VIRULENCE SCHEME OVERVIEW

ADHESION

Sucrose → Stronger ADHESION; Greater Accumulation

ACIDOGENICITY

Greater Acid Production

Bacterial factors that promote biofilm development

ACIDURICITY

Selection for *S. mutans* and other acidogenic, aciduric species

CARIES
ACQUISITION AND COLONIZATION of \textit{S. mutans}

-Sucrose-independent adhesion of \textit{S. mutans} is thought to be to salivary proteins that are part of the acquired enamel pellicle. However, this mechanism is not as efficient as it is for primary plaque colonizers. Consequently, \textit{S. mutans} is usually not represented in high proportions based on sucrose-independent adhesion.

-Sucrose-independent adhesion is mediated by AgI/II (also called SpaP, P1, PAc, AgB, IF, SR).

Figure from Kolenbrander et al. in Microbiol. Mol. Biol. Rev. 66: 486, 2002.
Main basis for sucrose-dependent adhesion is glucan synthesis catalyzed by glucosyltransferases.

GTFs can be associated with the surface of the bacterium or free in the plaque.
SUCROSE-DEPENDENT ADHESION

Variations on a theme:

1. *S. mutans* adheres to the acquired enamel pellicle (yellow) via sucrose-independent attachment.

2. When sucrose becomes available there is synthesis of glucans (red) that coat *S. mutans* and enhance adherence and accumulation.

1. In the presence of sucrose, *S. mutans* synthesizes glucans that aid in adhesion and accumulation.

1. In the presence of sucrose GTFs adhered to the pellicle synthesize glucan that aids in the adherence and attachment of *S. mutans*. 
S. mutans possess 3 GTFs:
- *gtfB* encodes a GTF-I
- *gtfC* encodes a GTF-SI
- *gtfD* encodes a GTF-S

S. sobrinus possesses 4 GTFs:
- *gtfI* encodes a GTF-I
- *gtfS* encodes GTF-S1
- *gtfT* encodes GTF-S2
- *gtfU* encodes GTF-S3

Water-soluble glucan is primarily alpha-1,6-linked with fewer branch points than water-insoluble glucan. Commercial preparations of linear alpha-1,6-linked dextran are used experimentally to simulate water-soluble glucan.

Water-insoluble glucan is primarily alpha-1,3-linked with more branching. It is also called *mutan.*
SUCROSE-RELATED FUNCTIONS

Glucan-binding Proteins

Gbpa: An extracellular protein. Three-quarters of the protein is composed of a series of amino acid repeats that comprise the glucan-binding domain. Provides structural support for biofilm development.

Gbpb: A peptidoglycan hydrolase that is necessary for proper cell wall synthesis and separation of daughter bacteria.

Gbpc: A cell wall-anchored protein that can act as glucan receptor. Responsible for dextran-dependent aggregation.

Gbpd: Like Gbpa, Gbpd is an extracellular Gbp with a similar glucan-binding domain. It provides structural support and cohesiveness for proper biofilm development. Also possesses lipase activity.

These are the S. mutans Gbps. Used to be thought they were confined to mutans streptococci but that may not be so.
Proportions of these organisms in normal plaque

- Caries free children: 0-1% of total cultivable flora
- Caries active children: 40-80% of total cultivable flora

Achieving dominant status: disruption of microbial communities
“Low pH” non-mutans streptococci

- Caries even with very low levels of mutans streptococci & lactobacilli?
- Cariogenic plaque: high levels of these organisms
- Role in caries development:
  - True initiation of lesions?
  - Synergistic interactions?
The in vivo plaque pH response

- Plaque pH response to sugar pulse (Stephan curve):
  - initial, rapid decrease from “resting” pH
  - establishment of a “minimum” pH
  - maintenance of minimum pH - variable period of time
  - slow increase back to resting pH
Higher proportions of acid tolerant bacteria

More frequent plaque acidification

More frequent carbohydrate consumption

Sequence of Events: Cariogenic Plaque
Cariogenic Potential of Plaque

Sequence of Events: Cariogenic Plaque

- Plaque acidogenesis at acidic pH increased
- Lowering of potential pH minimum in plaque
- Probability of net mineral loss over time increased