PLAQUE

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DEFINITION:

- **By Carranza**: dental plaque is defined clinically as a structured, resilient, yellow-grayish substance that adheres tenaciously to the tooth surface or other hard surfaces, including fixed and removable restorations.

- **By WHO**: Dental plaque is highly variable, dynamic, structural, acquired microbial gel like entity, consisting of microorganisms & their products on the surface of the teeth, restorations & prosthetic appliances characterized by microbial growth & colonization.

CLASSIFICATION:

- Based on position on the tooth surface:
- **Supragingival plaque**: It is found at or above the gingival margin: & when it is in direct contact with gingival margin, it is called as “marginal plaque”.
- **Subgingival plaque**: It is found below the gingival margin; between the tooth & the gingival sulcular tissue.

- Based on morphologic & studies it is subdivided into,
- tooth associated plaque
- tissue associated plaque

CLASSIFICATION OF DENTAL PLAQUE

According to its position on the tooth surface

Supragingival

- Is found above the gingival margin
- Direct contact with the gingival margin
- Its referred as marginal plaque

Subgingival

- Is found below the gingival margin
- Between the tooth and the gingival secular tissue

- Marginal plaque is of prime important in development of gingival
- Supragingival plaque and tooth-associated subgingival plaque are critical in calculus formation and root caries.

Significance of the Classification:

- The different regions of plaque are significant to different processes associated with diseases of the teeth & periodontium.
- Marginal plaque is of prime importance in development of gingivitis.
- Supragingival plaque & tooth associated plaque are critical in calculus formation & root caries.
- Tissue associated Subgingival plaque is important in soft tissue destruction that characterizes different forms of periodontitis.

COMPOSITION OF PLAQUE:

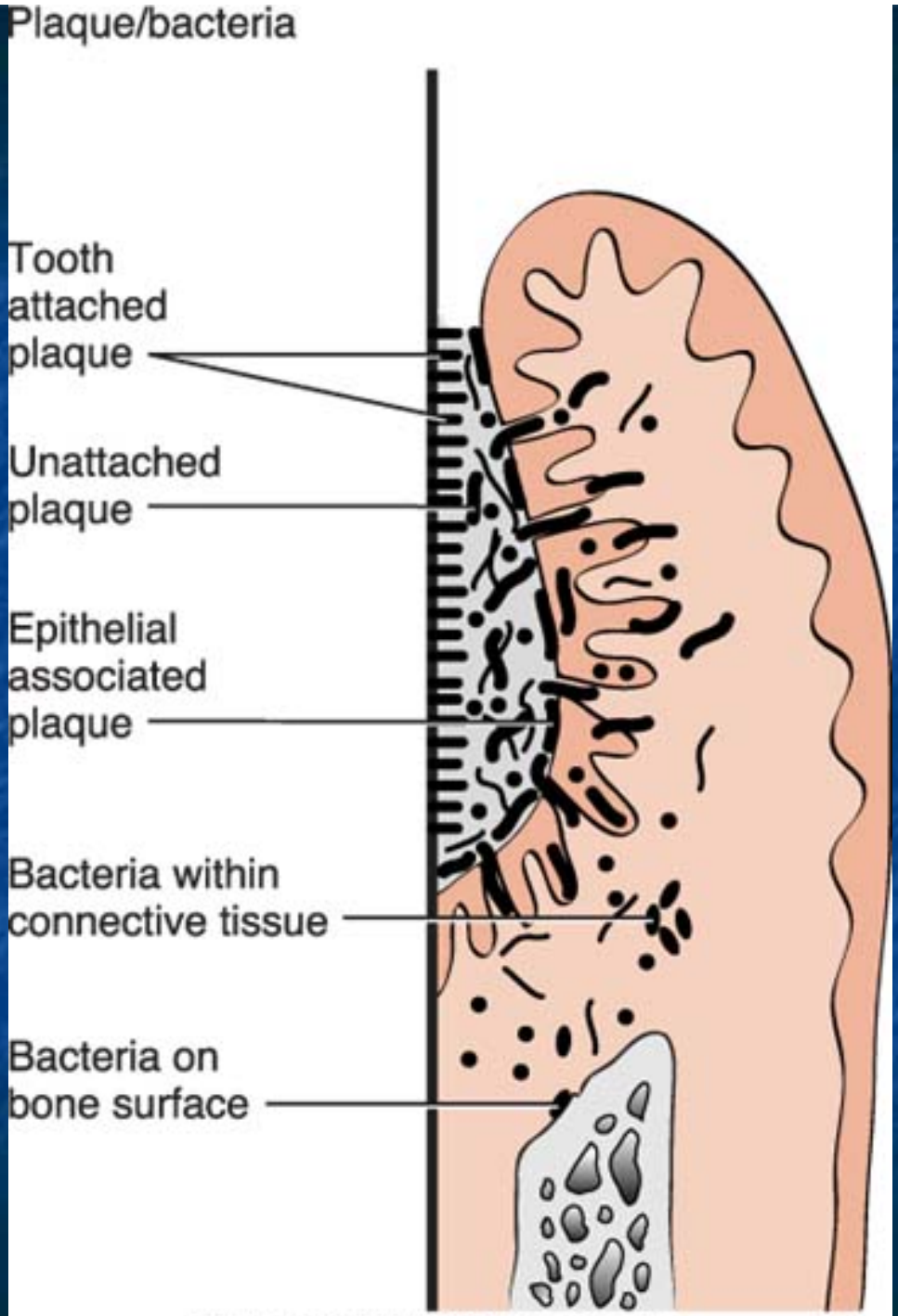
- Microorganisms - predominantly
- Intercellular matrix - 20-30% consists of organic & inorganic materials.

Microorganisms:

- 1 gm of plaque contains approx. 2×1011 bacteria.
- Because 1 gm pure strp. Cells packed by centrifugation contain 2.3×1011 bacteria.
- According to cultivation study, more than 500 distinct microbial species are found in the dental plaque.
- Nonbacterial microorganisms that are found in plaque are myco plasma species, yeast, protozoa & viruses.

- ***Intercellular matrix:***
- **Organic constituents**
  - Glycoproteins - from saliva
  - Polysaccharides - by bacteria
  - Albumin - crevicular fluid
  - Lipid material - consists of debris from membranes of disrupted bacteria & host cells & possibly food debris.
- **Inorganic constituents**
  - Calcium & phosphorus - predominantly
  - Sodium, potassium, fluoride - in traces

- ***Source:***
- for Supragingival plaque - saliva
- for Subgingival plaque - crevicular fluid (It is serum transudate)
- As the mineral content increases, the plaque mass becomes calcified to form calculi.
- This matrix confers a specialized environment, which distinguishes bacteria that exist & proliferate within the intercellular matrix through which the channels course. According to newer microscopic studies, there is presence of fluid filled channels in the plaque mass, they may provide far circulation within plaque to facilitate movement of soluble molecules such as nutrients as waste product.



❖ *Biofilm :*

It is a well organized co-operating community of microorganism formed by and initiated by interaction between tooth surface and microorganism than by physiology and physical interaction between microorganism.

Plaque is as a Biofilm; current research is showing that the properties of bacteria associated with a surface in a biofilm can be markedly different than those of the same cells growing in liquid broth (planktonic cells). Plaque is found preferentially at protected and stagnant surfaces, and these are at the greatest risk of disease.

- **Biofilm structure**:

(A). Biofilm environments:

The aerobic environment at the edges of the fluid channels and the anaerobic environment at the center of a micro colony.

(B). Fluid channel

That facilitate the movements of nutrients, oxygen, bacteria, metabolite and enzymes within the biofilm structure penterate the slim layer.

(C). Primitive communication system

The bacteria in the biofilm use chemical signal to communication within each other.

Formation of dental plaque:

- Dental plaque may be readily visualized on teeth alter 1 to 2 days with no oral hygiene measures.
- Color: White, Grayish and Yellow.
- globular appearance
- vulnerable areas:

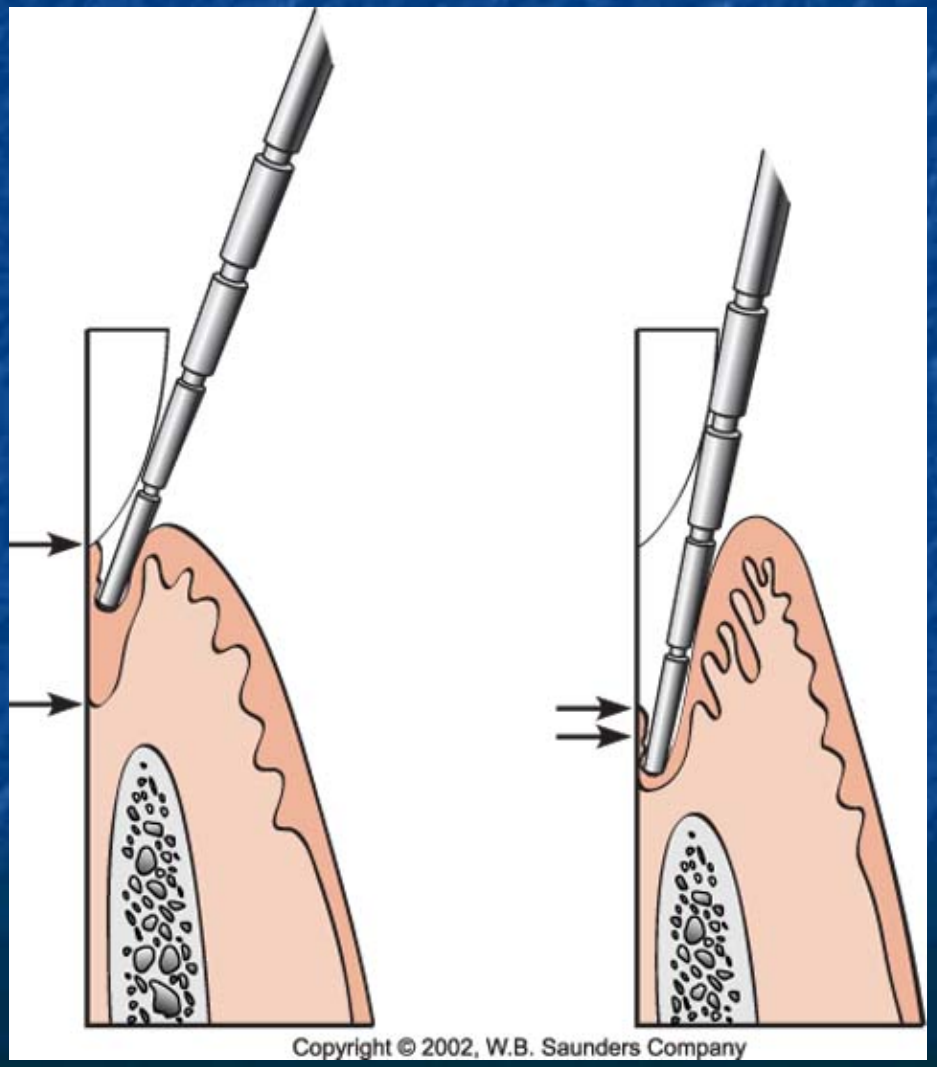
  - movement of tissues & food materials over the teeth results in mechanical removal of plaque, such removal is effective on coronal 2/3 of the tooth structure

  -Thus plaque is typically observed on the gingival 1/3 of tooth structure ,where it accumulates without disruption by movement of food & tissues over the tooth structure.

  - Plaque deposits also farm i cracks ,pits ,fissures in the tooth structure ; under overhanging restorations ; around mal aligned teeth.

Clinical Detection

- small amount of plaque that are not discernible on the tooth surface may be detected along the gingival 1/3 of tooth surface.
- use of disclosing agent.



Individual variation

- Location & rate of plaque formation vary among individuals.
- Factors are:

  -Oral hygiene

  -Diet

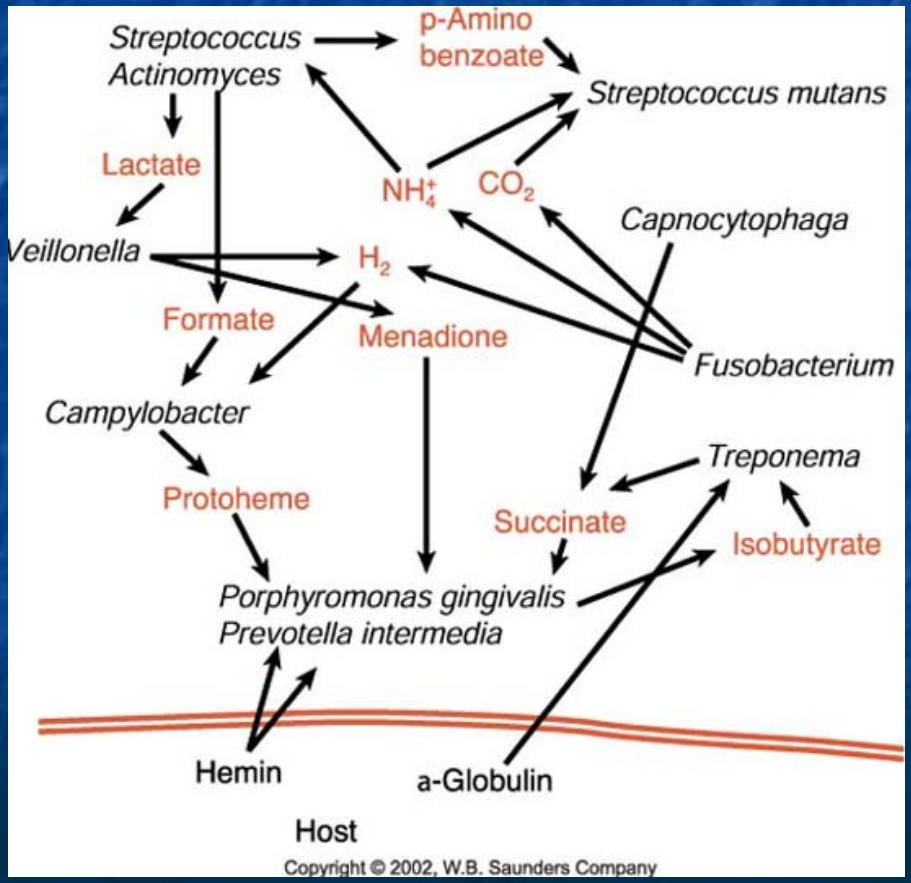
  -Salivary composition & flow rate.
- In absence of oral hygiene measures, plaque continue to accumulate until a balance is reached between the forces of plaque removal & those of plaque formation.

❖ Process of plaque formation

(I) formation of dental pellicle

(II) Initial colonization by bacteria

(III) Secondary colonization & plaque maturation.



(I) Formation of Dental pellicle.

- It is initial phase of plaque development
- All the structure of the oral cavity like tissue surfaces ,teeth & removable restoration are coated glycoprotein pellicle.
- Pellicle is derived from components of
  - saliva
  - crevicular fluid
  - bacterial & host tissue cell products & debris
- Pellicle is formed by selective adsorption of environmental macro molecules.

- **The mechanism involved in formation are:**
- Electrostatic
- Wandervals forces
- Hydrophobic forces

- Pellicle function as:
- Protective barrier
- Provide lubrication
- Prevent tissue desiclution
- They also provide substrate to which bacteria in the environment attach Because the epithelial tissue cells are continuously sloughed, bacterial population on the tissue surfaces is continually disrupted. In contrast pellicle on non shedding structure provides a substrate on which bacteria progressively to form dental plaque

(II) Initial colonization of tooth surface:

- within a few hours ,bacteria are found on the dental pellicle
- Initial colonizes:

- They are predominately gram positive facultative microorganisms take actinomyces, viscous & streptococcus sanguis.
- They adhere to the tooth surface through specific molecules ,adhesins ,on the bacterial surface that interact T receptors in dental pellicle
- (e.g.) cells of A viscous posses fibrous protein structures called fimbriae that extend, from bacterial cell surface. Protein adhesins on that Bacterial fimbriae bind to the proline rich proteins found in the pellicle ,resulting in attachment of bacterial cell to pellicle coated tooth surface.

(III) Secondary colonization & plaque maturation:

- secondary colonizes:

- These are the any which cannot initially colonize the clean tooth surface. They adhere to the cells of the bacteria already in the plaque mass.
- Here there is transition from early aerobic environment to a highly 0_2 derived environment in gram negative anaerobic microorganism predominate
- Organisms:
  - Prevotella intermedia
  - P. loescheii
  - Capnocytophaga species
  - Fusobacterium nucleatum
  - Porphyromonas gingivalis.

Co aggregation:

- "It is ability of difference species & genera of plaque microorganisms to adhere to one another"
- It occurs through the highly specific stereo chemicals interaction of protein & carbohydrate molecules located on the bacterial cell surface, in addition to less specific interactions resulting from hydrophobic, electrostatic & wandervals forces
- Initially there is interaction between gram +ve & -ve any.

  e.g.. co aggregation of
  - F. nucleatum with S.sanguis
  - P. loescheii with A.viscosus
  - C. ochracea with A.viscosus
- Later there is interaction between different gram -ve species.

  e.g. co aggregation of

  F nucleatum with P. gingivalis or

  denticola

Initial adhesion & attachment of bacteria.

- There are four stage sequence:
- **Phase-1 Transport to the surface:**
  - It involves initial transport of bacterium to tooth surface
  - Random contacts may occur
    - Through Brownian motion.
    - Through sedimentation of microorganism.
    - Through liquid flow
    - Through active bacterial movement

Phase-2 Initial adhesion:

- It results in reversible adhesion of bacterium by interaction between bacterium & surface from a certain distance, through long range & short range forces, including wandervals & electrostatics repulsive forces.
- The summation of previous forces describes total long range interaction.
- Total interaction energy is called total Gibbs energy
- The result of this summation is a function of separation distance between a negatively changed particle & negatively changed surface in a medium ionic strength suspension medium.

Phase-3 attachment:

- After initial adhesion a firm anchorage between bacterium & surface will be established by specific interactions (covalent, ionic, are hydrogen bonding.)
- On the rough surface, bacteria can better protected against shear forces so that a change from reversible to irreversible bonding occurs more easily & more frequently.
- The bonding between bacteria & pellicle is mediated by specific extra cellular protein components of organism & complementary receptors on the surface & is species specific.

Phase-4 colonization of surface & biofilm formation:

- As described in secondary colonization.

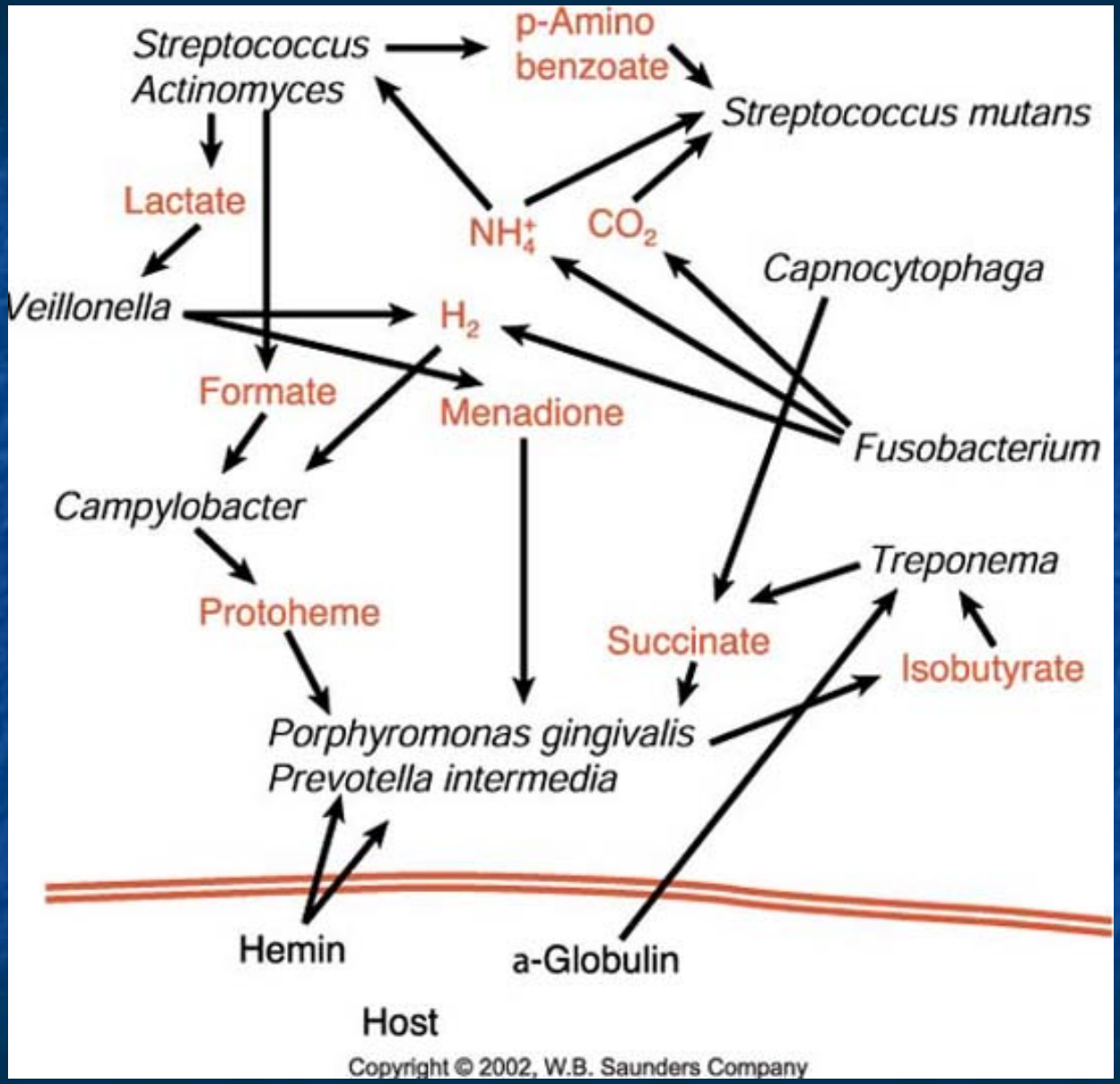
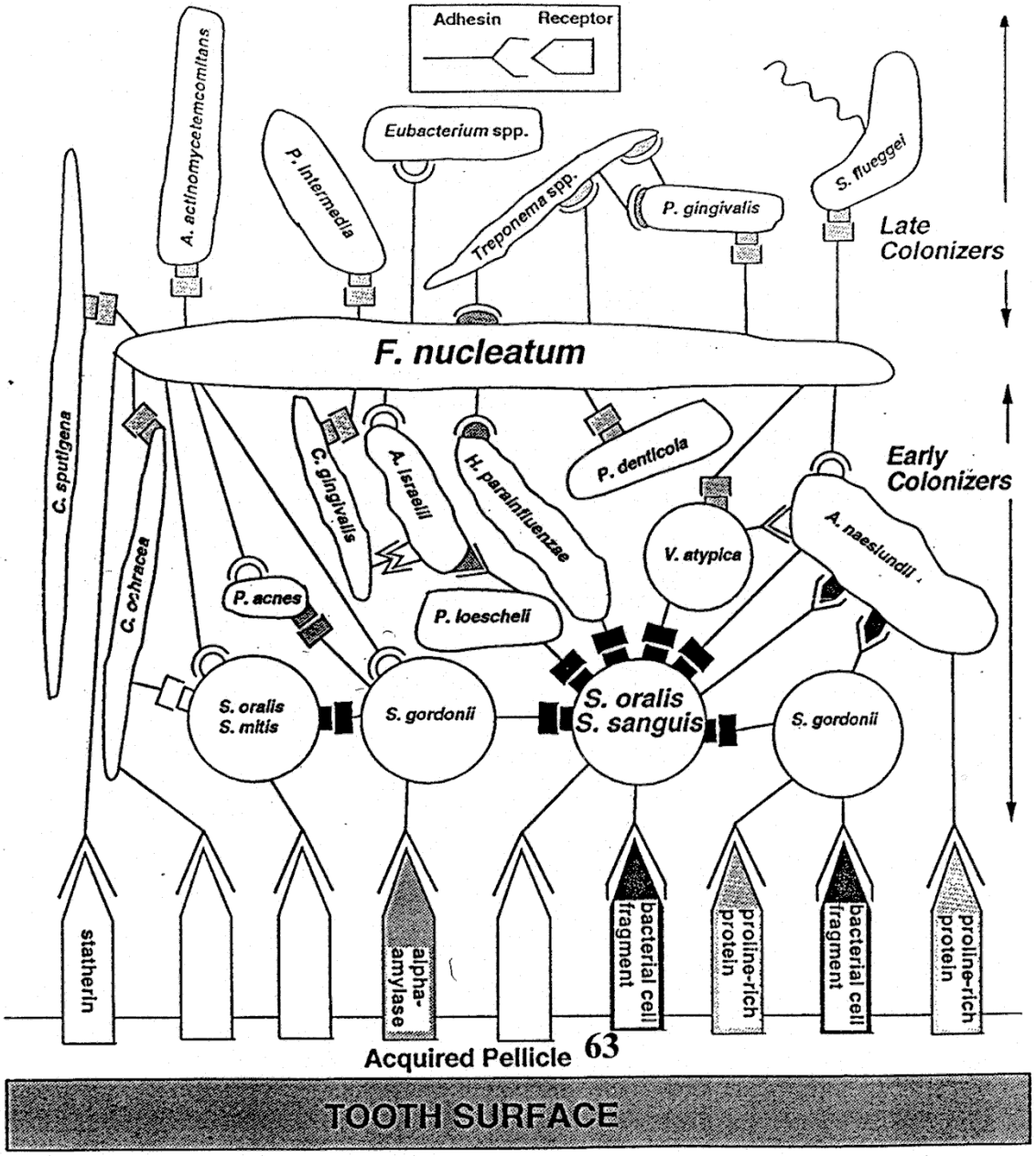


Fig: Some intermolecular interactions involved in plaque formation.



Factors affecting plaque formation

- Topography of Supragingival plaque
- Surface microroughness
- Individual variables influencing plaque formation
- Variation within dentition
- Impact of gingival inflammation
- Impact of patients age
- Spontaneous tooth cleaning

Principle of Bacterial transmission, translocation

- Transmission of plaque biospecies is an established fact.
- Plaque microorganisms are transmissible but not contagious
- Intraoral translocation (cross infection) is also an important consideration during treatment of Periodontal diseases.

Microbial Specificity of Periodontal Disease

- Non Specific Plaque Hypothesis
- Specific plaque hypothesis
  - Given BY Walter Loesche in 1976.

THANK YOU