THE MICROBIOME

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Bioscience in the 21st Century
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LEARNING OBJECTIVES

• Define the microbiome

• Discuss the diversity in the human microbiome

• Explain the effect of antibiotics on the microbiome

• Describe the relation of the microbiome to autoimmune diseases like Crohn’s Disease
The Human Microbiome

- All the microbes that live in/on us
- Thousands of different species
- Various roles:
  - Keep away pathogens
  - Needed for oral health
  - Helping to extract energy/nutrients from food
Initial Microbial Community Established From Mother to Child

adapted from Gonzalez et al. 2011, EMBO reports
Baby’s Microbial Communities Similar To Mother’s For Several Years

Infant early colonizer microbe: Bifidobacterium infantis
Microbial Dysbiosis
Microbial Dysbiosis

Introduction of pathogens and/or disease leads to dysbiosis and inflammation.
Pattern of Gut Microbiome Dysbiosis Observed In Autoimmune Disease

• Autoimmune diseases
  – e.g. lupus, celiac disease, Type I diabetes, Crohn’s disease

• Underlying cause of most poorly understood

• Gut bacteria differ from healthy individuals
Crohn’s Disease

- Chronic inflammatory bowel disease

- Often onset of disease follows course of antibiotics

Approximately 700,000 people in the United States
Long-term Effects of a Course of Antibiotics on an Adult Gut

BACTERIAL DIVERSITY

LONG-TERM EFFECTS OF A SEVEN-DAY COURSE OF ANTIBIOTICS

Did antibiotics caused Amelia’s Crohn’s disease?
Why did Amelia get Crohn’s and not her brother?

## Rates for Asthma, Allergic, & Autoimmune Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Prevalence</th>
<th>Country</th>
<th>Year</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>4%</td>
<td>UK</td>
<td>1964</td>
<td>Devenny et al. 2004</td>
</tr>
<tr>
<td>Asthma</td>
<td>24%</td>
<td>UK</td>
<td>1999</td>
<td>Devenny et al. 2004</td>
</tr>
<tr>
<td>Asthma</td>
<td>3%</td>
<td>Nepal</td>
<td>2003</td>
<td>Masoli et al 2004</td>
</tr>
<tr>
<td>Asthma</td>
<td>8%</td>
<td>Pakistan</td>
<td>2003</td>
<td>Masoli et al 2004</td>
</tr>
<tr>
<td>Asthma</td>
<td>28%</td>
<td>Australia</td>
<td>2003</td>
<td>Masoli et al 2004</td>
</tr>
<tr>
<td>Crohn's Disease</td>
<td>64.9/100,000 (men)</td>
<td>USA</td>
<td>1980</td>
<td>Gollop et al. 1988</td>
</tr>
<tr>
<td>Crohn's Disease</td>
<td>90.5/100,000 (women)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crohn's Disease</td>
<td>241.3/100,000</td>
<td>USA</td>
<td>2008–2009</td>
<td>Kappelman et al. 2013</td>
</tr>
<tr>
<td>Crohn's Disease</td>
<td>1.38/100,000</td>
<td>China</td>
<td>1950–2002</td>
<td>Zheng et al 2011*</td>
</tr>
<tr>
<td>Crohn's Disease</td>
<td>2.29/100,000</td>
<td>China</td>
<td>2003–2007</td>
<td>Zheng et al 2011*</td>
</tr>
<tr>
<td>Eczema</td>
<td>5%</td>
<td>UK</td>
<td>1964</td>
<td>Devenny et al. 2004</td>
</tr>
<tr>
<td>Eczema</td>
<td>21%</td>
<td>UK</td>
<td>1999</td>
<td>Devenny et al. 2004</td>
</tr>
<tr>
<td>Type 1 Diabetes</td>
<td>0.35/1000 (boys)</td>
<td>USA</td>
<td>1935–1936</td>
<td>Gale 2002</td>
</tr>
<tr>
<td>Type 1 Diabetes</td>
<td>1.2/1000</td>
<td>USA</td>
<td>1989–1992</td>
<td>Gale 2002</td>
</tr>
<tr>
<td>Type 1 Diabetes</td>
<td>1.93/1000</td>
<td>USA</td>
<td>2009</td>
<td>Dabelea et al 2014</td>
</tr>
</tbody>
</table>

Source: Chunco & Uno. National Center for Case Study Teaching in Science, University at Buffalo, State University of New York

What patterns of disease occurrence can you observe from the table above? Submit one answer per group to pollev.com/mcvassar or text MCVASSAR to 37607 to join)
The Hygiene Hypothesis

• Current hypothesis:
  – *In the absence of exposure to a species-rich environment full of pathogens and parasites, the human body will tend to shift toward a more inflammatory state associated with allergies, asthmas, and autoimmune diseases*

• Developed in 1980s
  • increasing incidence of asthma/allergic disorders in industrialized countries
Factors Linked To Lower Rates of Asthma and/or Allergies in Children

- Include:
  ① being raised on a farm
  ② vaginally delivered babies (versus C-section)
  ③ attending daycare or having older siblings
  ④ living in a home where dishes are hand-washed (versus in a dishwasher)
Well Established Treatment For Crohn’s Disease: Steroids

• Suppresses immune system by decreasing the production of inflammatory proteins
  – Decreases general immune cell activity in body.

• Can cause weight gain, high risk for secondary infection.
Experimental New Treatments

• Fecal Microbiota Transplant
  – Transplant from healthy donor restores more diverse microbial community
  – Stool collected from tested donor, administered rectally or orally
  – Some clinical success.

• Helminthic Treatment
  – Deliberate infection with parasitic worm
  – Hypothesized to change immune system activity
  – Anecdotal evidence, mouse studies
  – Not FDA approved (yet?)

Preserving The Microbiome

• Diet rich in fiber, fruits and vegetables

• Consuming microbes
  – Fermented foods like yogurt, cheese, sauerkraut, kimchi, kombucha
    • *Bifidobacterium*

• Probiotics (use with caution)
YOU SHOULD NOW BE ABLE TO

• Define the microbiome

• Discuss the diversity in the human microbiome

• Explain the effect of antibiotics on the microbiome

• Describe the relation of the microbiome to autoimmune diseases like Crohn’s Disease