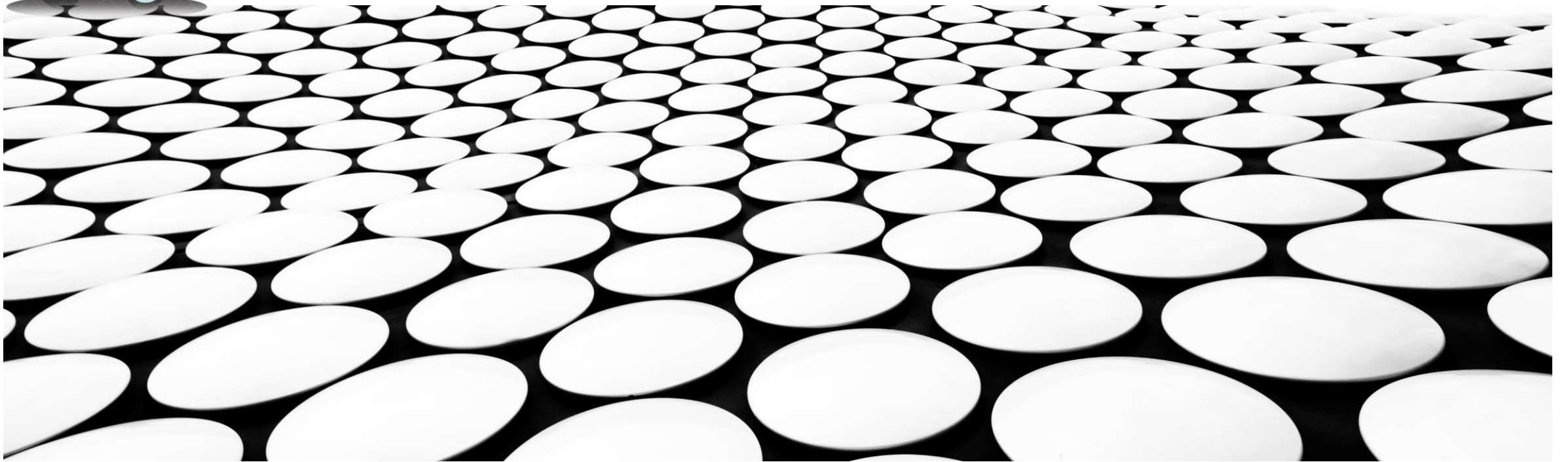




DENTAL CARIES



DEFINITION

Dental caries is an irreversible microbial disease of calcified tissues of teeth, characterized by demineralization of inorganic portion and destruction of organic substance of tooth which often leads to cavitation



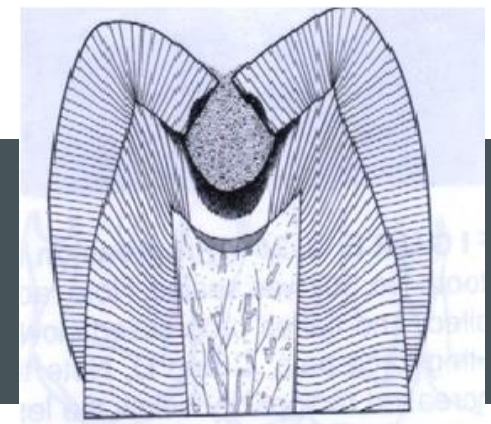
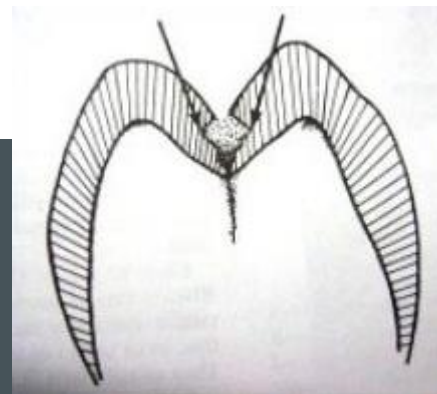
- **According to occurrence:** – **Incipient**—initial primary caries often reversible – **Recurrent**—secondary caries – **Residual**—carries left due to mistake of dentist

- **According to speed:** – **Acute**—fast spreading – **Chronic**—slow spreading

CLASSIFICATION

- **According to location:** – Pit and fissure– Smooth surface– Root surface

- **According to direction:** – **Forward caries**—when caries in enamel is in a **V-shape**, i.e. base pointed towards DEJ. – **Backward caries**—when the more extensive destruction is towards DEJ with small apex.



- **According to age:** – Early childhood caries – Adolescent caries – Senile caries

- **According to surface:** – Simple – one surface – Compound – two surfaces – Complex – more than two surfaces

- **According to type of surface:** – Occlusal – Proximal

CLASSIFICATION

THEORIES OF CARIES FORMATION

■ EARLY THEORIES

■ LEGEND OF WORM

■ EXOGENOUS THEORIES

1. Chemical Theory (Parmly and Robertson) 1819
2. Parasitic or Septic Theory (Erdl and Ficinus) 1843
3. Chemico-parasitic (1889 MILLER)

■ ENDOGENOUS THEORIES

1. Humoral theories (Hippokrates)
2. Vital theories

■ NEW THEORIES

- Proteolytic Theory - Gottlieb 1941
- Proteolysis-chelation Theory- Martin-Schatz 1955
- Sucrose chelation theory

■ OTHER THEORIES

- Sulfatase theory – Pincus 1949
- Autoimmune theory

Legend of the WORM THEORY

- Early reference of tooth decay and tooth ache came from the ancient Sumerian text known as the legend of worm (5000 BC)
- In Japanese the word for dental caries is mush-ha (mushi-room)(ha-tooth), meaning hollow teeth.
- Same terminology is employed by the Chinese the word for hollow tooth is 'Chung Choo'.
- DC → caused by worm that drank blood of teeth and it fed on roots of jaws
- Chinese and Egyptians Remedy → mixed plants , their oils or fumigate by burning leeks and hyoscyamus



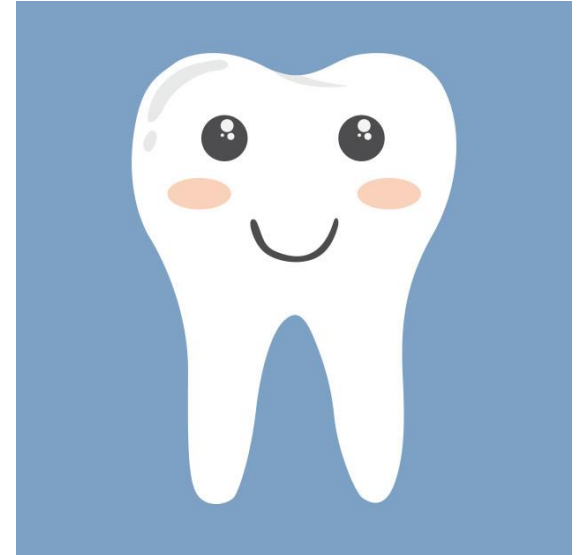
Endogenous- HUMORAL THEORY

- Greek physicians proposed the humoral theory of disease.
- The ancient greeks considered that a persons physical and mental constitution was determined by the relative proportions of the four elemental fluids of the body which corresponds to the 4 humors.
 - **Blood, Phlegm (mucous), Black bile, Yellow bile**
- Any change in relative proportion of these elements causes disease
- Galen → ancient Greek physician → dental caries was produced by internal action of acid and corroding humors'
- Remedy → Local/ General medicaments → strengthening of the teeth by the use of astringents and tonic remedies.



Endogenous- VITAL THEORY

- Teeth are integral part of the body & that they were vitally affected by and in turn it affected the body
- A vital theory of tooth decay was advanced towards the end of 18th century, which postulated the **tooth decay originated like bone gangrene form within the tooth itself.**



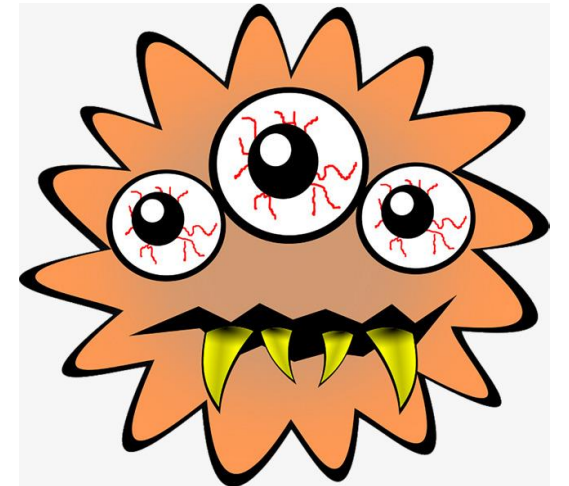
CHEMICAL THEORY

- In 1835 → Robertson
- This theory proposed that dental decay was caused by **acid**(unidentified chemical agent) formed by **fermentation of food particles around teeth**
- Since fermentation was considered to be a strictly non-vital process the possibility that microorganisms were involved was not as yet recognized.



PARASITIC THEORY

- The possibility that microorganisms can have toxic and destructive effects on tissue was postulated
- In 1843 – **Erdl** described filamentous parasites are removed from carious cavities.
- The same was confirmed by **Anton Von Leeuwenhoek** microscopically.



MILLER'S CHEMOPARASITIC THEORY

Chemicoparasitic Theory (Acidogenic theory)-1889

- Acid and microorganisms were involved in the etiology of dental caries
- “Die Mikroorganismen der Mundhöhle”
- **Pasteur** had discovered that microorganisms mediate the process of conversion of sucrose to lactic acid. This enabled Miller to assign to oral microorganism the role of acid formation
- DC caused not by a single species of microorganisms but was related to **multiple microbial activities involving acid production and protein degradation.**

“Dental decay is a chemoparasitic process consisting of two stages: decalcification or softening of the tissues and dissolution of softened residue”.

MILLER'S CHEMOPARASITIC THEORY


Microorganisms – secretion of enzymes or by their own metabolism, degrade the fermentable carbohydrate food material so as to **form acids.**

Carbohydrate food material lodged between and on surfaces of teeth is the source of the acid, which **demineralizes the lime salts of the tooth.**

The enamel is destroyed by the acid of fermentation and the **disintegrated enamel is subsequently mechanically removed by forces of mastication.**

After penetration of the enamel, the dissolution of dentin is brought about in the same manner with the organisms **penetrating along the dentinal tubules.**

The final breakdown of dentin results from the **secretion of proteolytic enzymes that digest the organic part of dentin and form a cavity**

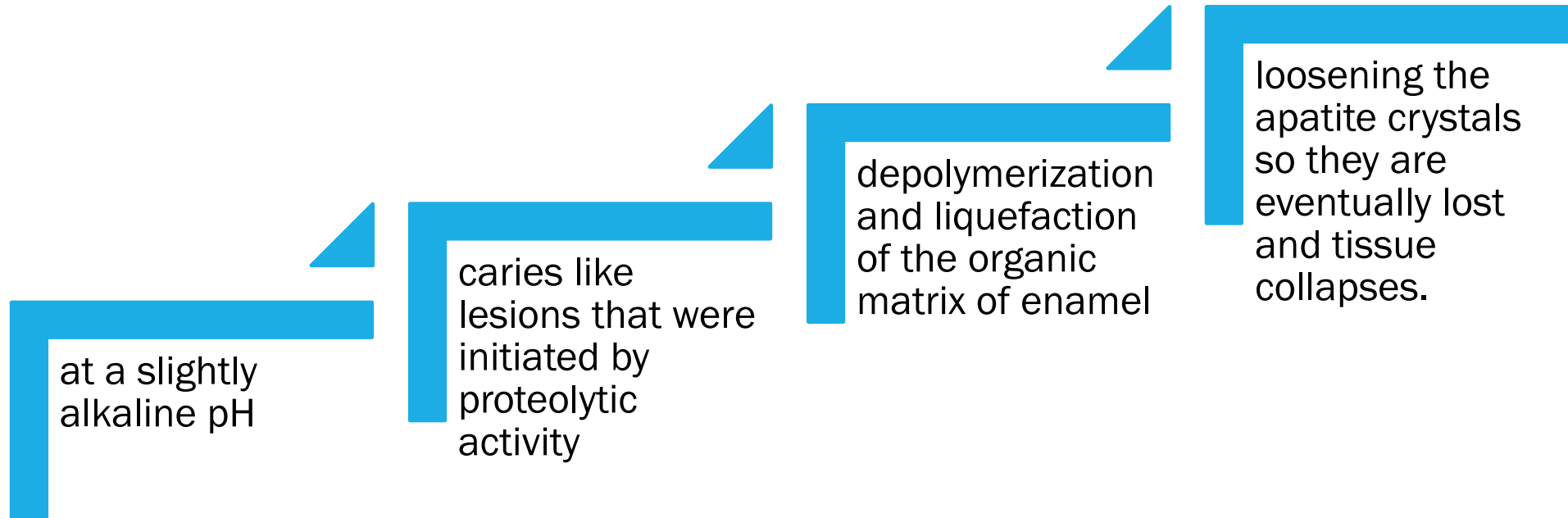
- 
- Even though, at that time, this theory couldn't explain
 - 1) predilection of specific sites on a tooth
 - 2) initiation of smooth surface caries
 - 3) why some populations are caries free
 - 4) the phenomenon of arrested caries.

This theory is still considered as the backbone of current knowledge and understanding of the etiology of dental caries.

PROTEOLYTIC THEORY

- Alternative explanation given for the acidogenic theory in the form of proteolytic theory
- **Gottlieb ,Frisbie, Nuckolls & Pincus** gave considerable contribution to this theory (1947- 1950)
- Evidence states that **proteolysis of the organic of the tooth** plays an important role in the development of dental caries
- The surface coverings found on the tooth, in **grooves and pits**, are organic in nature; also enamel contains small but significant amount of organic material (**rods/lamelle**).

PROTEOLYTIC THEORY



- Gottlieb proposed that microorganisms invade the organic pathways of enamel and initiate caries by proteolytic action.
- Subsequently, the inorganic salts are dissolved by acidogenic bacteria
- **No Formation of acid**
- **Proteolysis is independent of the pH**

- Drawbacks of this theory

1)It couldn't provide sufficient evidences to support the claim that the **initial attack on enamel is proteolytic;**

2)also experimental studies have shown the **occurrence of caries even in the absence of proteolytic microorganisms**

However , this theory is still helpful in explaining the **progression of a more advanced carious lesion.**

PROTEOLYSIS CHELATION THEORY

- This theory is proposed by Schatz et al(1955)
- Proteolysis+ Chelation
- **Simultaneous** microbial **degradation** of organic components (hence, proteolysis) and the **dissolution** of minerals of the tooth by the process known as chelation.
- Proteolysis – Keratinolytic microbes → soluble chelates(keratin, citrate, MPS, lipid)→ decalcify Enamel at neutral or alkaline pH

According to the proteolytic chelation theory, dental caries results from an initial bacterial and enzymatic, proteolytic action on the organic matter of enamel without preliminary demineralization.

Such action, the theory suggests, produce an initial caries lesion and the release of a variety of complexing agents, such as amino acids, polyphosphates and organic acids (possess chelating properties)

The complexing agents then dissolve the crystalline apatite (inorganic)

LIMITATIONS

- Enamel contains only 1.0-1.5 % organic matrix, thus its dissolution to produce sufficient amount of chelates to disintegrate the rest of inorganic part of enamel is doubtful.

- ✓ Increased caries incidence with increased sugar intake.
- ✓ Increased caries activity with increased lactobacillus count.
- ✓ Decreased caries incidence following topical or systemic administration of fluoride.

SULPHATASE THEORY

- Proposed by Pincus in 1951
- G-ve bacteria → sulphatase.
- Bacterial sulfatases hydrolyses the **mucoitin sulphate of enamel and chondroitin sulphate of dentin producing sulphuric acid** that in turn causes decalcification

Limitations

- Sulfated polysaccharide in enamel is very small and not readily available as a substrate for enzymatic degradation
- Highly unlikely hypothesis

COMPLEXING AND PHOSPHORYLATING THEORY

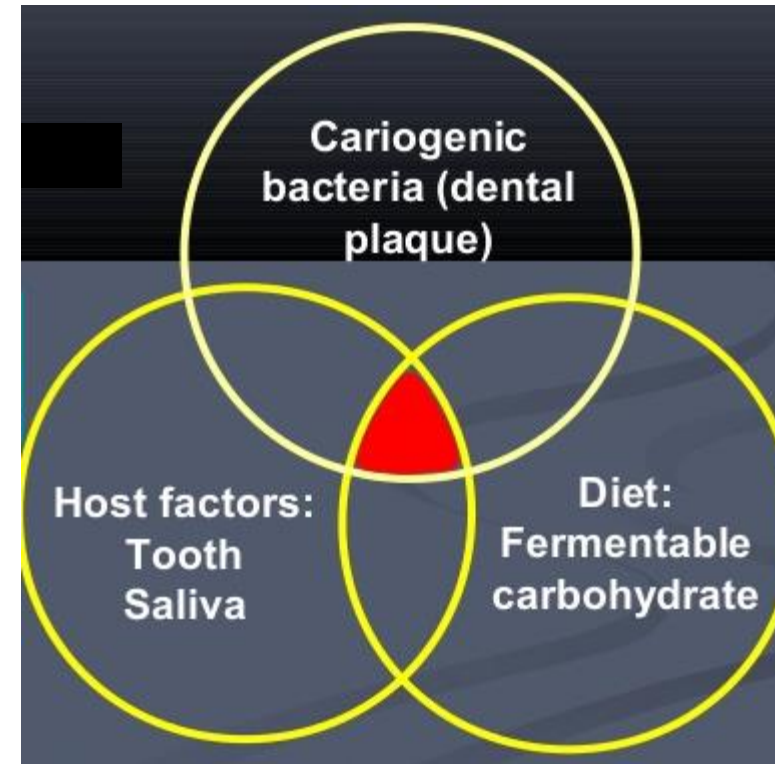
- According to this theory, the high bacterial utilization of phosphate in plaque causes a local **disturbance in the phosphate equilibrium** in the plaque and the tooth enamel resulting in loss of inorganic phosphate from enamel. **Soluble calcium complexing compounds produced by bacteria cause further tooth disintegration.**

BURCH AND JACKSON HYPOTHESIS

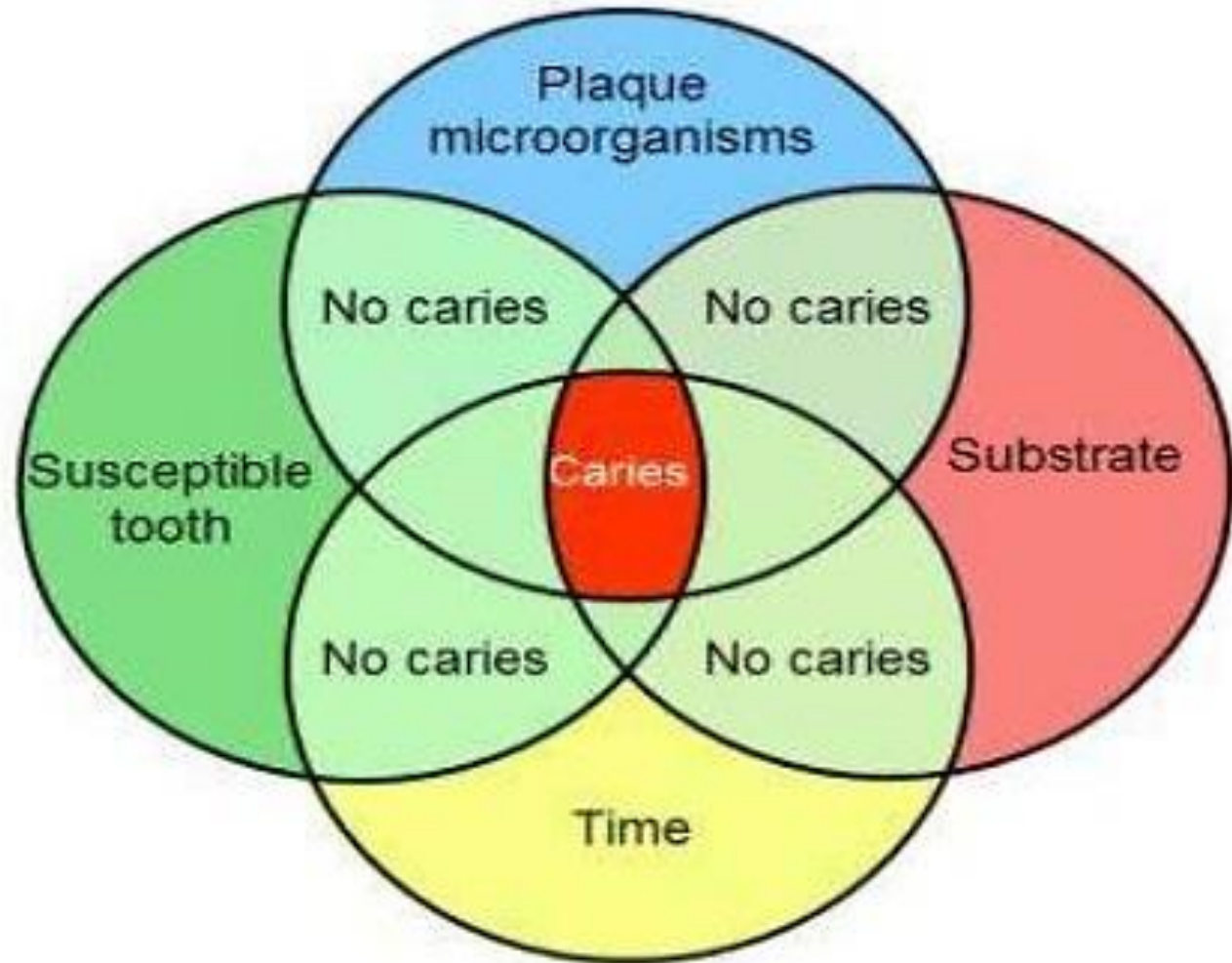
- **Genes** (partly inherited & partly as a result of mutations) determine whether a site on the tooth is at risk.
- An **abnormal mitotic control protein** has been proposed that causes **disorders of the odontoblasts** as a random event that leads to **changes in the resistance of the enamel to acid attack**

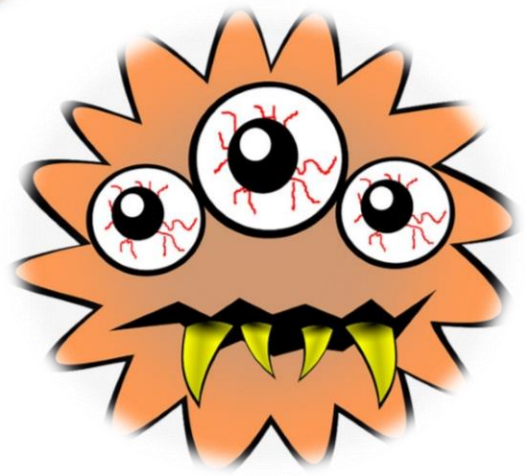
CONCEPT OF DENTAL CARIES – Keyes and Jordan 1960 (Primary risk factors)

- Host → Tooth
- Agent → Micro organisms
- Substrate → Carbohydrates in diet



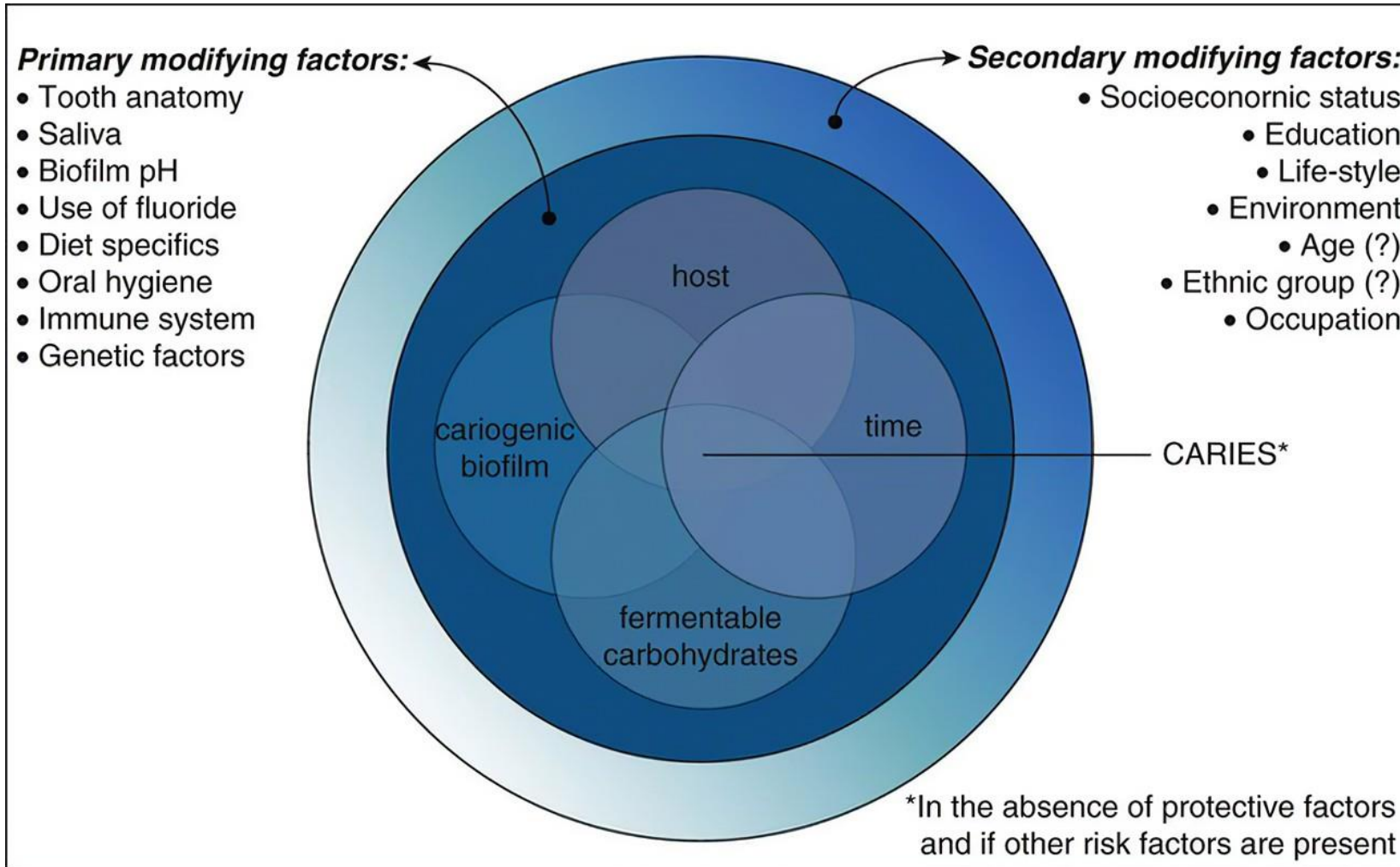
NEWBRUN TETRAD





Primary factors:
Initiate caries

Secondary factors:
Modify the progression



HOST : TOOTH

Caries progression depends on tooth

1. Composition
 2. Location
 3. Morphological characteristics
 4. Position
- Caries susceptibility of a tooth is inversely proportional to its **fluorine, calcium** and tin contents.
 - **Surface enamel** is more highly mineralized and tends to accumulate greater quantities of fluoride, zinc, lead and iron than the underlying enamel. This explains why surface enamel is more resistant to caries than subsurface.
 - Presence of **deep, narrow occlusal fissures or buccal or lingual pits**, Enamel hypoplasia
 - The most susceptible permanent teeth are the mandibular first molars, closely followed by the maxillary first molars & mandibular & maxillary 2nd molar.
 - Teeth which are malaligned, out of position, rotated or otherwise not normally situated may be difficult to clean and tend to favour accumulation of food and debris.

ESSENTIALITY OF ORAL BACTERIA

- Dc develops as result of change in the ecosystem at tooth surface → shift in microbial community
- New born → sterile oral cavity → few hrs → bacterial invasion
- Streptococcus, Neisseria, Actinomyces, Veionella, Lactobacillus
- Site specificity – teeth, tongue, cheek, interdental area

Pit & fissure

S.mutans
Lactobacillus species
Actinomyces species

Smooth surface

S. mutans
S.Salivaris

Root surface

A.viscosus
A.naeslundi
S.mutans
S.Sanguis

Deep dentinal caries

Lactobacilli species
Actinomyces species

ESSENTIALITY OF ORAL BACTERIA

- S.mutans- Initiation of caries → important pathogen (5-6yrs to penetrate Enamel of 2.7mm)
- Lactobacillus acidophillus, L.casei, Actinomyces, Strep sanguis – progression
- Produce Extracellular polysaccharide from either glucose or sucrose
- Acid producing + proteolytic nature

Initiation of Dental Caries	Progression of Dental Caries
Streptococci <ul style="list-style-type: none">• S. mutans• S. milleri• S. mitior• S. sanguis• S. salivaris	Streptococcal species: Streptococcal species in deep dentinal caries and root caries
Lactobacilli <ul style="list-style-type: none">• L. acidophillus• L. casei	Lactobacilli in dentin <ul style="list-style-type: none">• L. acidophillus• L. casei
Actinomycoses <ul style="list-style-type: none">• A. viscosus• A. naeslundii	Actinomycoses <ul style="list-style-type: none">• A. Israeli• A. odontolyticus

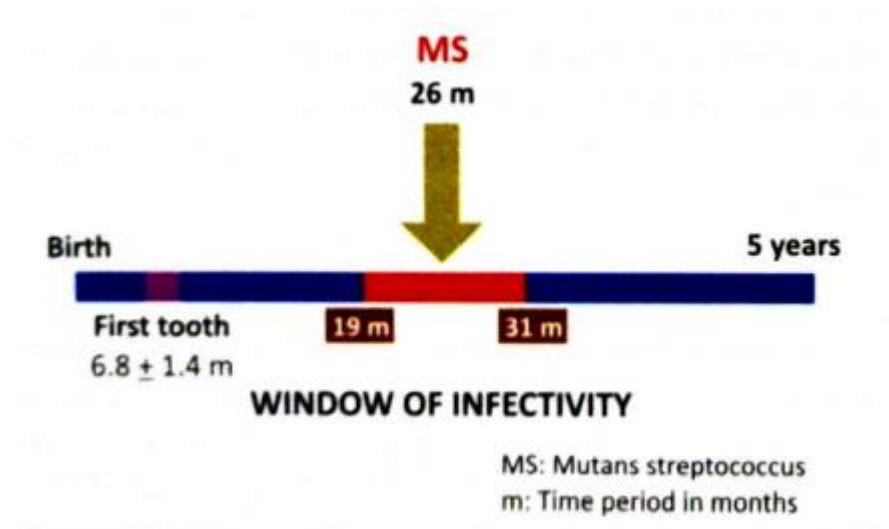


Fitzgerald in 1968 concluded that

- Microbes are a prerequisite for caries initiation
- Single type of organism is capable of inducing caries
- Organism varies in their virulence to induce caries
- Ability to produce acid is a prerequisite, but not all acid producing bacteria are cariogenic

WINDOW OF INFECTIVITY

- Caufield (1993) monitored oral cavity microbial levels from birth upto 5 years
- Initial acquisition of *S mutans* → window of infectivity
- Eruption of primary teeth → virgin habitat → colonize → 7- 31 mo
- 2 - 6yrs → less susceptible age
- Second window → 6 to 12 yrs



ESSENTIALITY OF ORAL SUBSTRATE

- Food substances act as substrate for microorganisms of dental plaque

- **Frequency of ingestion** : Repeated/ Between meals → constant supply of bacteria to produce acids
- **Physical form** : sticky & solid carbohydrates → high sugar concentration in saliva- prolonged clearance time and caries activity
- **Chemical composition** : Low molecular weight sugars (mono/di saccharides) make themselves easily available for fermentation by plaque bacteria by rapid diffusion
- **Route of administration** : More - oral intake of sticky food
- **Presence of other food constituents** : refined pure carbohydrates

TOOTH

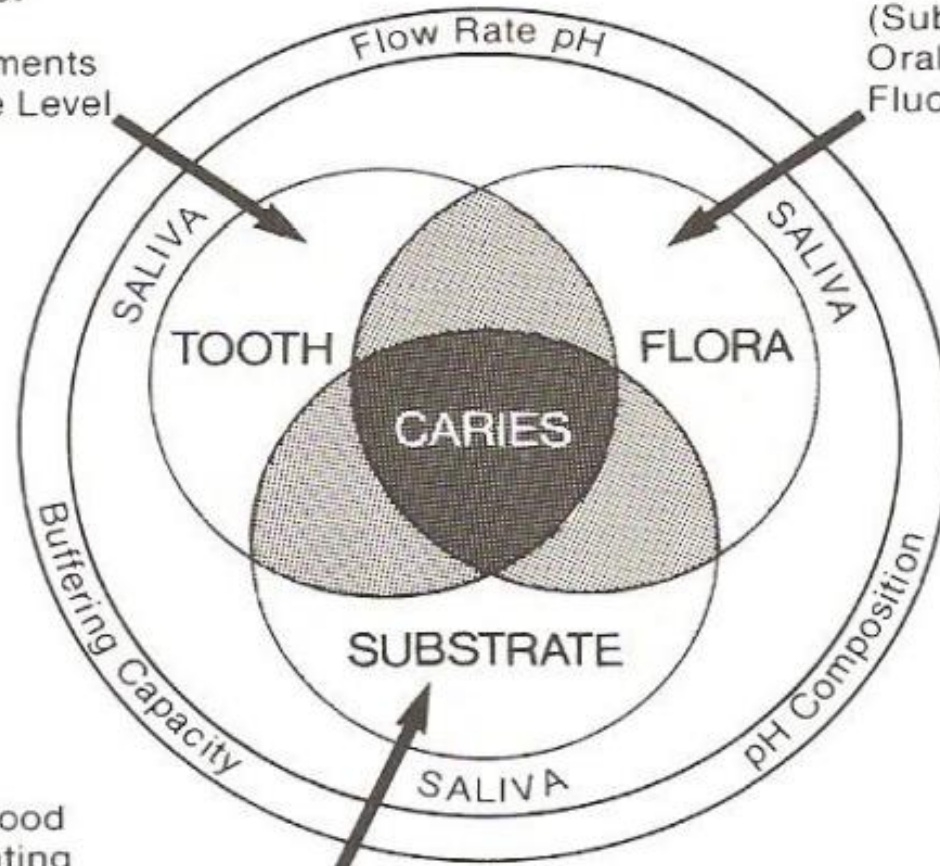
- Age
- Fluorides
- Morphology
- Nutrition
- Trace Elements
- Carbonate Level

FLORA

- Strep. mutans*
(Substrate)
- Oral Hygiene
- Fluoride in Plaque

SUBSTRATE

- Oral Clearance
- Oral Hygiene
- Detergency of Food
- Frequency of Eating
- Carbohydrate (type, concentration)



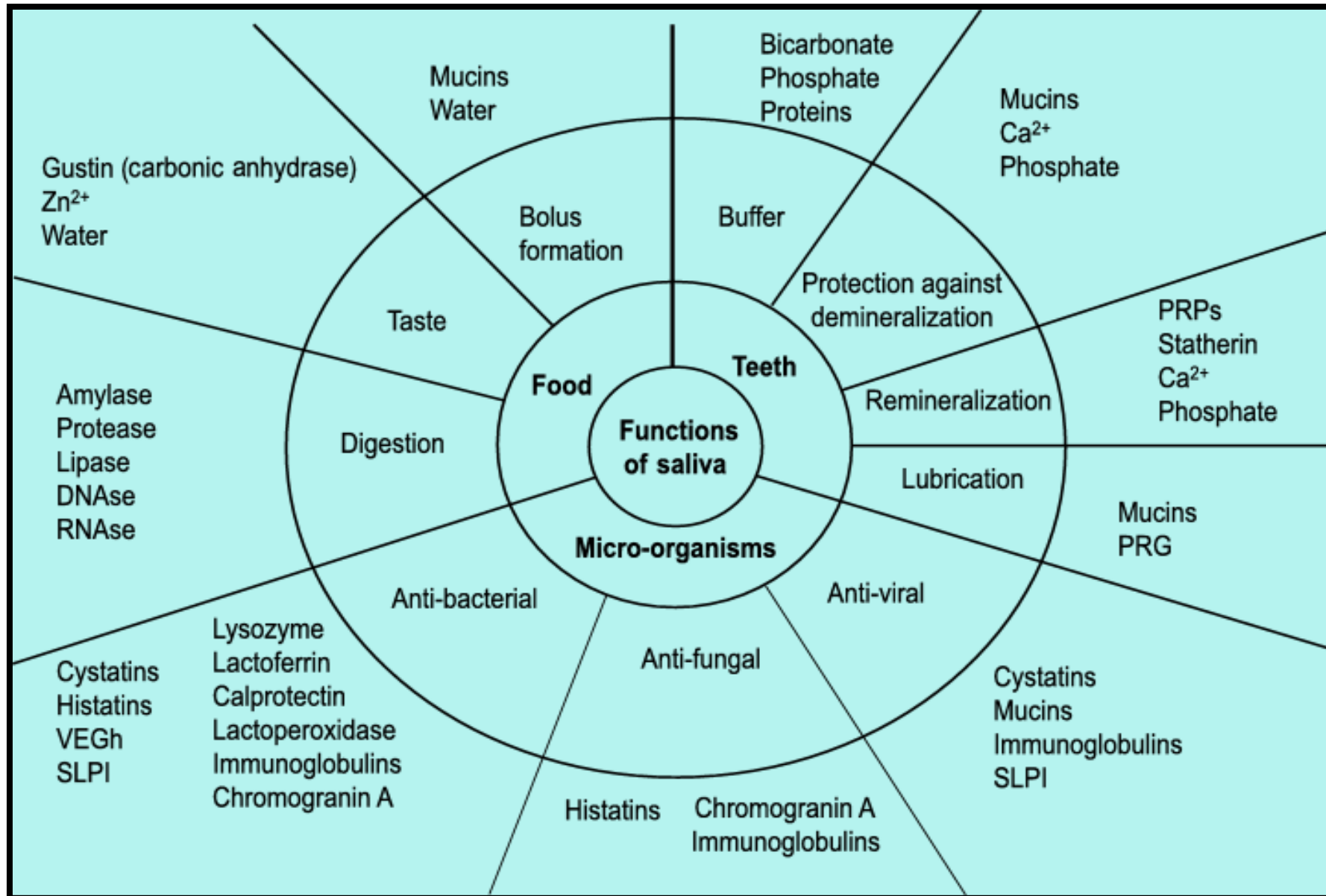


OTHER HOST FACTORS CAN BE

- Salivary & Plaque factors
- Habits
- Group susceptibility
- Age
- Muscular activity
- Environment

SALIVA

- Composition - Caries susceptibility is usually inversely proportional to the salivary **phosphate content**.
- At neutral pH saliva is **super saturated** with Ca^{++} & PO_4^{++} ions with respect to enamel apatite which not only prevents enamel from dissolving, but even tend to precipitate apatite in the surface enamel of carious lesions
- Initial drop in pH- buffering action of saliva (bicarbonates and phosphates)
- Critical pH -5.2 to 5.5 → demin starts
- Quantity - evident in case of salivary gland aplasia and xerostomia in which salivary flow may be entirely lacking, resulting in rampant dental caries.
- Antibacterial factors - Lysozyme, salivary peroxidase
- Quality and viscosity – more prone to Dc → high viscous



Stephens curve

- In 1940's, Dr Robert Stephan, suggested there was a continuous change in salivary pH following consumption of foods and beverages, especially with fermentable carbohydrates.
- Stephan curve is a graph published by Stephan and Miller in 1944 which reflected the fall in salivary pH following a glucose rinse.
- Stephan selected patients who were either caries-free or caries-inactive or who exhibited various degrees of caries activity.
- Subjects were asked not to brush their teeth for three to four days prior to the measurement of the plaque biofilm pH on the labial surfaces of the anterior teeth.
- Prior to rinsing with 10 mL of a 10 percent glucose solution for 10 seconds, pH readings were obtained.
- After rinsing with the glucose solution, pH readings were obtained at various time intervals until the pH returned to its original value.

- The graph has four landmarks viz: resting pH, the rapid fall in pH, the critical pH and the recovery phase.
- **Resting plaque pH:** This describes plaque that has not been exposed to fermentable carbohydrates for approximately 2 hours and generally has a pH of between 6 and 7.
- **Decrease in plaque pH:** After exposure of dental plaque to fermentable carbohydrates, the pH decreases rapidly.

The rate at which the pH decreases is due in part to the **microbial composition of dental plaque**. In general, if more acidogenic, aciduric bacteria is present in plaque, the pH would lower more rapidly.

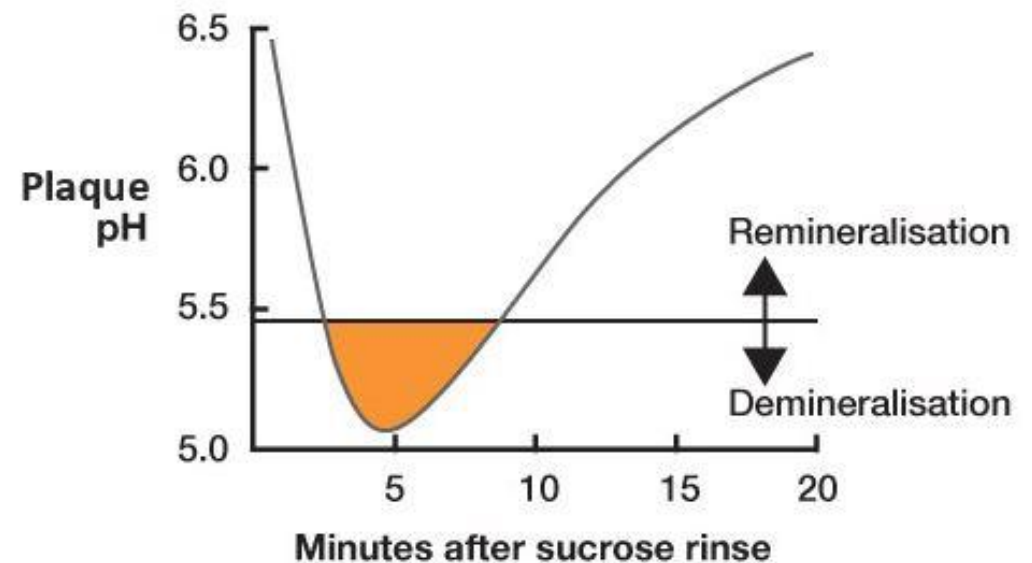
The rate of pH decrease is also dependent on the **speed** with which plaque bacteria are able to metabolize the dietary carbohydrate. While sucrose would be metabolized quickly, prompting a more rapid decrease, larger molecules, like starch, would diffuse into plaque more slowly because it would need to be broken down before it can be assimilated by plaque microbes.

Another factor that affects the rate of pH decrease is the **buffering capacity of unstimulated saliva**.

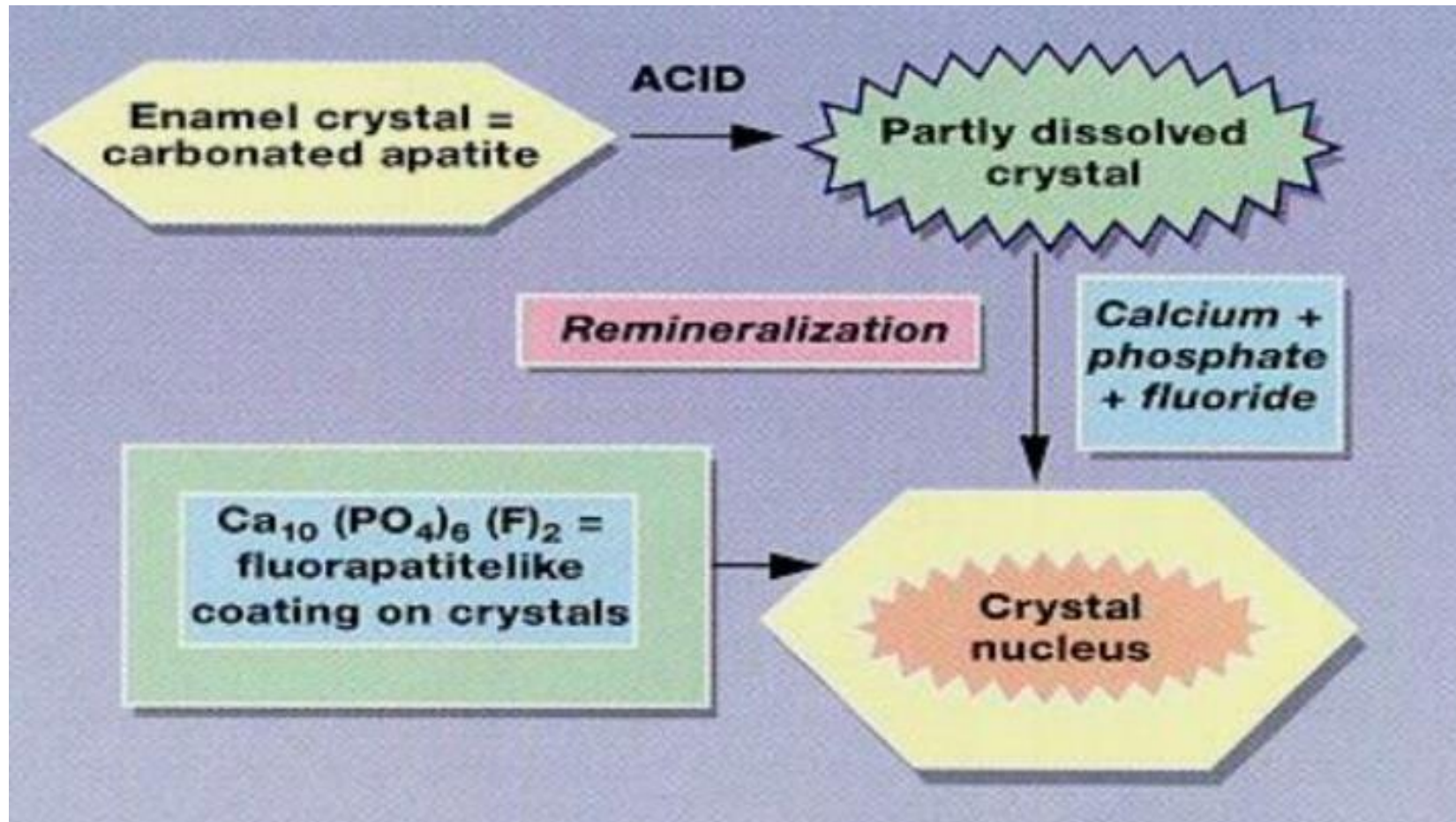
The rate at which plaque pH decreases is also influenced by the **density of plaque**. Less dense plaque can be penetrated more easily by buffering saliva and oxygen causing slower pH decreases than very dense plaque, which cannot be accessed by saliva and oxygen.

Critical pH: The critical pH is the pH at which saliva no longer remains saturated with calcium and phosphate, thereby permitting the hydroxyapatite in dental enamel to dissolve. It is the highest pH at which there is a net loss of enamel from the teeth, which is generally accepted to be about 5.5 for enamel.

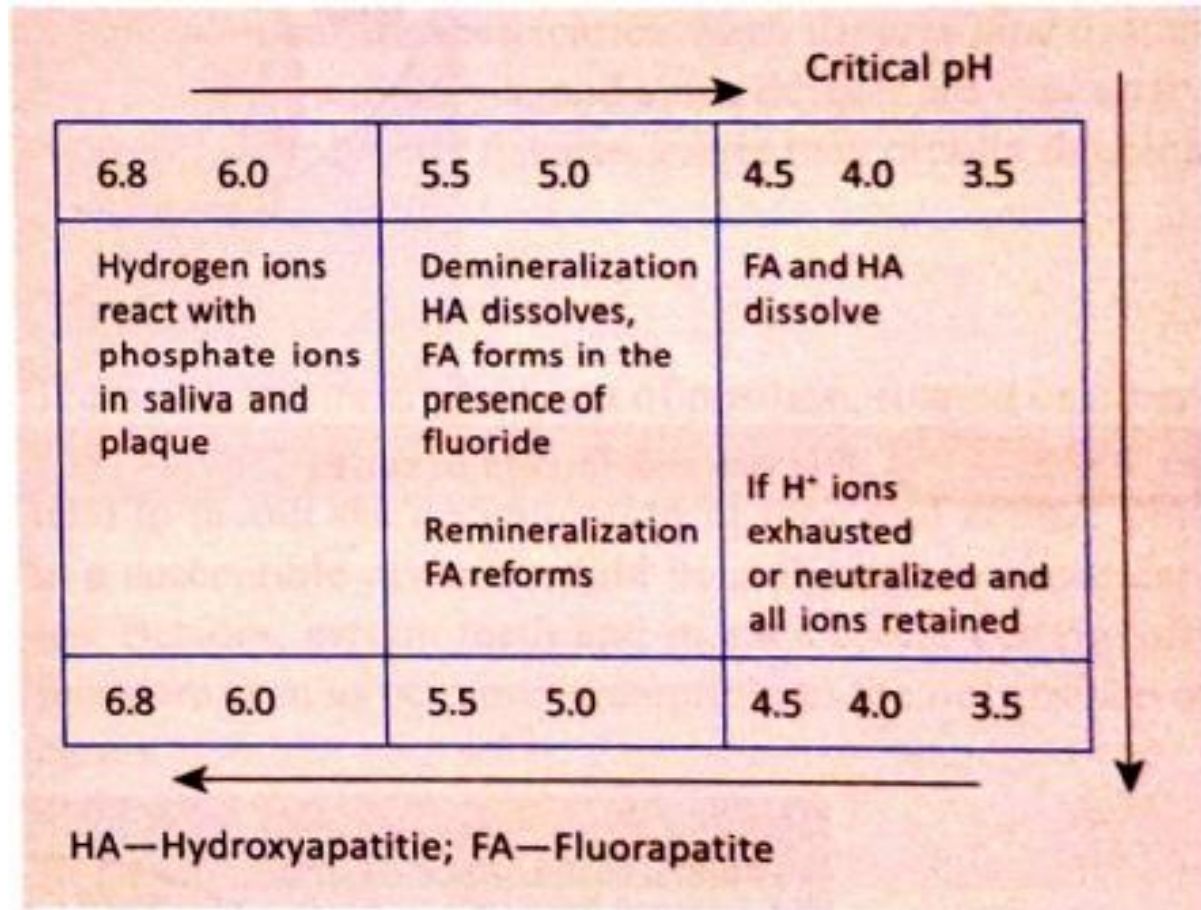
Increase in plaque pH: The low pH remained for some time, taking 30 to 60 minutes to return to its normal pH (in the region of 6.3–7.0).



CONCEPT OF DENTAL CARRIES – Demineralisation- Remineralisation



CONCEPT OF DENTAL CARRIES – Demineralisation- Remineralisation



THE CARRIES BALANCE

Disease Causing Factors

BAD disease-causing factors include the following:

Bad Bacteria – Acid-producing Bad bacteria

Absence of Saliva – The Absence of healthy salivary function (for example, dry mouth)

Dietary Habits (Poor) – Frequent sugars and acids lead to de-mineralization and a low pH allowing bad bacteria to thrive starting the decay process

Protective Factors

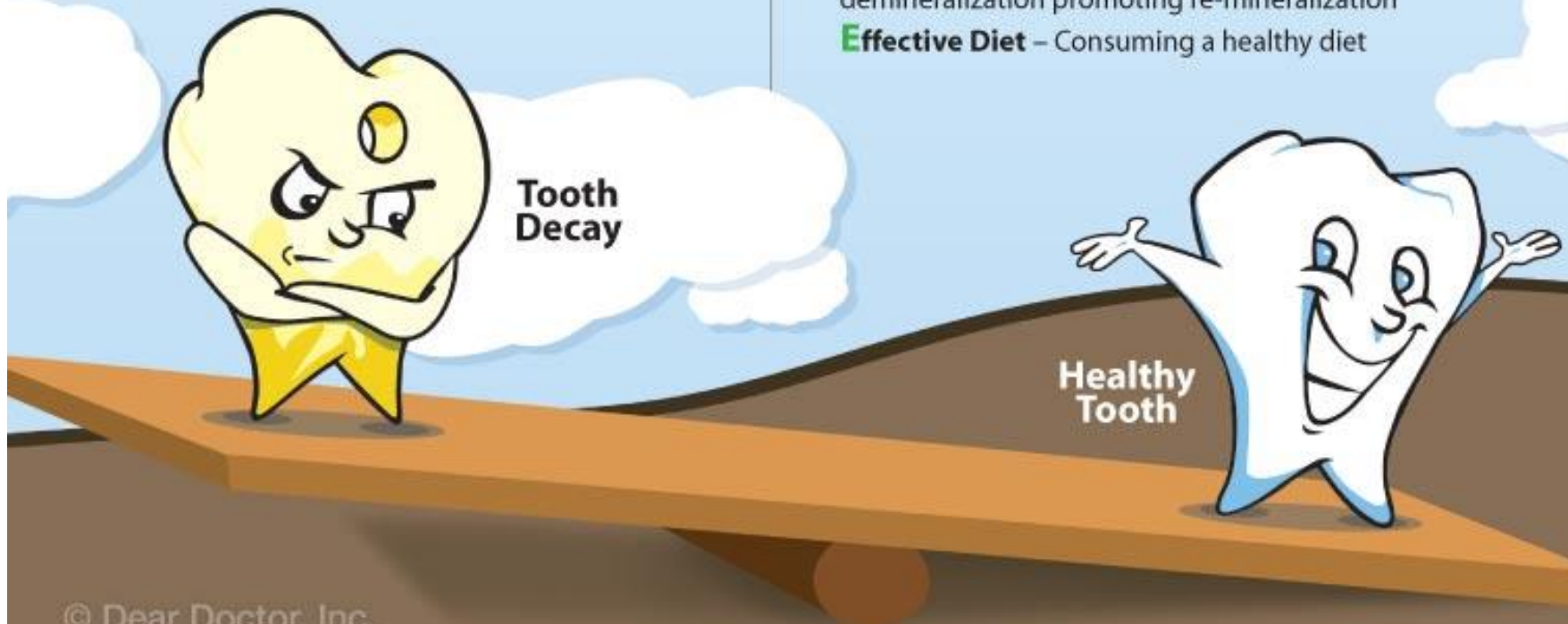
SAFE protective factors include the following:

Saliva and Sealants – Saliva neutralizes acid encouraging good bacteria to thrive and aids re-mineralization. Sealants seal the chewing surfaces of the teeth most likely to decay

Antimicrobials – Helping rid the bad bacteria and establish health-promoting bacteria

Fluoride – Strengthening the tooth surfaces against demineralization promoting re-mineralization

Effective Diet – Consuming a healthy diet





- **Habits**

Certain host habits will enhance caries activity.

e.g. poor eating habits such as desserts and snacks, bruxism

- **Group susceptibility**

Females are more susceptible to decay than males because teeth erupt earlier in females

- **Age :**

Age of the host is significant in caries process as decay activity is highest between ages of 14 and 20 years.

- **Muscular activity**

Host musculature ie. activities of the tongue, cheeks, lips and muscles of the face will create and guide the self cleansing activities with in the oral cavity.

- **Host's environment :**

Host environment is the final influencing factor. The phosphate content of the food and the fluoride content of water, will definitely diminish the caries activity

OTHER FACTORS CAUSING CARIES

- Systemic health – Xerostomia due to drugs, radiation, diabetes/ sugar syrups/ Cystic fibrosis, phenylketonuria –diet regimens
- Hereditary –High DMF parents, identical twins
- Race- racial tendency, blacks<whites,
- Prenatal deficiency of proteins, minerals, vitamins predispose DC
- Vitamin, Protein content of diet
- Trace elements that increase Dc- Se, Cd,Pb, Mn,Ba

CONTENTS

Caries risk assessment

Caries activity test

Cariogram

Caries vaccine

DENTAL CARIES – PART 2



TERMINOLOGIES

- **Caries risk assessment** can be defined as a procedure to predict future caries development before the clinical onset of the disease.
- **Caries activity test** are defined as tests that estimate the actual state of disease activity (progression/regression).
- **Risk factor** is defined as factor which plays an essential role in the etiology and occurrence of the disease, like the lifestyle and biochemical determinants to which the tooth is directly exposed and which contribute to the development or progression of the lesion (plaque, saliva, diet, etc.).
- **Risk indicator** is a factor or circumstance that is indirectly associated with the disease like socioeconomic factors and epidemiologic factors.

Caries Risk Assessment

- CRA is the determination of likelihood of **incidence of caries** (i.e) no of new cavitated or incipient lesions during a certain time period or the likelihood that there will be a change in the size or activity of lesion already present
- With ability to detect caries in its early stages (WSL), health care providers can help prevent cavitation
- **Caries activity**- sum of new carious lesions and the enlargement of existing cavities during a certain time period
- **Caries susceptibility**- inherent property of host and tooth to be affected by various process (lesion that might occur)



NEED FOR CRA

- To identify reliable predictors & allow them **treatment need and management** in children
- Determine need and extent of personalized **preventive measures**
- **Motivation** of patient
- To **identify** high-risk groups
- Aid in **recall** appointments
- Anticipates **caries progression or stabilization**

HIGH-RISK

LOW RISK

SOCIAL HISTORY

Socioeconomic status
Sibling caries
Dental awareness
Motivation level

Low
High caries
Poor
Low

Middle/upper
Low
Conscious
High

MEDICAL HISTORY

Medical conditions
Handicapped
Long term illness
Traumatic delievery

Mc predisposing to xerostomia
Poor manual control
On cariogenic syrups
Traumatic delievery

No medical problem/handicapped
with normal birth

DIETARY HABITS

Sugar intake frequency
Refined carbohydrates
Pacifier/prolonged breast feeding

Frequent (solid & liquid exposure >3)
More
Gives history

Sugar intake in limits
Less
No such history

FLUORIDE

Fluoride content
Fluoride supplements, toothpaste

Deficient
No

Optimum water fluoride level
Uses

ORAL HYGIENE

Oral health

Poor hygiene with excessive plaque
accumulation

Fair

SALIVA

Buffering capacity
S.mutans count
Lactobacillus count

Low
>10⁵
Less than 10,000/mL saliva

High
<10⁵
Less than 1000/mL saliva

CARIES ACTIVITY TESTS – CLASSIFICATION

■ MICROBIAL TEST

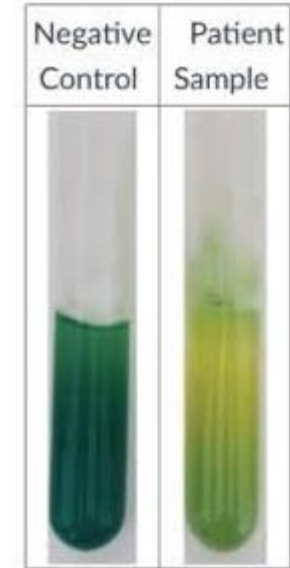
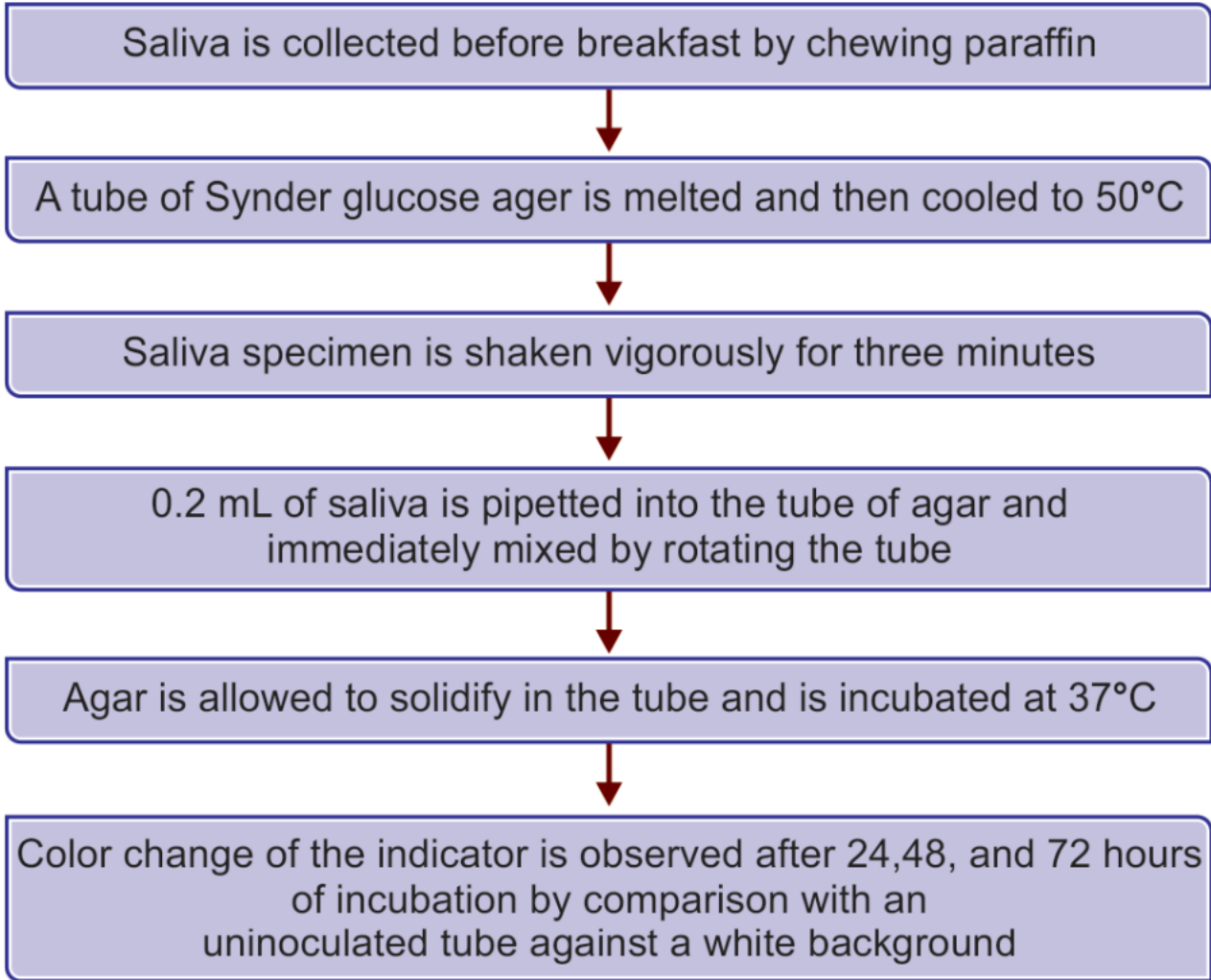
- a) S.Mutans screening test
- b) Lactobacillus count test
- c) Snyder test
- d) Alban test
- e) Dentocult
- f) Swab test
- g) Oricult test

■ TEST FOR EVALUATING SALIVARY DEFENSE

- a) Salivary reductase test
- b) Dentobuff test
- c) Salivary viscosity, flow rate
- d) Fosdick calcium dissolution
- e) Dewar test

CARIES ACTIVITY TESTS – SNYDER TEST

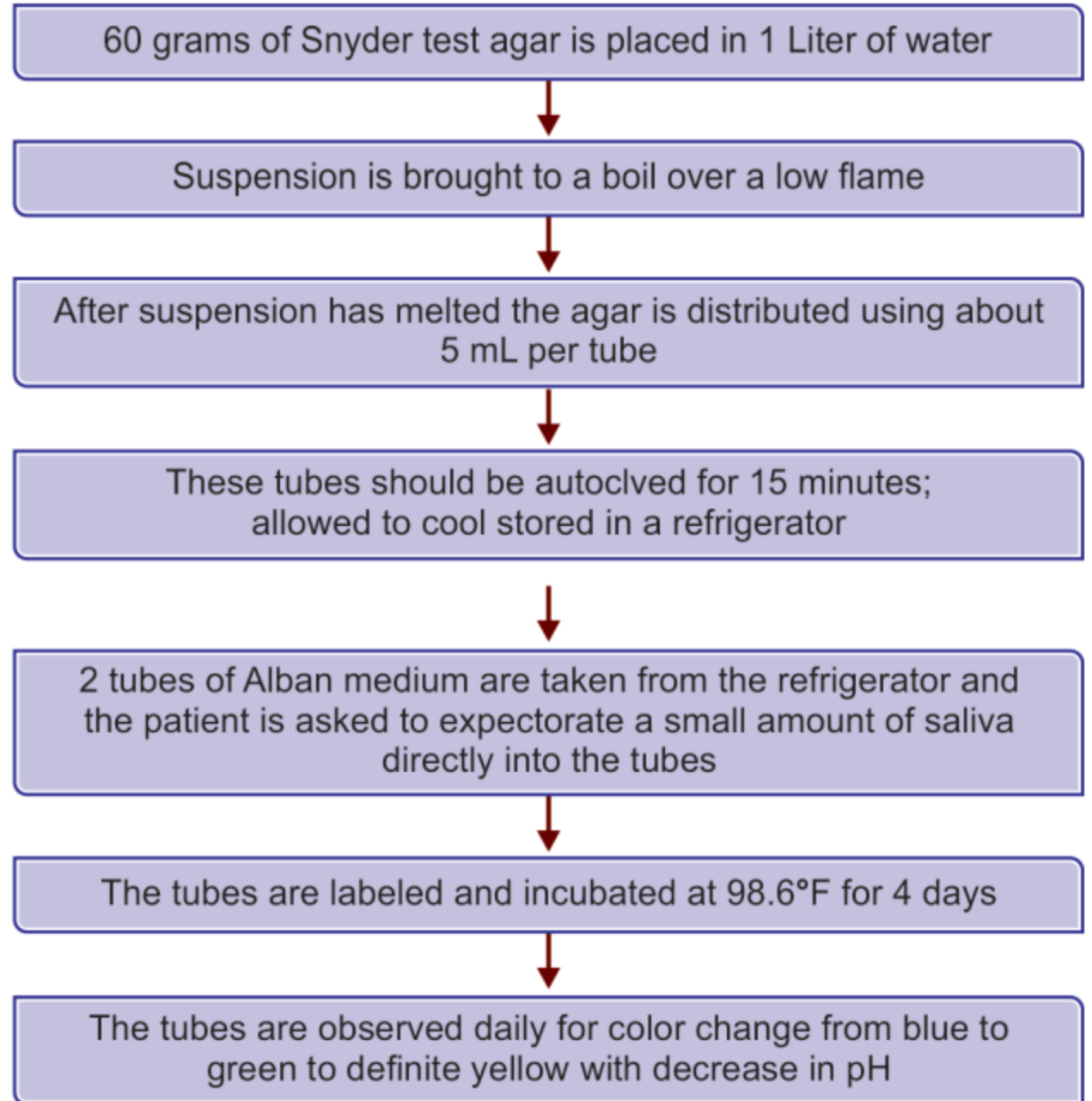
- It measures the ability of salivary microorganisms to form organic acids from carbohydrate medium.
- The Snyder test **measures the rapidity of acid formation** when a sample of stimulated saliva is inoculated into glucose agar adjusted to pH 4.7 to 5 and with bromcresol green as color indicator.
- The equipment includes saliva-collecting bottles, paraffin, a tube of Snyder glucose agar containing bromcresol green and adjusted to pH 4.7 to 5, pipettes, and incubating facilities.
- **Advantages** include simplicity of equipment and doing, only some training is needed and is cost effective.
- **High correlation** between the Snyder acid production test and the lactobacillus plate count.



<i>Results of Snyder test</i>			
	<i>24 hours</i>	<i>48 hours</i>	<i>72 hours</i>
Color	If yellow	If yellow	If yellow
Caries activity	Marked	Definite	Limited
Color	If green	If green	If green
Caries activity	Continue to incubate	Continue to incubate	Caries inactive

ALBAN TEST

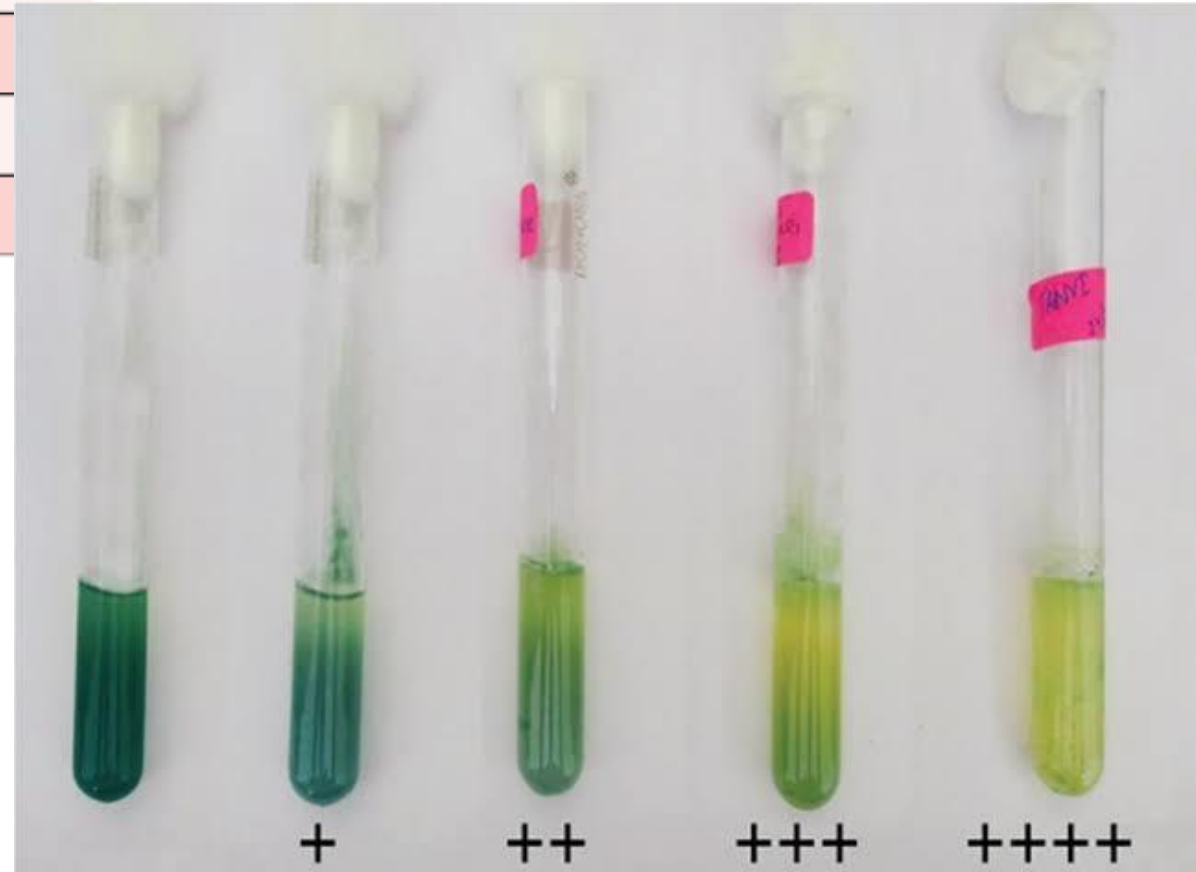
- It is a **simplified substitute** for the Snyder test.
- Its advantages are that it is simple, cost effective and can act as motivational tool for patient.
- **Color change from blue to yellow is indicative of caries activity**



Scoring is based on the depth in medium to which color has changed

Results of Alban test

<i>Color change</i>	<i>Score</i>
No color change	$\frac{3}{4}$
Beginning color change	+
One half color change	++
Three fourths color change	+++
Total color change to yellow	++++



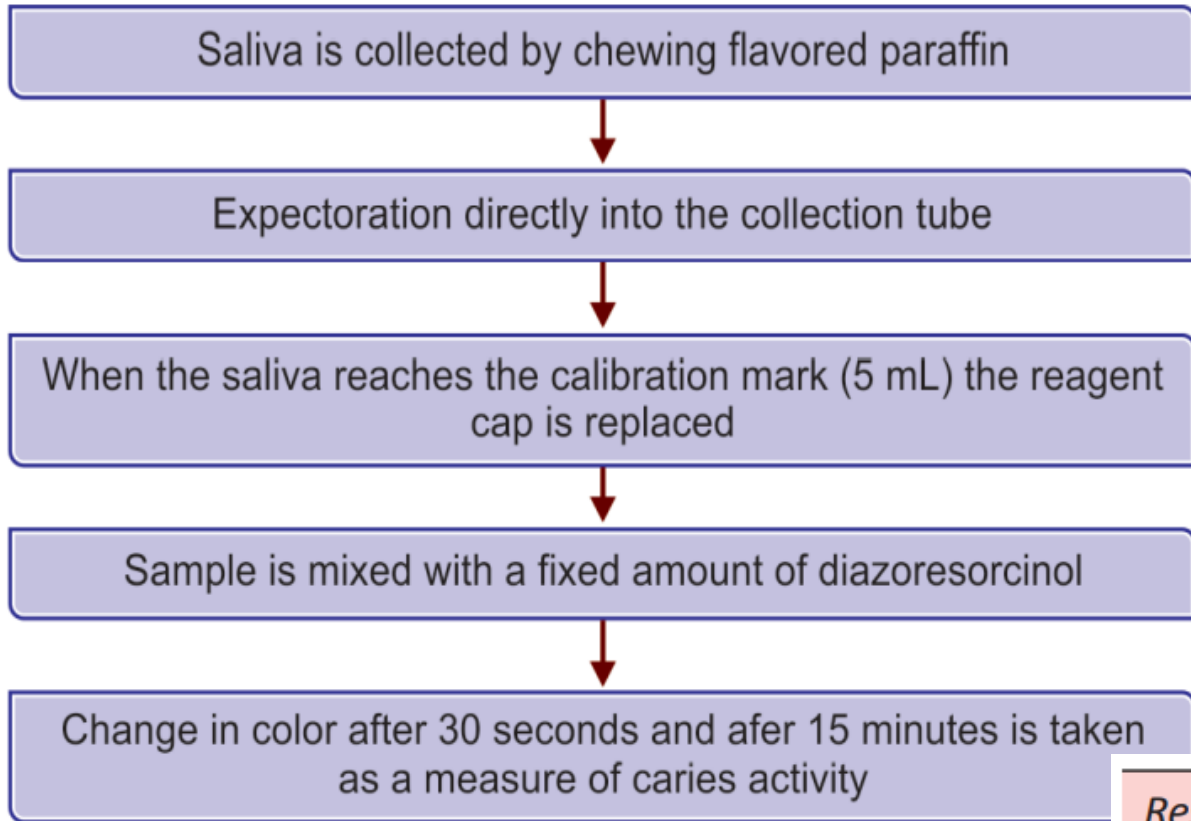
SWAB TEST

- This test was developed by Grainger et al. in 1965.
- This can be used in **young and uncooperative patients** as there is **no need for salivary collection**.
- The oral flora is sampled by **swabbing the buccal surfaces of the teeth** with a cotton applicator which is subsequently incubated for 48 hours.

<i>Result of swab test</i>	
<i>pH</i>	<i>Caries activity</i>
4.1	Marked caries activity
4.2–4.4	Active
4.5–4.6	Slightly active
Over 4.6	Caries inactive

REDUCTASE TEST

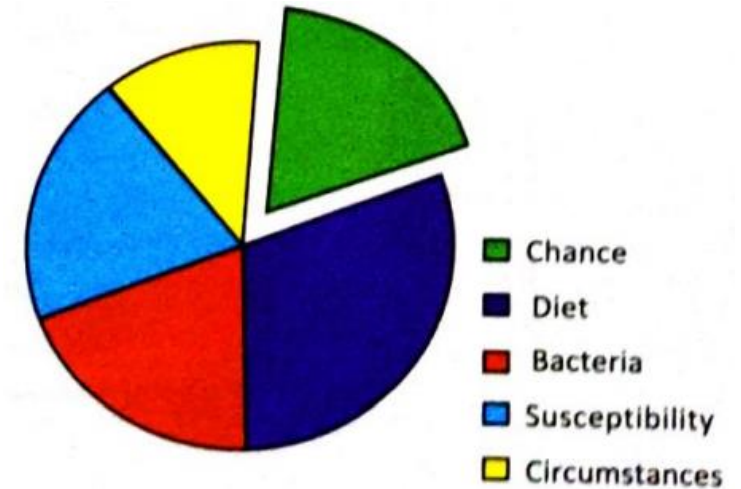
- This test measures the **ability of reductase enzyme** present in salivary bacteria.
- The test measures the rate at which an indicator molecule, diazo-resorcinol, changes from **blue to red to colorless on reduction by the mixed salivary flora**.
- The reductase test comes in a kit “Treatex (CW Erwin and Co.) which includes calibrated saliva collection tubes with the reagent on the inside of the tube’s cap, plus flavored paraffin.



<i>Results of Reductase test</i>			
<i>Color</i>	<i>Time</i>	<i>Score</i>	<i>Caries activity</i>
Blue	15 min	1	Non-conductive
Orchid	15 min	2	Slightly conductive
Red	15 min	3	Moderate conductive
Red	Immediate	4	Highly conductive
White	Immediate	5	Extremely conductive

CARIOGRAM

- Douglas Bratthal 1997
- computer-based caries risk assessment model called Cariogram
- presents a pie diagram where 'bacteria' appears as a red sector, 'diet' as a dark blue sector and 'susceptibility'- related factors as a light blue sector (fluoride program, saliva secretion and saliva buffer capacity). In addition, some 'circumstances' are presented as a yellow sector (caries experience and related diseases).
- The four sectors take their shares, and what multifactorial risk assessment is left appears as a green sector and represents the chance of avoiding caries.
- The bigger the green sector, the better from a dental health point of view; small green sector means low chance of avoiding caries = high caries risk.
- Cariogram shows if the patient over all is at high, intermediate or at low risk for caries. It also shows for every individual examined, which etiological factors are considered responsible for the caries risk. The results also indicate where targeted actions to improve the situation will have the best effect



CARIES RELATED FACTORS ACCORDING TO THE PROGRAM

CIRCUMSTANCES

Factor	Comment	Info/data needed
Caries experience	Past caries experience, including cavities, fillings and missing teeth due to caries. Several new cavities definitely appearing during preceding year should score '3' even if number of fillings is low.	DMFT, DMFS, new caries experience in the past one year.
Related general diseases	General disease or conditions associated with dental caries.	Medical history, medications.

DIET

Diet, contents	Estimation of the cariogenicity of the food, in particular fermentable carbohydrate content.	Diet history, (lactobacillus test count).
Diet, frequency	Estimation of number of meals and snacks per day, mean for a normal day.	Questionnaire results (24-h recall or 3 days dietary recall).
Plaque amount	Estimation of hygiene, for example according to Silness-Löe Plaque Index (PI). Crowded teeth leading to difficulties in removing plaque interproximally should be taken into account.	Plaque index.
Mutans streptococci	Estimation of levels of mutans streptococci (Streptococcus mutans, Streptococcus sobrinus) in saliva, for example using Strip mutans test.	Strip mutans test or other similar test.

BACTERIA

SUSCEPTIBILITY

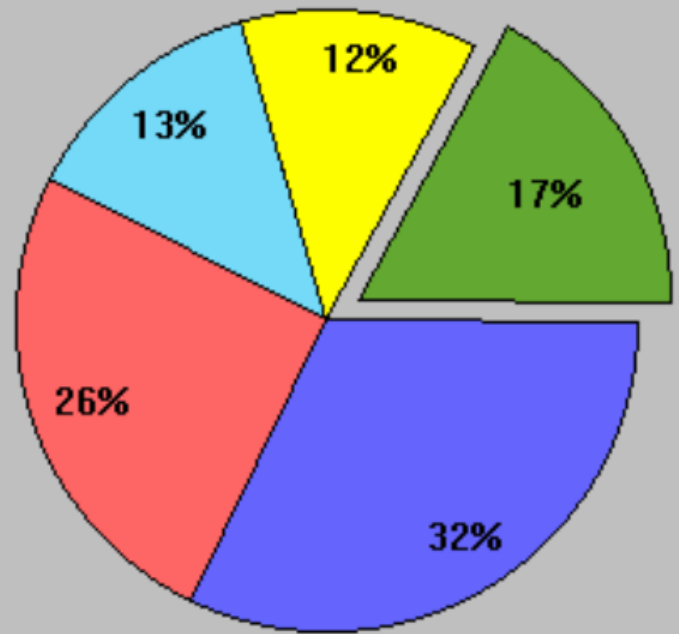
Fluoride programme	Estimation of as to what extent fluoride is available in the oral cavity over the coming period of time.	Fluoride exposure, interview the patient.
Saliva secretion	Estimation of amount of saliva, for example using paraffin-stimulated secretion and expressing results as ml saliva per minute.	Stimulated saliva test - secretion rate.
Saliva buffer capacity	Estimation of capacity of saliva to buffer acids, for example using the Dentobuff test.	Dentobuff test or other similar test.

Cariogram - Evaluation of the Caries Risk



Country/Area Group

Brown, Arnold, Mr
1947-02-19
Date
JS



- Actual chance to avoid new cavities
- Diet
- Bacteria
- Susceptibility
- Circumstances

- Caries experience 0-3
- Related diseases 0-2
- Diet, contents 0-3
- Diet, frequency 0-3
- Plaque amount 0-3
- Mutans streptococci 0-3
- Fluoride program 0-3
- Saliva secretion 0-3
- Buffer capacity 0-2
- Clin. judgement 0-3

MANAGEMENT

To Do	Low Risk	Moderate Risk	High Risk
Recall	Every 6-12 months	Every 6 months	Every 3 months
Fluoride	Twice daily brushing with FI paste (> 1000ppm) (age appropriate)	Twice daily brushing with FI paste (> 1450ppm) F mouth rinse F varnish – twice a year	Twice daily brushing with FI paste (> 1450ppm) F mouth rinse F varnish – every 3 months
Diet	If required - modify	Diet counselling	Diet counselling Sugar substitute
Restoration	Surveillance	Sealants Surveillance- incipient lesion	Restore with ITR/ definitive restoration

S.Mutans count, Periodic radiographs



CARIES DIAGNOSIS

DIAGNOSIS OF DENTAL CARIES

CONVENTIONAL

Visual

Eyes, Magnifying lens

Tactile

Probe, Dental floss, Mechanical separation

Dyes

Basic fuchsin Procion dyes

Illumination

UV illumination

Radiography(IOPAR)

Intraoral periapical Bitewing Xeroradiography

RECENT ADVANCES

Illumination (Fluorescence)

FOTI, DIFOTI, WFOTI, Fluorescence camera

Radiograph (Digital)

RVG, DSR, MRMI, TACT

Laser

DIAGNOdent, Midwest Caries ID, Dye enhanced laser fluorescence, D-Carie mini

Electric- ECM

Vanguard electronic caries detector, Caries meter, CarieScan Pro

Endoscopy

Endoscope, Videoscope

Ultrasonic

Ultrasound caries detector

Miscellaneous

Species specific monoclonal antibodies
Intraoral television camera
Infrared thermography

VISUAL INSPECTION

- Assessment of features such as **color and texture** are qualitative in nature. These assessments provide some information on the severity of the disease but fall short of true quantification.
- They are also **limited** in their detection threshold and their ability to **detect early, noncavitated lesions** restricted to enamel is poor.
- The clinical accuracy is only **25 to 50 percent**.
- **Magnifying loupes**

EKSTRAND CRITERIA

- The visual inspection can be performed using **air/water spray**.
- 0: **Slight or no change** in enamel translucency after prolonged air drying
- 1: **Opacity or discoloration hardly visible** on wet surface, but distinctly visible after air drying
- 1a: Opacity (brown) hardly visible on the wet surface, but distinctly visible after air drying (>5 s)
- 2: **Opacity or discoloration distinctly visible without air drying**
- 2a: Opacity (brown) distinctly visible without air drying
- 3: Localized **enamel breakdown** on opaque or discolored enamel and/or **grayish discoloration from underlying dentin**
- 4: **Cavitations** in opaque or discolored enamel exposing dentin








LUSSI CRITERIA

- 0: Caries free
- 1: Caries extending up to halfway through the enamel
- 2: Caries extending in the inner half of the enamel
- 3: Caries in the outer half of the dentin
- 4: Caries in the inner half of the dentin

INTERNATIONAL CARIES DETECTION AND ASSESSMENT SYSTEM (ICDAS)

- In 2003, the ICDAS-I was devised based on the principle that the visual examination should be carried out on **clean, plaque-free teeth, with carefully drying of the lesion/surface to identify early lesions.**
- ICDAS II - 2005
- ICDAS is a **two-digit identification system**. Initially, the **status of the surface** is described as unrestored, sealed, restored or crowned.
- After that, a second code is attributed to identify **six stages of caries extension**, varying from initial changes visible in enamel to frank cavitation in dentine

ICDAS II

Score 0	Score 1	Score 2	Score 3	Score 4	Score 5	Score 6
No visual signs of carious lesions or any enamel defect	First visible changes in the enamel. Visible only after drying with air. Changes in coloration confined to areas of pits	Change in visible enamel even in the presence of moisture. More extensive and not restricted to pits.	Destruction located in enamel without visible dentin, discontinuities of enamel surface	Dark shadow on the underlying dentin, with or without localized destruction of enamel	Clear cavity with visible dentin; cavity that involves less than half the dental surface	Extensive cavity evident in dentin; cavity deep and wide, involves more than half of the tooth
						

1st digit codes

Description

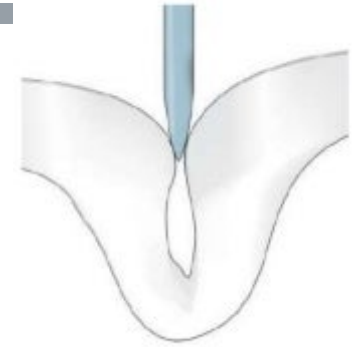
0	Sound
1	Sealant, partial
2	Sealant, full
3	Tooth colored restorations
4	Amalgam restoration
5	Stainless steel crown
6	Porcelain or gold or PFM crown or veneer
7	Lost or broken restoration
8	Temporary restoration
Special codes	Description
96	Tooth surface cannot be examined
97	Tooth missing because of caries
98	Tooth missing for other reasons
99	Unerupted

2nd digit codes

Description

0	Sound
1	First visual change in enamel
2	Distinct visual change in enamel
3	Localized enamel breakdown
4	Underlying dark shadow from dentin
5	Distinct cavity with visible dentin
6	Extensive distinct cavity with visible dentin

TACTILE EXAMINATION



- GV Black in 1924 suggested that the use of a sharp explorer, based on tug back action for diagnosis of dental caries.
 - ✓ Right angled probe- no.6
 - ✓ Back action probe- no.17
 - ✓ Shepherds crook- no. 23
 - ✓ Cowhorn with curved ends- no.2
- However, tactile examination of dental caries has been criticized because of the **possibility of transferring cariogenic microorganisms from one site to another**, leading to the fear of further spread of the disease in the same oral cavity.
- Moreover, use of an explorer can cause **irreversible damages to the iatrogenic and demineralized tooth structure**
- Because of this a **mirror and a blunt probe** visual examination is now advocated

DENTAL FLOSS

- When a string of unwaxed floss is moved on the carious proximal tooth surfaces there is resistance on withdrawal and the fibers appear torn



TOOTH SEPARATION

- Separating the tooth for visualizing the **posterior approximal surfaces**
- This method uses **orthodontic modules or bands** and **achieves slow separation**.
- Taking **impressions** of the approximal surfaces thus separated have been used to assist in the detection of cavitations.



(a)



(b)

UV ILLUMINATION



- Ultraviolet(UV)light has been used to increase the **optical contrast** between carious lesion and the surrounding soft tissue
- In area of less mineral content like **the carious lesion**, the **natural fluorescence of tooth enamel** as seen under UV illumination is **decreased**.
- **Under UV illumination carious lesion appears as a dark spot against fluorescent background**



CARIES DETECTOR DYES

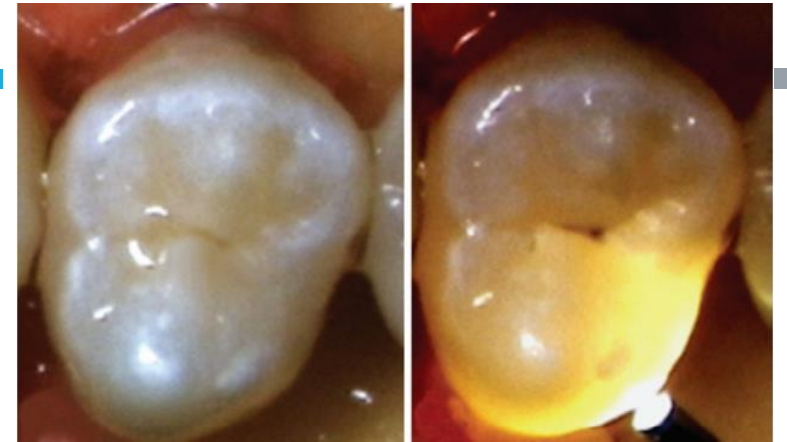
- The property of dyes to enhance contrast by their color can be used in clinical dentistry.
 - They are applied for about **10 seconds and rinsed off**.
 - Any deeply stained tooth structure should be removed, usually with slow speed burs or spoon excavators.
 - They should be reapplied after you remove all the stained dentin to confirm no residual caries remains in the tooth.
- **Following dyes are used to detect carious enamel specifically:**
 - 0.5 percent basic fuchsin
 - Procion dyes
 - 1 percent acid red in propylene
 - Methylene blue



CONVENTIONAL RADIOGRAPHS

- The accuracy of radiographs to diagnose dental caries is between **40 and 65 percent**.
- Though conventional radiographs like **bitewing and intraoral periapical radiograph** are most frequently used for the detection of caries, they may cause overlapping of teeth due to faulty angulations and may also miss the initial lesion.
- During the primary dentition, the occlusal surface is most susceptible to caries attack, but with the eruption of first permanent molars the incidence of proximal lesions greatly increases. In such situation bitewing radiographs are absolutely required to detect proximal lesions in primary molars.
- The limitations of radiographs are that it is not able to differentiate between an active and an arrested caries lesion, and also to distinguish a cavitated and a non-cavitated lesion

FIBEROPTIC TRANSILLUMINATION (FOTI)



- Fiberoptic transillumination, it is a practical method of imaging teeth in the presence of multiple scattering
- The illumination is delivered via light source to tooth surface. The light propagates from the fiber illumination across tooth tissue to nonilluminated surfaces. The resulting images of light distribution are then used for diagnosis.
- Carious area appears as darkened shadow that follows the decay
- The equipment includes a **150 w halogen lamp** and a **rheostat** to provide light of maximum intensity.
- A **mouth mirror** mounted on steel cuff and fiberoptic probe are placed in embrasure region below contact point to produce a narrow beam for transillumination.

No Shadow → High index of light transmission → **No Lesion**

Darkened shadow → low index of light transmission → **Carious lesion**

FIBEROPTIC TRANSILLUMINATION (FOTI)



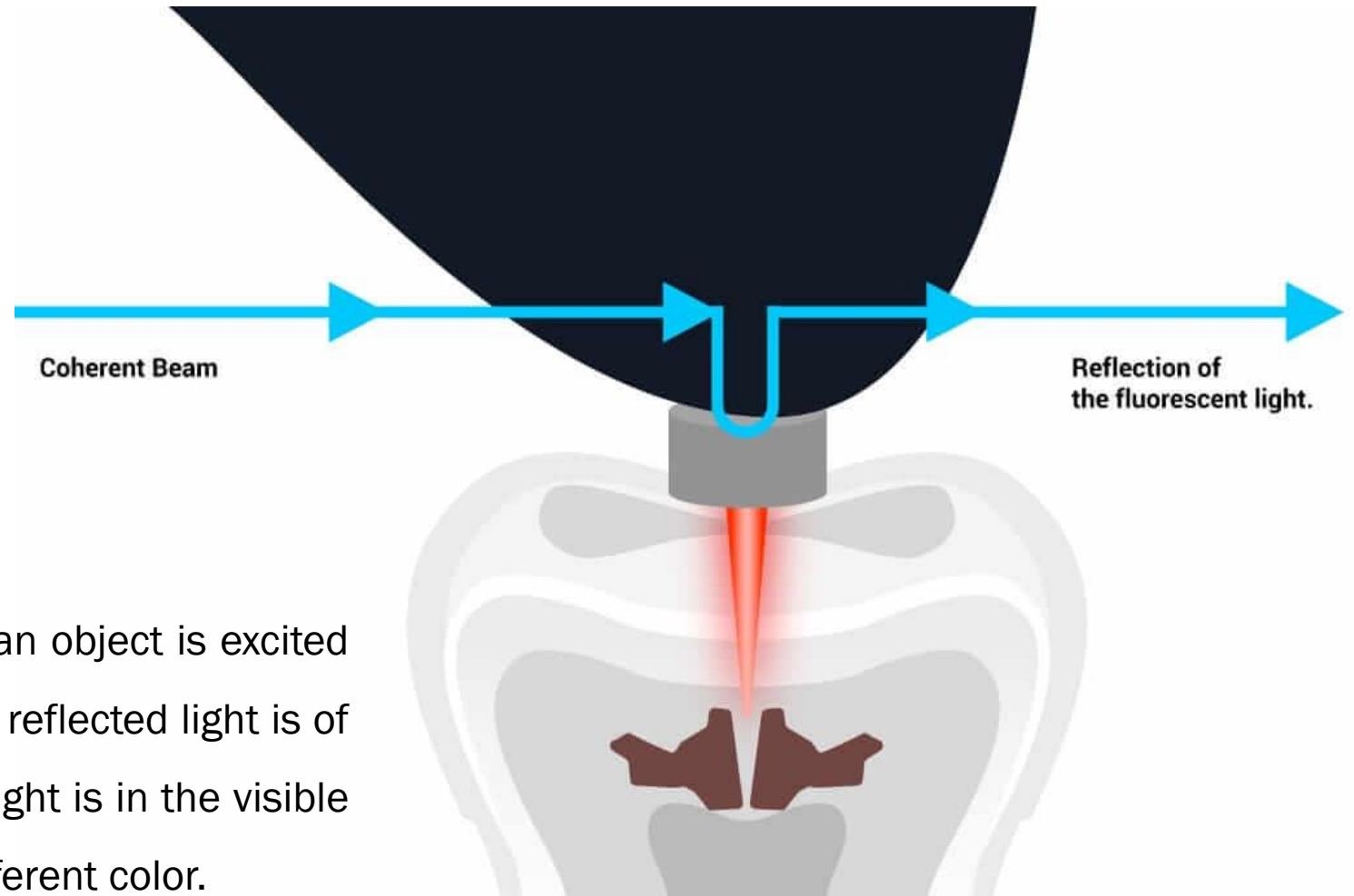
- Advantages are that it is simple noninvasive examination technique, no radiation hazards, can be used on all surfaces.
- Disadvantage is that the system is subjective rather than objective, as there is no continuous data outputted and it is not possible to record what is seen in the form of an image.
- Another modification is **wavelength-dependent fiber optic transillumination (WFOTI)** which is used for detection of early incipient and approximal carious lesion.

DIGITAL IMAGING FIBEROPTIC TRANSILLUMINATION (DIFOTI)

- This was suggested as a tool for caries assessment by Scheneiderman A et al. in 1997.
- This is a new method for detection of dental caries in which the images of teeth are obtained through visible light fiberoptic transillumination and digital CCD camera.
- These images are then sent to a computer for analysis with specific algorithms. These algorithms are developed to facilitate the location and diagnosis of the carious lesion and provide quantitative characterization for monitoring the lesions.
- Advantage is that it can indicate the presence of incipient and recurrent caries even when radiological images fail to show their presence.

Combination of FOTI & digital CCD

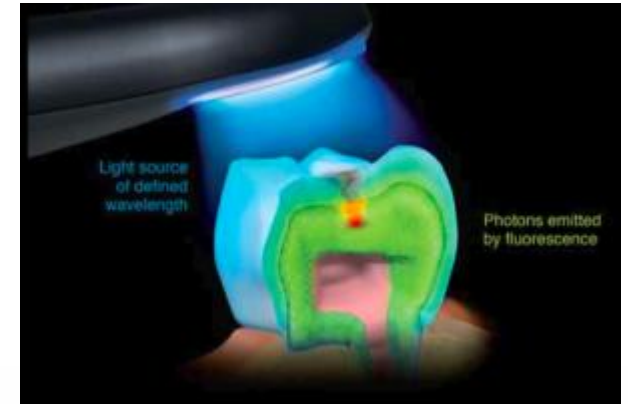
FLUORESCENCE



Fluorescence is a phenomenon by which an object is excited by a particular wavelength of light and the reflected light is of a larger wavelength. When the excitation light is in the visible spectrum, the fluorescence will be of a different color.

SOPROLIFE

- The blue LED emits light at 450 nm.
- This wavelength excites the dentin which, in reaction, reflects a light signal named fluorescence.
- The spectrum (color) of the fluorescence signal is green when the dentin is healthy and dark red, when the dentin is infected

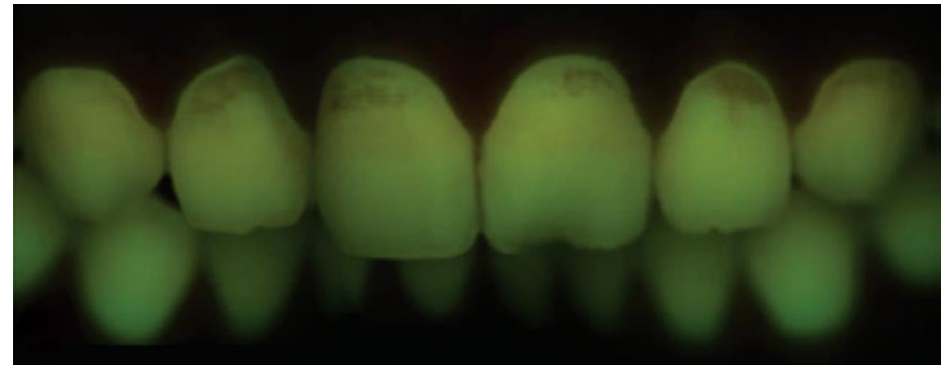


QUANTITATIVE LIGHT-INDUCED FLUORESCENCE (QLF)

- In the case of the quantitative light induced fluorescence (QLF) the visible light has a wavelength of **370 nm**, which is in the **blue** region of the spectrum. The resultant autofluorescence of human enamel is then detected using a band pass filter at > 540 nm by a small intraoral camera.
- This produces an image that is comprised of **only green and red channels** (the blue having been filtered out) and the predominant color of the enamel is green.
- **Demineralization of enamel results in a reduction of this auto-fluorescence.** This loss can be quantified using proprietary software and has been shown to correlate well with actual mineral loss.

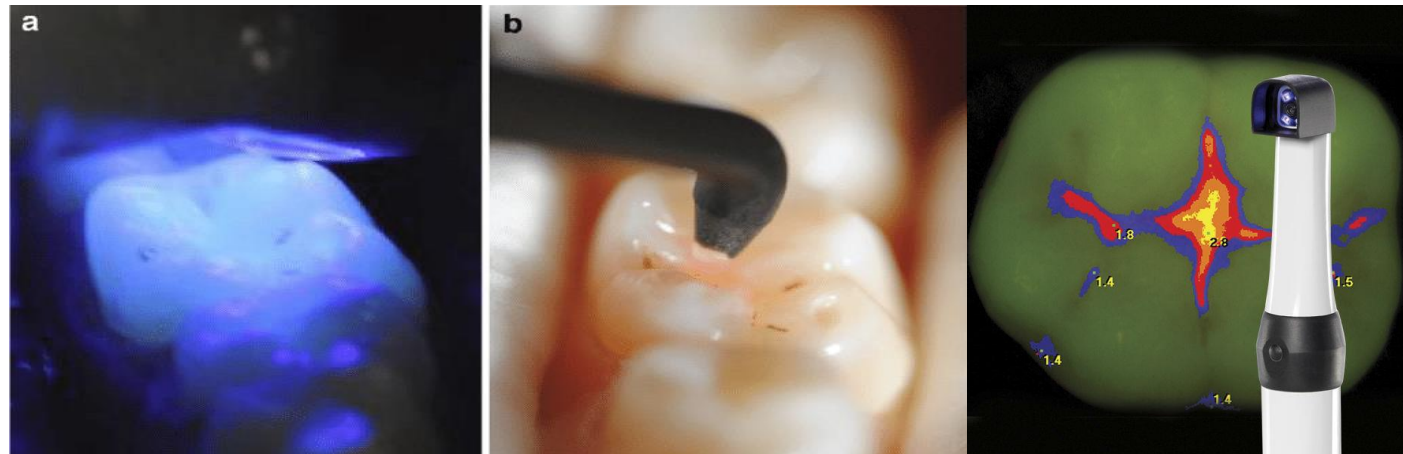


- The QLF equipment is comprised of a light box containing a **xenon bulb** and a handpiece, similar in appearance to an intraoral camera.
 - Live images are displayed via a computer and accompanying software enables patient's details to be entered and individual images of the teeth of interest to be captured and stored.
 - Once an image of a tooth has been captured, the next stage is to analyze any lesions and produce a quantitative assessment of the demineralization status of the tooth. This is undertaken using proprietary software and involves using a patch to define areas of sound enamel around the lesion of interest. Following this the software uses the pixel values of the sound enamel to reconstruct the surface of the tooth and then subtracts those pixels which are considered to be lesion.
- Advantages are high reproducibility, detection of small incipient lesions in enamel and dentin, image storage and transmission and can act as motivational tool for patient. • Disadvantage is that it is a isolation sensitive procedure.



FLUORESCENCE CAMERA (VISTA PROOF)

- This device is an intraoral camera which consists of **six blue LEDs** emitting a 405- nm light, **charge couple device (CCD) sensor** and **DBSWIN software** for analysis.
- With this camera it is possible to digitize the video signal from the dental surface during fluorescence emission using a CCD sensor. On these images,
- it is possible to see different areas of the dental surface that fluoresce in green (sound dental tissue) and in red (carious dental tissue)



ADVANCED RADIOGRAPH - RVG

Digital radiography is a filmless technique for intraoral radiography, utilizes very little of the radiation to which the patient has been exposed and avoid the need for developing films. This technique has offered the potential to increase the diagnostic yield of dental radiographs.

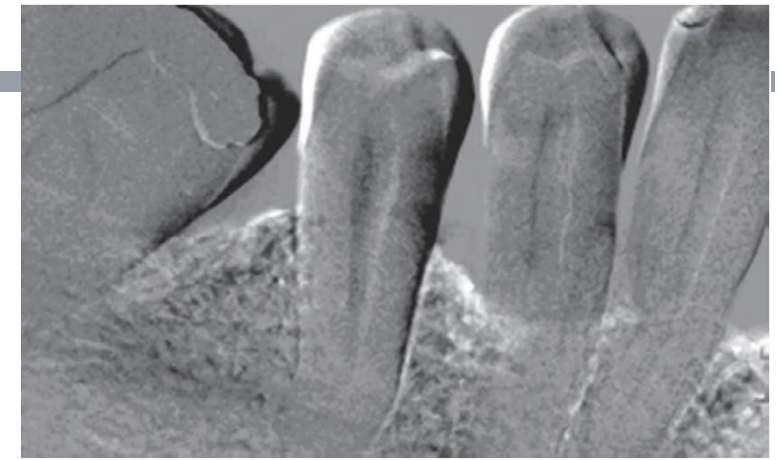
Advantages –

- ✓ The image is displayed immediately and no need of processing
- ✓ Reduction in radiation dose
- ✓ Digital manipulation of the image is possible to enhance the viewing
- ✓ It can be used as a visual aid to be shown to the patient on the computer screen

Disadvantages-

- ✓ The rigidity and thickness of sensor can cause discomfort to the patient
- ✓ The lifespan of sensor is unknown
- ✓ High initial system cost

DIGITAL SUBTRACTION RADIOGRAPH



- Digital subtraction radiography (DSR) is a more advanced image analysis tool which allows professionals to distinguish small differences between subsequent radiographs that otherwise would have remained unobserved because of overprojection of anatomical structures or differences in density that are too small to be recognized by the human eye.
- The procedure is based on the principle that two digital radiographic images obtained under different time intervals, with the same projection geometry, are spatially and densitometrically aligned using specific software.
- If the two digital images are identical, this method will produce an image without details (**the result is zero**). However, if caries has regressed or progressed in the mean time, the result will be different from zero.
- When there is **caries progression**, the outcome will be a value **above zero** (increase in pixel values).
- In case of caries **regression**, the result is opposite and the outcome will be a value **below zero** (decrease in pixel values) (Hekmatian et al. 2005).
- The major disadvantage of this technique is **very sensitive to any physical noise** occurring between the radiographs and even minor changes leads to large errors in the results.

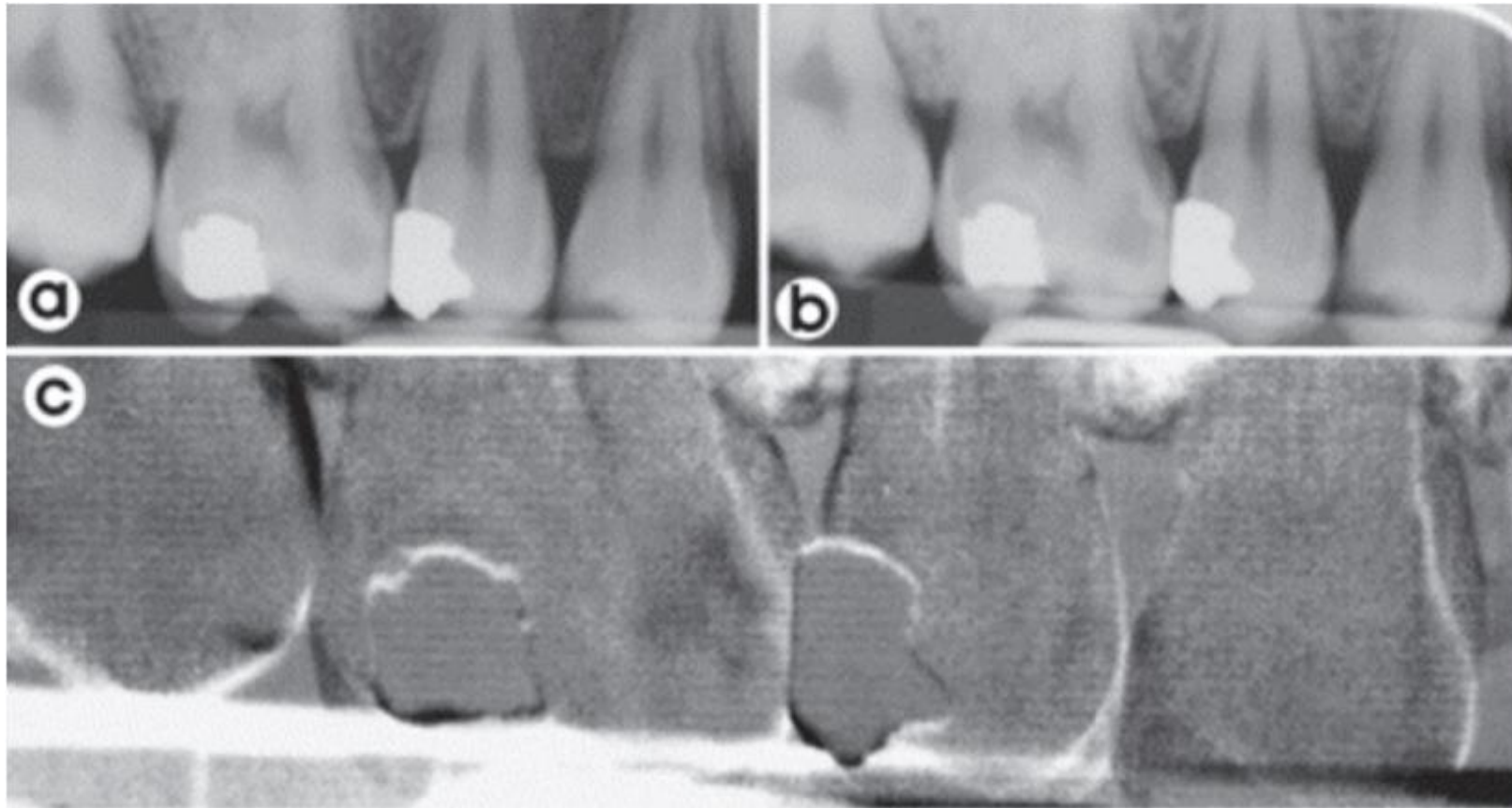
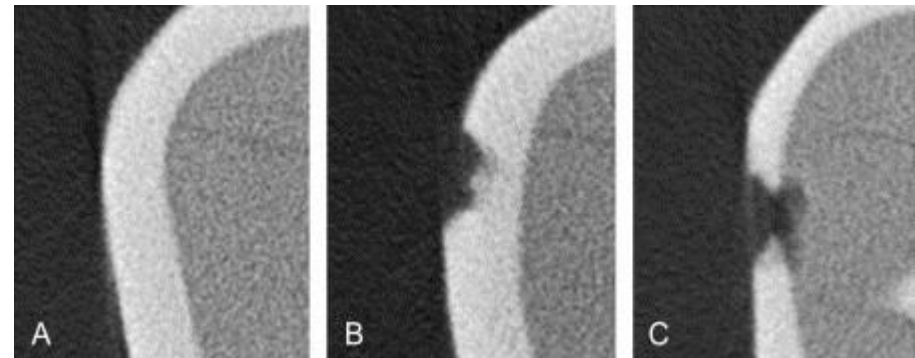


Fig 3: Example of a subtraction of two digital bitewing radiographs. (a) Radiograph showing proximal lesion on mesial surface of first molar, (b) follow up radiograph taken 12 months later, (c) the areas of difference between the two films are shown as black, i.e. in this case the proximal lesion has become more radiolucent and hence has progressed.

ADVANCED RADIOGRAPHIC TECHNIQUES

- Magnetic resonance microimaging (MRMI)
- Photo stimulable phosphor radiography
- Tuned aperture computed tomography (TACT)- is a new imaging device which enhances the image by **decreasing the superimposition of anatomical structures**. It uses digital radiographic images and its software correlates these images into layers so that sliced sections can be viewed. A series of eight radiographs can be assimilated into one TACT image.

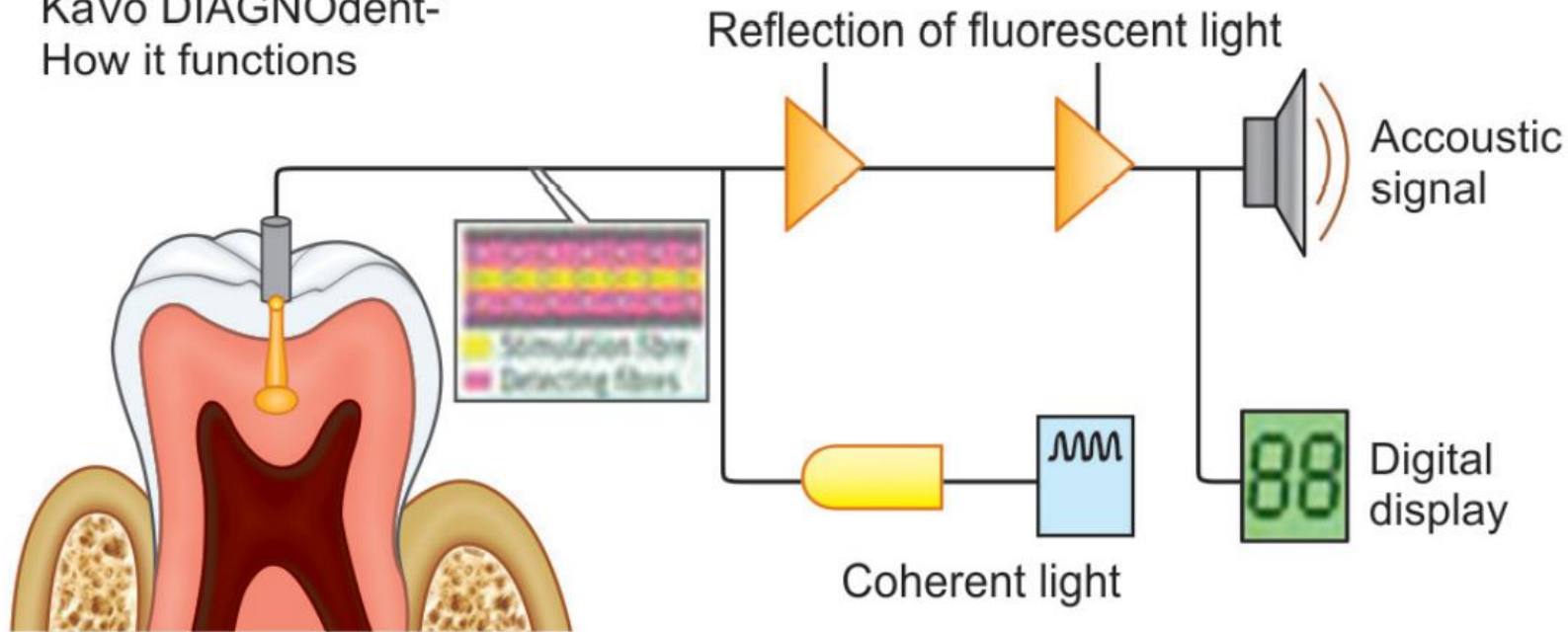


LASER FLUORESCENCE (DIAGNODENT)



- The DIAGNOdent (DD) instrument (KaVo, Germany) is another device employing fluorescence to detect the presence of caries.
- Using a small laser the system produces an excitation wavelength of **655 nm which produces a red light**. This is carried to one **of two intraoral tips**; one designed for pits and fissures, and the other for smooth surfaces.
- The tip both emits the excitation light and collects the resultant fluorescence. This is then displayed as a numerical value on two LED displays. The signal comes out as a number on instrument on a scale of **0 to 99**. **Higher the number more is caries**.
- Principle of DIAGNOdent is based on the fact that the **caries induced changes in teeth lead to increased fluorescence at specific excitation wavelength**.
 - Advantages are **early detection of lesion, quantification of caries and improved diagnostic accuracy**.
 - Disadvantages are that it **cannot detect secondary caries and proximal caries** accurately.

KaVo DIAGNOdent- How it functions



Caries interpretation based on the criteria put forward
by the manufacturer (KaVo, 2001)

<i>Caries level</i>	<i>Interpretation</i>
Sound (D0)	0-9
Enamel caries (D1-D2)	10-17
Dentin caries (D3)	18-99

DIAGNOdent PEN

Hand-held laser caries detection aid that provides the same high detection accuracy as DIAGNOdent.



MIDWEST CARIES ID (LED TECHNOLOGY)

- This technology utilizes a handheld device which emits a soft light emitting diode (LED) between **635 nm and 880 nm** and analyzes the reflectance and refraction of the emitted light from the tooth surface, which is captured by fiberoptics and is converted to electrical signals for analysis.
- The demineralization leads to a change in the LED from **green to red with a simultaneous audible signal**, which is directly related to the severity of caries lesions.
- Advantage is that sensitivity and specificity is higher than that of DIAGNOdent.
- Disadvantage is that Midwest Caries ID is not able to differentiate enamel lesions from sound surfaces



D-CARIE MINI



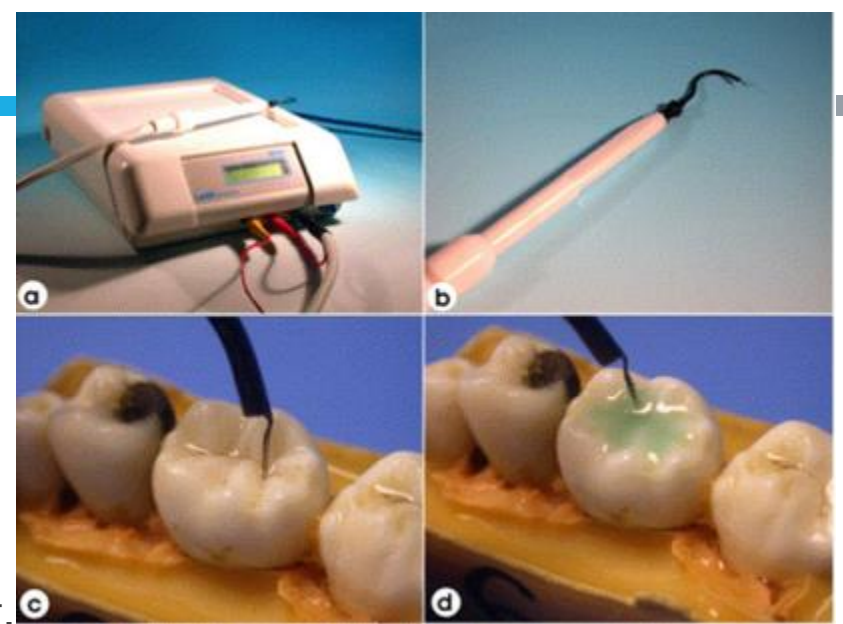
- This is a new device introduced by Neks technology in October 2006 at ADA annual session in Las Vegas.
- This was initially developed in Canada.
- This is **pen-sized, light weight, cordless, fully sterilizable** unit that uses laser fluorescence to detect occlusal lesions.
- The D-Carie mini has been shown to detect **more than 92 percent of occlusal caries and over 80 percent of interproximal caries.**
- Approved by FDA in 2007.



ADVANCED DYE DETECTION TECHNIQUES

- Confocal laser scanning microscopy (CLSM)
- Dye-enhanced laser fluorescence (DELFL)

ELECTRICAL CONDUCTANCE MEASUREMENT



- The idea of electrical method for caries detection was proposed by Magitot.
- It is based on the principle that **sound tooth surfaces possess limited conductivity whereas demineralized or carious enamel act as conductive pathway**. Based on the differences in the electrical conductance of carious and sound enamel, two instruments were developed and tested in 1980,
- **Vanguard electronic caries detector**
 - i. Resistance measurements are made between a hand-held connector and probe tip placed in fissure of teeth and superficial saliva is removed to prevent surface conduction.
 - ii. Machine gives a reading on scale of 0 to 9 which is directly proportional to degree of demineralization.

- Caries meter

- i. Teeth are **dried and isolated** before starting the treatment. **Tooth fissure is moistened with a drop of saliva** to ensure good electrical conductance. The resistance measurement is made between probe tip and clip attached to oral electrode and colored lights reflect the status of tooth.
- ii. Advantage is that it is small, handy and provides accurate diagnosis.
- iii. Disadvantages are that area of diagnosis is confined to dimension of probe, it is **technique sensitive and the status of lesion is not known like arrested or active.**



<i>Values of caries meter</i>			
<i>Light</i>	<i>Electric impedance value (K)</i>	<i>Status of tooth</i>	<i>Recommended treatment</i>
Green	Above 600 K	No caries	No treatment
Yellow	250–600 K	Enamel caries	Observe
Orange	15–250 K	Dentinal caries	Need for restoration
Red	Below 15 K	Pulpal involvement	Pulpal treatment

CARIESCAN PRO (ALTERNATING CURRENT IMPEDANCE SPECTROSCOPY)

- It involves the passing of an **insensitive level of electrical current** through the tooth to identify the presence and location of the decay.
- The device is indicated for the **detection, diagnosis, and monitoring of primary coronal dental caries (occlusal and accessible smooth surfaces)**, which are not clearly visible to the human eye.
- This device uses **disposable tufted sensors for single use and a test sensor** (non-disposable), which is used to check if the device is operating correctly.
- For assessment of caries, while tufted sensor brush contacts the tooth surface being examined, a soft tissue contact, which is a disposable metal clip that is placed over the lip in the corner of the patient's mouth, connects to the CarieScan via a soft tissue cable to complete the circuit.
- During measurement, a **green color display indicates sound tooth tissue**, **while a red color indicates deep caries requiring operative**, and **a yellow color associated with a range of numerical figures from 1 to 99 depicts varying severity caries, which require only preventive care.**
- Superior sensitivity and specificity (92.5%)
- Disadvantage is that it cannot be used to **assess secondary caries, the integrity of a restoration, dental root caries, and the depth of an excavation within a cavity preparation.**



ULTRASOUND CARIES DETECTOR



- This is a new ultrasonic proximal caries detector that works by **transmitting surface ultrasonic waves.** (sound)
- The ultrasound caries detector (UCD) device is based on pulse echo method and has software, hardware and transducer as components.
- A **medical grade silicon wedge** is positioned in front of probe to yield surface waves on the tooth surface when the transducer comes in contact with the tooth.
- This detector records specific profiles of ultrasonic echoes obtained from the enamel surface, dentino-enamel junction and pulpo-dentinal junction. Changes in this profile have been described in demineralized lesions, suggesting a substantial difference in the sonic conductivity between sound and demineralized enamel.
- **UCD reduced patient exposure to ionizing radiation and improved caries detection;**

INTRAORAL TELEVISION CAMERA



- Through intraoral television camera (IOTV) the dentist can educate the patient and at the same time can also improve their own diagnostic expertise as they see magnified oral conditions, which are significantly better than direct vision.
- Certain advantages such as increased vision, improved posture, and patient positioning, and increased magnification helps in diagnosis. • Disadvantage is loss of specificity



SPECIES SPECIFIC MONOCLONAL ANTIBODIES

- This was given by Shi et al. in 1998, who identified specific monoclonal antibodies that recognize the surface of cariogenic bacteria.
- The probes are tagged with fluorescent molecules that measure quantitatively with spectrometer.
- They can be used at chair side by dentist and provide instant results.



INFRARED THERMOGRAPHY

- Thermal radiation energy travels in the form of waves.
- It is possible to measure changes in thermal energy when fluid is lost from a lesion by evaporation.
- The thermal energy emitted by sound tooth structure is compared with that emitted by carious tooth structure.
- Has been proposed as a method of determining lesion activity rather than a method of determining the presence or absence of a lesion.

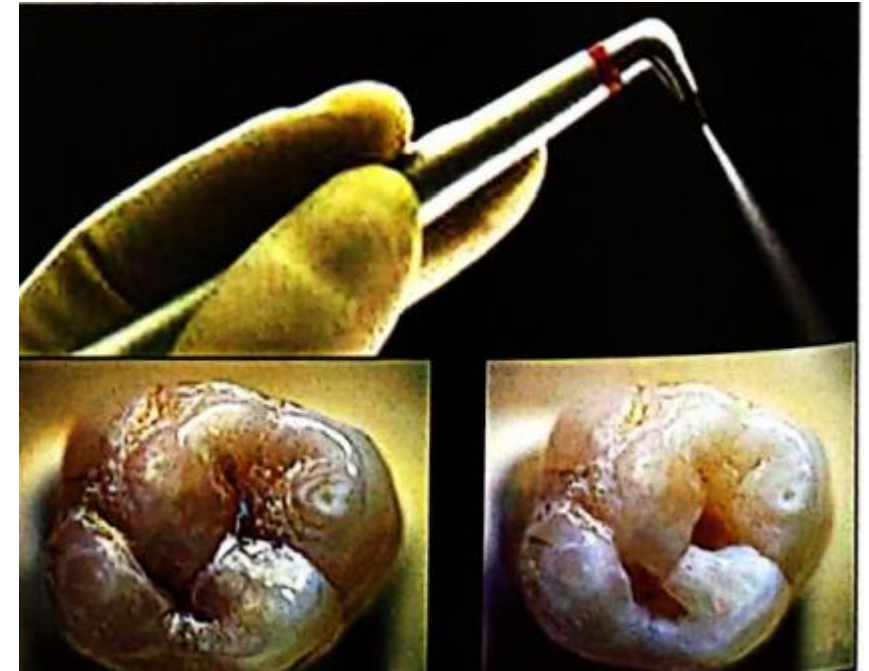
VIDEOSCOPE

- The integration of the camera and endoscope is called a videoscope.
- This is designed in such a way that the image of the surface of enamel can be viewed directly over a television screen.
- The videotapes are viewed by expert independent examiners who had also examined the teeth visually and by conventional methods.
- It has certain advantages like providing a magnified image and being clinically feasible. However, it requires meticulous drying and isolation of teeth and is time consuming and very costly thus making it for limited use only.

MICRO ABRASION



- Uses a narrowly focused particle stream that abrades tooth structure – particle size, air pressure, nozzle distance
- To diagnose pit and fissure caries – esp darkened areas in pits n grooves
- Short bursts of alumina powder
- Stain/ organic plug – eliminate them leaving healthy tooth structure intact
- Underlying decay exposed



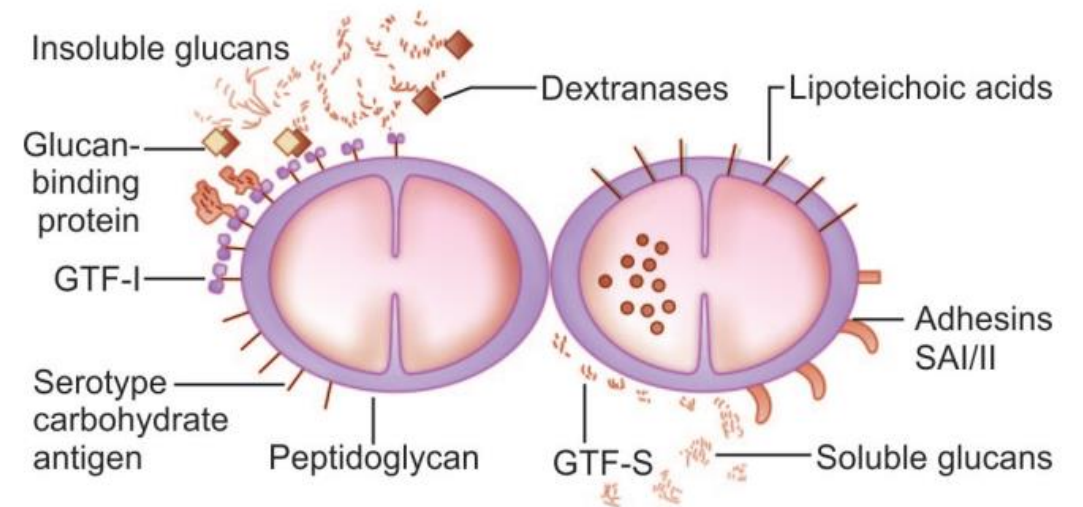


CARIES VACCINE

- A vaccine is defined as ‘a suspension of attenuated or killed microorganisms administered for the prevention, amelioration or treatment of infectious diseases’.
- an anticipated scientific breakthrough since 1940s
- Initially the etiological agents were thought to be lactobacilli.
- Targeted on Mutans streptococci colonization in oral cavity

CARIES VACCINE

- Prevent the occurrence of caries on large scale
- Initiate secondary immune response (Memory T and B lymphocytes)
- Induce IgA, IgG
- Effective Molecular Target:
 - Adhesins: Antigen I/II, Pac, P1.
 - Glucosyl transferases (GTF): gtfB, gtfC, gtfD, gtfI, gtfS
 - Glucan binding proteins: GbpA, GbpB, GbpC .



ROUTE OF ADMINISTRATION

1. Common mucosal route – Oral(capsules), intranasal, tonsillar (palatine, nasopharyngeal tonsils), minor salivary gland (lips, cheeks, and soft palate),rectal
2. Systemic (subcutaneous)
3. Active gingivo-salivary [GCF] – lysozyme, live S.mutans, low mol weight
4. Passive dental immunization- cow's milk, chicken egg IgY // mouthwashes and dentifrices//

Proposed for Infants, young mothers

Not successful yet, discussion over 30 years

Use of fluoride in its many forms, use of sugarless products and sealants, and increased access to dental care