Objectives
1. Define probiotic and prebiotics
2. Discuss clinical situations in which prebiotics and probiotics are found to be useful based on evidence.

Table 1: Probiotic Criteria
- Strain identification
- Human origin
- Live microorganism
- Viable
- Safe for human consumption
- Survive proximal GI tract
- Reach distal intestine and colon
- Function/adhere to gut epithelial tissue
- Colonize distal gut impacting microbiome composition
- Scientifically proven health benefits

Table 2: Probiotic Proposed Mechanisms of Action
Colonization resistance
- Competitive exclusion

Intestinal barrier function maintenance
- Maintain tight junctions (ZO-1, claudin1)
- Reduce macromolecular permeability and bacterial translocation

Enhance gut microbiome pattern
- Enhance ratio of commensal bacteria

Modulation of inflammatory and immunoregulatory signaling
- NF-κB
- IL-10
- Toll-like receptor(s)

Innate/Adaptive immune modulation
- Increase mucin regulatory genes and mucin production
- Defensin production
- Engagement with dendritic cells
- IgA, IgG, IgM production

Metabolic effects
- Nutrient metabolism
- Bacteriocins
- Decrease luminal pH
- Quorum sensing

### Table 3: Some Commercially Available Probiotics

<table>
<thead>
<tr>
<th>Strain</th>
<th>Initial Product</th>
<th>Supplier</th>
<th>Year Introduced</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>L. casei</em> strain Shirota</td>
<td>Yakult</td>
<td>Yakult</td>
<td>1935</td>
</tr>
<tr>
<td><em>S. thermophilus</em></td>
<td>Yogurt</td>
<td>Stoneyfield</td>
<td>1973</td>
</tr>
<tr>
<td><em>L. bulgaricus</em></td>
<td>Yogurt</td>
<td>Stoneyfield</td>
<td>1973</td>
</tr>
<tr>
<td><em>L. acidophilus</em></td>
<td>Yogurt</td>
<td>Stoneyfield</td>
<td>1973</td>
</tr>
<tr>
<td><em>Bifidus</em></td>
<td>Yogurt</td>
<td>Stoneyfield</td>
<td>1973</td>
</tr>
<tr>
<td><em>B. longum</em> BBS36</td>
<td>Bifidus Milk</td>
<td>Moringa Milk Products</td>
<td>1977</td>
</tr>
<tr>
<td><em>B. breve</em> strain Yakult</td>
<td>Mil-Mil (Bifiene)</td>
<td>Yakult</td>
<td>1978</td>
</tr>
<tr>
<td><em>B. lactis</em> BB-12</td>
<td>Yogurt</td>
<td>Chr. Hansen</td>
<td>1988</td>
</tr>
<tr>
<td><em>L. rhamnosus</em> GG</td>
<td>Gefilus</td>
<td>Valio</td>
<td>1990</td>
</tr>
<tr>
<td><em>L. casei</em> DN-114-001 (L. casei Immunitas)</td>
<td>Actimel (DanActive)</td>
<td>Danone</td>
<td>1994</td>
</tr>
<tr>
<td><em>L. johnsonii</em> La-1</td>
<td>LC1</td>
<td>Nestle</td>
<td>1994</td>
</tr>
<tr>
<td><em>L. plantarum</em> 299v</td>
<td>ProViva</td>
<td>Probi</td>
<td>1994</td>
</tr>
<tr>
<td><em>B. animalis</em> DN-173-010 (Bifidus regularis)</td>
<td>BIO (Activia)</td>
<td>Danone</td>
<td>1995</td>
</tr>
<tr>
<td><em>L. gasseri</em> LG21</td>
<td>LG21</td>
<td>Meiji Milk Products</td>
<td>2000</td>
</tr>
<tr>
<td><em>B. lactis</em> HN-019</td>
<td>Supplement</td>
<td>Danisco</td>
<td>2001</td>
</tr>
<tr>
<td><em>L. casei</em> KW2110</td>
<td>Yogurt</td>
<td>Kirin Holdings</td>
<td>2003</td>
</tr>
<tr>
<td><em>L. casei</em> F19</td>
<td>Cultura</td>
<td>Arla Foods</td>
<td>2004</td>
</tr>
<tr>
<td><em>E. Coli Nissle 1917</em></td>
<td>Mutaflor</td>
<td>Medical Futures</td>
<td>2004</td>
</tr>
<tr>
<td>L casei, L. plantarum, L. acidophilus, L. delbrueckii subsp. bulgaricus, B. longum, B. breve, B. infantis, S. salivarius subsp. thermophilus</td>
<td>VSL#3</td>
<td>Sigma-Tau Pharmaceuticals</td>
<td></td>
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<tr>
<td>ifidobacterium infantis 35624</td>
<td>Align</td>
<td>Proctor &amp; Gamble</td>
<td></td>
</tr>
</tbody>
</table>

Note: Google search: 12,40,000 hits

### Table 4: Prebiotic Characteristics (104)

| Three Necessary Criteria of Ingredient | 1. Must be resistant to gastric acidity, to hydrolysis by mammalian enzymes, and to gastrointestinal absorption  
2. Must be fermented in the GI tract by gut microbiota  
3. Must be selective in the stimulation of the gut microbiota growth and/or activity that contribute to health and well-being |  
Not available to all bacterial species in gut microbiome | Lactobacilli and Bifidobacteria considered indicator organisms |
| Simple, naturally occurring or synthetic sugars |  
- Inulin (chicory, leeks, onion, garlic, artichoke, asparagus: DP 10-60)  
- Inulin-type fructans (oligofructose or FOS): $D_{\text{max}}<10$  
  • via partial hydrolysis of inulin or synthetically from monomers  
- Trans-galactooligosaccharides (GOS)  
  • Enzymatic synthesis based on lactose |
- Lactulose

**Other Resources:**

International Scientific Association for Prebiotics and Probiotics
[http://www.isapp.net/](http://www.isapp.net/)
