an ecologically diverse microbial population group and contains at least 350 cultivable species.[1] As early as 1674, Antony Van Leeuwenhoek, father of modern day microscope, observed his own dental plaque and reported 'little living animalcules prettily moving'.[2] This was the hallmark from which many other studies evolved in relation to oral microflora in disease and health.

TYPES OF ORAL FLORA

Indigenous Flora

It refers to the organisms present in greater than 1% of the total viable count in a particular site such as surface of tongue or supragingival plaque. They are in a compatible relationship with the host and do not compromise the survival of the host. The common indigenous organisms present in the oral cavity are *Streptococcus*, *Actinomyces* and *Neisseria*.[3]

Supplemental Flora

It refers to the microorganisms identified in a significant amount (less than 1%) in certain individuals. The most common include *Lactobacillus*. They are influenced by environmental changes, e.g. *Lactobacillus* is normally found in low levels in plaque, i.e. 0.00001 to 0.001% of the viable flora. In a carious lesion, as the pH of plaque becomes acidic, *Lactobacillus*, which is acid tolerant multiplies and becomes the dominant microorganism.[3]

Transient Flora

This flora comprises of organisms that may be present in the oral cavity for very short periods (hours to days) of time. These organisms may be temporarily established due to exogenous factors like food or drinks and are not harmful to the host. This flora may flourish and become opportunistic in conditions where the host is immunocompromised.[3,4]

ACQUISITION OF NORMAL ORAL FLORA

The oral cavity before birth is sterile. Colonization begins at or shortly after birth. Those that initially colonize immediately after birth are called pioneer species, e.g. *Streptococcus salivarius*. By the first birthday the oral cavity is invaded predominantly by aerobes and may include *Streptococcus*, *Neisseria*, *Veillonella*, *Lactobacillus* and *Actinomyces*. Once tooth eruption starts, nonshedding surfaces are established for these organisms to colonize. After all teeth have erupted, more surfaces are established, gingival crevices develop for colonization of periodontal microorganisms, plaque accumulates at different sites on the tooth, like smooth surfaces, pit and fissures, for different microbial colonies to be established. By this process and microbial succession high species diversity develops and is called the climax community. In old age, once all teeth are lost, the flora is similar to child before tooth eruption[1] (Flow Chart 1).

ACQUISITION OF MUTANS STREPTOCOCCI IN NEONATES

Vertical Transmission

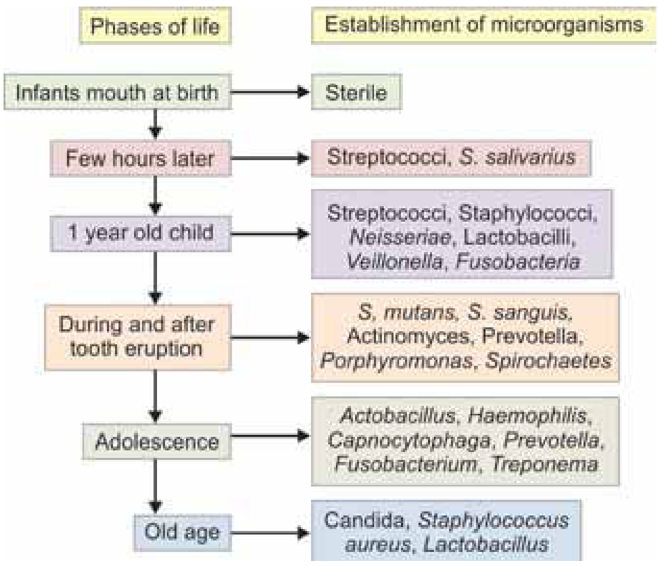
Vertical transmission is defined as the passing of a microbe from the parent to the offspring. The major reservoir from which infants acquire mutans streptococci are their mothers. Vertical transmission occurs during passage of the neonate through the birth canal or through maternal milk.

Horizontal Transmission

Horizontal transmission refers to the passing of microbes from one individual to another in the same generation, either by direct or indirect contact; e.g. family members.

Mattos-Graner and colleagues isolated mutans streptococci from groups of nursery school children (age: 12-30 months) and genotyped the isolates. They reported

Flow Chart 1: Acquisition of normal oral microflora in phases of life



that many children contained identical genotypes of mutans streptococci strains, which indicates that horizontal transmission may be another vector for acquisition of these organisms.[5]

FACTORS CONTRIBUTING TO NORMAL MICROBIAL GROWTH

Anatomical

Anatomical factors that result in bacterial stagnation and growth are as follows:
- Shape, topography, malalignment of the teeth
- Poor quality of restorations
- Nonkeratinized sulcular epithelium.

Saliva

Saliva contributes to the oral ecosystem in many ways:
- Adsorption of salivary glycoproteins results in formation of salivary pellicle which in turn facilitates bacterial adhesion
- It is a rich source of food, i.e. carbohydrates and proteins
- It has the property of growth inhibition of exogenous organisms owing to the presence of nonspecific defence factors like lysozyme, lactoferrin, histatins and specific defence factors like IgA, salivary leukocyte protease inhibitor (SLPI)
- It plays a major role in maintenance of pH due to its buffering capacity. Acidic saliva promotes growth of cariogenic bacteria.

Gingival Crevicular Fluid (GCF)

- GCF flushes microbes out of crevice
- It also acts as a primary source of nutrients to the crevicular bacteria
- Maintains pH of the gingival crevice
- It has specific and nonspecific defence factors like IgG
- Neutrophils found in GCF are involved in phagocytosis.

Microbial Factors

- There is competition for receptors among different microbes resulting in prevention of attachment by 'late comers'. Production of toxins: *S. salivarius* produces enocin that inhibits *S. pyogenes*
- Production of metabolic end products by certain bacteria lower the pH
- Some bacteria use the metabolic end products of other bacteria for nutritional purposes
- Coaggregation of same or different species; e.g. bacteria-corn-cob formation.

Miscellaneous Factors

a. Local environment pH:
   - This is regulated by saliva and it depends on frequency of dietary carbohydrates.
   - Many microbes favor neutral pH, while others grow well in acidic environment (lactobacilli).

b. *Oxidation-reduction potential*: This varies in different locations of mouth, falls during plaque development which favors growth of bacteria.

c. *Antimicrobial therapy*: Broad spectrum antibiotics wipe out most endogenous flora and also favor the emergence of yeast species.

d. *Diet*: Fermentable carbohydrates are the major source of nutrients which promote acidogenic bacteria.

e. *Iatrogenic factors*: Dental scaling alters the composition of periodontal pocket flora of diseased sites.

f. *Diurnal variations*: Bacterial counts highest in the morning, decreases during the day.

g. *Drugs*: May cause decrease in salivary flow thereby allowing transient microflora to proliferate and cause immunosuppression leading to opportunistic infections, e.g. steroids.

h. *Extraction of teeth*: Leads to decrease in *S. sanguis* and *S. mutans* that colonize on teeth.

i. *Intraoral appliance*: Appliances may help in harboring *S. sanguis* and *S. salivarius* (Flow Chart 2 and 3) (Table 1).[1,6-8]

ORAL MICROBIAL FLORA IN NEONATES

Mutans Streptococci

Controversies related to Mutans Streptococci in Neonates

Earlier studies demonstrate that infants acquire mutans streptococci only after the eruption of primary teeth as mutans streptococci require a nonshedding oral surface for its persistent oral colonization.

Flow Chart 2: Factors influencing the oral microflora

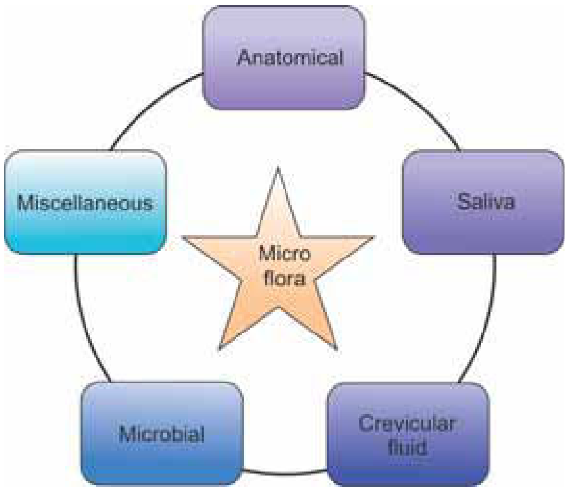


Table 1: Pros and cons of normal microbial flora[6-8]

Advantages	*Disadvantages*
Helps in preventing disease by bacterial antagonism, competition for nutrition, alteration of environment	Source of endogenous infection, when host resistance decreases
Host immune response stimulation	May predispose host to exogenous infection
Provision of essential nutrition to the host	Sensitization of the host to oral microbial antigens–accentuated response to subsequent specific antigenic encounters
Enhancement of removal and maturation rates of oral epithelium	

Recent studies indicate that mutans streptococci can colonize the mouth of predentate infants. The furrows of the tongue appear to be an important ecological niche.

Tanner et al reported that mutans streptococci were found to be present in 55% of plaque samples and 70% of tongue scraping samples of 57 children aged 6 to 18 months living in Saipan. These recent studies on acquisition of mutans streptococci raise doubts that a nonshedding oral surface is required for their oral colonization.[9]

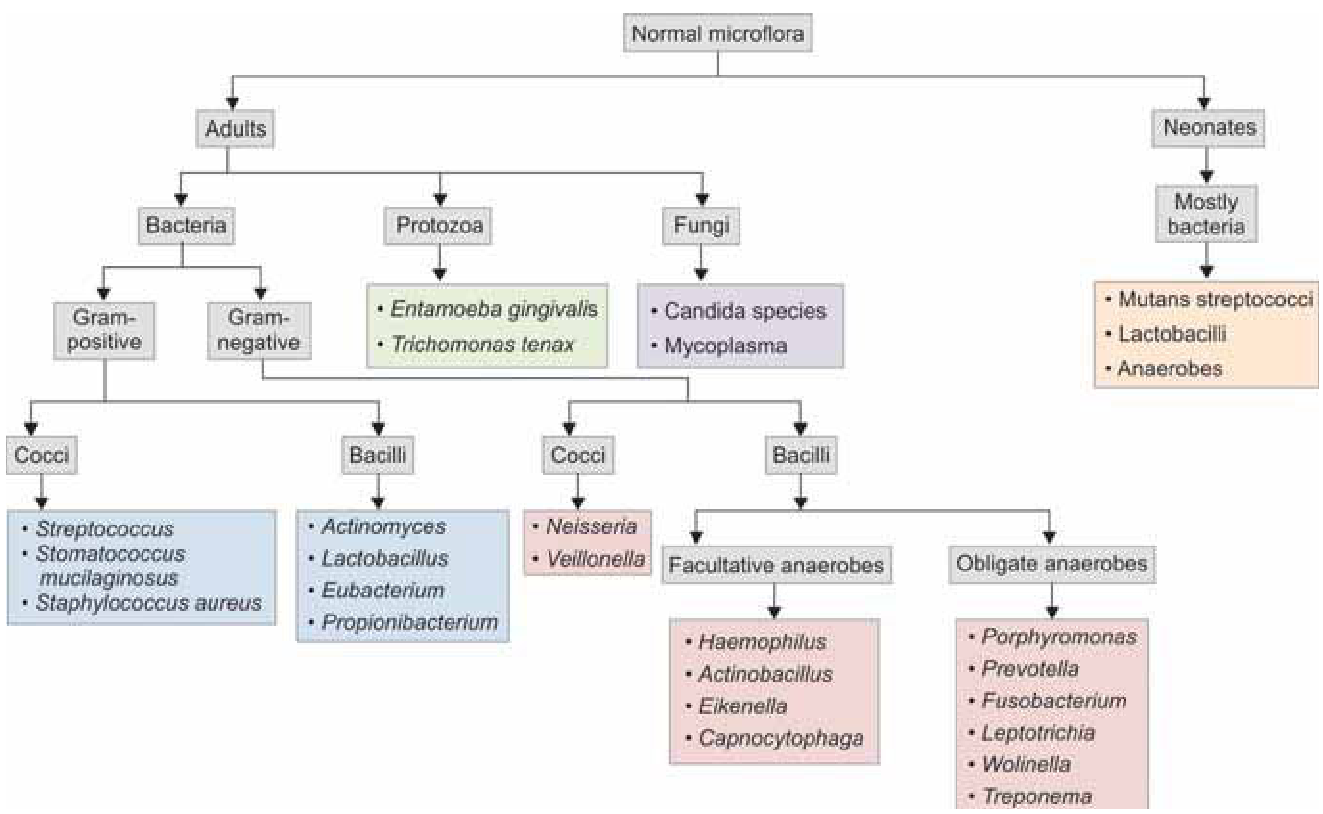
Lactobacilli

Lactobacilli absent from the oral cavity of newborns appear during the first year of life. Their presence depends on numerous factors such as the presence of ecological niches; e.g. natural anfractuosities of the teeth.

Lactobacilli were isolated from the tongue surface and gums in sound children and was noted that 42.3% of the lactobacilli came from the tongue and 11.8% from the gums and species *L. fermentum* and *L. plantarum* are predominant on the tongue; *L. rhamnosus* is predominant on the gum.

Among children, the presence of lactobacilli in coronal caries is incontestable. Among adults, *Lactobacilli casei* group are found in root caries. In children, *L. casei* is predominant, but, in early childhood caries, *L. fermentum* is the most frequently found species.[10]

Flow Chart 3: Working classification of normal oral flora



Anaerobes

Obligate anaerobes *Veillonella* species and the *Prevotella melaninogenica* group organisms as well as facultative anaerobes *Actinomyces* species are common salivary findings in 2-month old infants, and in addition, the frequency of *F. nucleatum*, *Porphyromonas catoniae*, nonpigmented *Prevotella* species and *Leptotrichia* species also remarkably increases between 2 and 6 months of age. *P. catoniae* was more frequent in infants with the early emergence of the first tooth.

Among the 'late colonizers,' corroding rods, *Capnocytophaga* species, and other *Fusobacterium* reached the prevalence of 10% in infants up to 1 year of age. Once established, the species tend to persist in the mouth.

After the first year of life,

A. Remarkable increases in the frequency of several oral anaerobic groups occur.
B. Early colonizing species can be isolated nearly from every mouth.
C. The 'late colonizers,' such as other fusobacteria than *F. nucleatum*, *Capnocytophaga* species, corroding rods, *Selenomonas* species, and the *Prevotella intermedia* group organisms, are frequently present in the oral cavity before 4 years of age.

Among the *P. intermedia* group, *Prevotella nigrescens* and *Prevotella pallens* are common colonizers during childhood.

Indeed, children with deciduous dentition already harbor a multiform oral anaerobic microflora. However, the transition to mature oral microflora corresponding to that of adults probably does not take place until puberty and the colonization of main periodontal pathogens rarely takes place in early childhood (e.g. *Actinobacillus actinomycetemcomitans*, *Porphyromonas gingivalis* and *Bacteroides forsythus*).[11]

ORAL MICROBIAL FLORA IN ADULTS (TABLE 2)

Table 2: Oral microbial flora in adults

Microorganism	*Habitat*	*Most common species*
Bacteria		
Streptococcus	Oral flora-gingival and supragingival plaque, tongue and saliva.	*Mutans*, *salivarius*, *anginosus* and *mitis* group
Stomatococcus mucilaginosus	Mainly tongue and gingival crevice	No species types
Staphylococci	Human saliva	*S. aureus*, *S. epidermidis* and *S. saprophyticus*
Actinomyces	Minor component of healthy gingival flora	*A. israelii*, *A. gerencseriae*, *A. odontolyticus*, *A. naeslundii*.
Lactobacillus	<1% of the oral flora	*L. casei*, *L. fermentum*, *L. acidophilus*
Eubacterium	Dental plaque and calculus	*E. brachy*, *E. timidum*, *E. nodatum*, *E. saphenum*
Propionibacterium	Dental plaque	*E. brachy*, *E. timidum*, *E. nodatum*
Neisseria	Tongue, saliva, oral mucosa and early plaque	*N. subflava*, *N. mucosa*, *N. sicca*
Veillonella	Tongue, saliva and dental plaque	*V. parvula*, *V. dispar*, *V. atypia*
Hemophilus	Dental plaque, saliva and mucosae	*H. parainfluenzae*, *H. segnis*, *H. aphrophilus*
Actinobacillus	Periodontal pocket	*A. actinomycete-mcomitans* (serotype a-e)
Eikenella	Dental plaque, dentoalveolar abscess	*E. corrodens*
Capnocytophaga	Dental plaque, mucosa, saliva	C. gingivalis, *C. sputigena*, *C. ochracea*
Porphyromonas	Gingival crevice and subgingival plaque	*P. gingivalis*, *P. endodontalis*
Prevotella	Periodontal pocket, dental plaque	*P. intermedia*, *P. nigrescens*, *P. loescheii*
Fusobacterium	Normal gingival crevice	*F. nucleatum*, *F. alocis*, *F. sulci*
Leptotrichia	Dental plaque	*L. buccalis*
Wolinella	Gingival crevice	*W. succinogenes*
Treponema	Gingival crevice	*T. denticola*, *T. macrodentium*
Entamoeba gingivalis	Periodontal tissue especially in patients who received radiotherapy	*E. gingivalis*
Trichomonas tenax	Gingival crevice	*T. tenax*
Fungi		
Candida species	Subgingival flora, periodontitis	*C. albicans*, *C. glabrata*, *C. krusei*, *C. tropicalis*

Contd...

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