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Colleen, Sofia, Gillian, Alissa, Kristaps, Hannah
sugar + yeast = fermentation (alcohol & co2)
Glucose is converted to pyruvic acid, which can be further metabolized by different organisms:

- **Propionibacterium** produces CO₂ and propionic acid, leading to Swiss cheese.
- **Aspergillus Lactobacillus Streptococcus** produces lactic acid, leading to Cheddar cheese, yogurt, soy sauce, wine, beer, nail polish remover, rubbing alcohol, and vinegar.
- **Saccharomyces** produces CO₂ and ethanol, leading to wine, beer.
- **Clostridium** produces acetone, isopropanol, leading to nail polish remover, rubbing alcohol.
- **Escherichia Acetobacter** produces acetic acid, leading to vinegar.

NAD⁺ and NADH are indicated in the diagram to represent the electron transport chain.
A banqueting scene.
The two figures on the right are drinking beer through straws inserted in a vessel placed on a tall stand between them.
A dog crouches under the chair in the center.
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The potential of Fermented Foods

- Three main functions
  - Antioxidants
  - Anti-inflammatories
  - Microbes

Red Wine Fixes Everything
The Failures of a Western Diet

- As we have discussed, a Western Diet is:
  - High fat
  - High sugar
  - Low in nutrients (macro and micro)
INFLAMMATION

- A response to stress and alters gut-brain interactions
- Repeated stress effects pro-inflammatory cytokines levels
- Chronic stress has shown to disrupt intestinal barrier, causing the barrier to become more porous (leaky gut)
Reactive Oxygen Species (ROS)

- **What am I?**
  - Hydrogen Peroxide (H₂O₂)
  - Hydroxyl Radical (OH⁻)
  - Superoxide Anion (O₂⁻)

- **How am I formed?**
  - Unavoidable byproduct of cellular respiration (making energy)
  - The byproducts of some enzyme reactions

- **What do I do?**
  - Reaction with any organic molecule to stabilize
  - Modify or change the shape of proteins - now they are no longer useful!
  - React with lipids, dissolving them, AND creating another ROS in the process
Stressors

- Aging/Senescence
- Wounding
- Xenobiotics
- Radiation/Light
- Heat & Cold
- Pathogens
- Biotoxins
- Drought
- Heavy Metals
- Air Pollutants
  \( \text{O}_3; \text{SO}_2 \)
- Hormones

Oxidative Stress

- \( \text{O}_2^- \)
- \( \text{H}_2\text{O}_2 \cdot \text{OH} \)

Molecular Damage

- Lipids & Fatty Acids
- Amino Acids
- Proteins
- Nucleic Acids
- Pigments

Cellular Effects

- Membrane Damage
- Loss of Organelle Functions
- Reduction in Metabolic Efficiency
- Reduced Carbon Fixation
- Electrolyte Leakage
- Chromatid Breaks
- Mutations

Cell Death
How do cells get damaged?

- **Reactive Oxygen Species**
  - Toxic by-products of oxidative phosphorylation (last stage of ATP/energy production which occurs in the mitochondria of cells)
  - High calorie levels cause mitochondria to become porous and then ROS is released → Damage cellular lipids, proteins, and DNA
  - GLUT 4 transporter protein altered and as a result, less responsive to insulin → sudden onset of insulin resistance
Anti-Oxidants to the rescue!

- We can protect ourselves from reactive oxygen species by eating foods high in antioxidants.
- Who am I?
  - Special molecules that inhibit the oxidation from other molecules and delay cell damage.
  - **Flavonoids**: plant metabolites thought to help cell signalling pathways and antioxidant effects (found in fruits and vegetables).
    - Anti-viral, Anti-cancer, Anti-inflammatory, Anti-allergic.
    - **Quercetin**: Alleviates eczema, sinusitis, asthma, and hay fever.
    - **Soy flavonoids**: lowers cholesterol, protects against osteoporosis and alleviates symptoms in menopause.
    - **FUN FACT**: flavonoids are also found in red wine and is theorized to help protect against heart disease (Eg. Incidence of heart disease in France is low despite the “French Paradox”).
    - **General rule**: more color, more flavonoids (help with the pigmentation of...
Polyphenols

- They are the secondary metabolites of many plants that are used to protect the plant from ultraviolet.
- In humans they modulate the activity of a wide range of enzymes and cell receptors.
- Tea is exceptionally high in polyphenols.
- Flavonoids and other Antioxidants are forms of polyphenols.
Foods with antioxidants

- Cranberries
- Blueberries
- Blackberries
- Raspberries
- Rustic potatoes
- Black beans
- Pecans
- Artichokes
- Acai
- Pomegranates
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TRADITIONAL DIETS AND MICROBIOTA

- 35% of bacteria from fruits and vegetables can survive gastric conditions
- Bacteria that survive are mainly from Lactobacillus Plantarum strain
- Traditional Mediterranean and Japanese diets are higher on fruits, vegetables, fish and seafood when compared to a modern Western diet
TRADITIONAL DIETS AND MICROBIOTA

- It's all about poop
- Using samples of rural Japanese and urban Canadian poop to look for diversity
- 9 Japanese and 8 Canadian, where Japanese have a diet higher in fruits, vegetables and fish/seafood
- Results: Japanese have higher diversity and more Bifidobacterium as well as Lactobacillus, and lower levels of Clostridia
- Clostridia = pathogen that can lead to botulism
- Further studies
TRADITIONAL DIETS AND MICROBIOTA

- More recent study (2010) was comparing poop of European children and African children, who are on a more traditional high fiber diet, also using fermented foods
- Results: Found that African kids had significantly lower number of salmonella family bacteria as well as more short-chain fatty acids
- Numerous lactic acids in African traditional fermented foods that help to synthesize folate and riboflavin
TRADITIONAL DIETS AND MICROBIOTA

- Even though long-term diets determine the main phyla of gut microbial profile, stress and short-term changes in diet can induce change in intestinal microbiota.
- Research has shown that even single strain Bifidobacterium or Lactobacillium can increase the quantity of completely separate strains of the same family.
- Significance: even short term change in diet can lead to change in microbiota.
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Microbiota and Mental Health

\[ \text{Healthy foods} - \text{Unhealthy foods} = \text{Diverse Microbiome} \]
DIVERSE MICROBIOME
Reframing the Teenage Wasteland: Adolescent Microbiota-Gut-Brain Axis

Recadrer le terrain vague de l'adolescence : l’axe microbiote-intestin-cerveau de l’adolescence

Karen-Anne McVey Neufeld, PhD¹; Pauline Luczynski, MSc¹; Timothy G. Dinan, MD, PhD¹,²; and John F. Cryan, PhD¹,³
Intestinal dysbiosis
Stress, Sleep, Poor Nutrition, Drugs, Alcohol

Depression, Anxiety, Substance abuse, Schizophrenia, Eating disorders
THE MICROBIOME IN AUTISM SPECTRUM DISORDER

The human gut microbiota with reference to autism spectrum disorder: considering the whole as more than a sum of its parts

Michael C. Toh and Emma Allen-Vercoe*

Department of Molecular and Cellular Biology, University of Guelph, Guelph, Ontario, Canada
What's going on?

- Composition of gut microbiota highly influenced during adolescence
- Environmental challenges can change the trajectory of microbiota
  - antibiotics
  - 'Dead food'
- Maybe this is why psychiatric disorders tend to emerge at this time. What role does the gut microbiota play?
- Antidepressants
- 'Dead food'
- Maybe this is why psychiatric disorders tend to emerge at this time. What role does the gut microbiota play?

Gut microbes become more diverse
Bifidobacterium & Lactobacillus

Myelination
Pruning

Depression
Anxiety
Substance abuse
Schizophrenia
Eating disorders
Germ Free Mice

= abnormalities in HPA, stress hyper-reactivity, abnormal social behavior, cognitive dysfunction. Diversity in microbiome is gone.

↑ adrenocorticotropic hormone

If administered in adulthood, it's hard to reverse while when administered in adolescence, there is a chance of recovery!
What do we do?
Use intestinal microbiome manipulation as therapy through probiotics and fermented foods.
Let's take it back to the traditional diet.
Good Bacteria:

- *Bifidobacterium lactus*
- *Lactobacillus Curvatus*
- *Lactobacillus Plantarum*
- *Myobacterium Vaccae*
• Protect inner intestinal lining
• Decrease lipid peroxidation
• NT & Neuropeptides
• Prevent stress-induced alterations of HPA
• Direct alterations of neural pathways - VAGUS BABY
• Reduce inflammation
• BDNF modulation
• Limit carb malabsorption
• Increase OMEGA-3's and minerals
• Analgesic
BUT HOW?
Probiotics $\rightarrow$ ↑L-Tryptophan $\rightarrow$ 5-HT $\rightarrow$ ↑Mood $\rightarrow$ Sleep $\rightarrow$
Frontal Lobe and limbic system

- Depression = lack of GABA and Serotonin (5-HT)
- GABA - relaxant, inhibitor, influenced by 5-HT
- Probiotics -> L-tryptophan (L-tryp) -> 5-HT -> GABA
- Maybe can also help autism?
Other evidence and research...

- Germ Free mice treated with Bifido
- increase in BDNF
- BDNF is low in depression
Other evidence and research:

- Germ Free mice treated with Bifido
  - increase in BDNF
  - BDNF is low in depression
  - decrease lipid peroxidation
- Germ Free mice treated with:
  - increase in BDNF
  - BDNF is low in depression
  - decrease lipid peroxidation

- Rats & Probiotic water
  - Lactobacillus helveticus & Bifido longum in h20
  - Nerve cell resiliency
  - decrease in apoptosis

Patients w/IBS:
Inception of prebiotic fiber
- IBS
  - 44 Patients w/IBS
  - consumption of prebiotic fiber
    - Trans-galactooligosaccharide
    - more bifidobacteria and reduced anxiety

- Lactobacillus helveticus & Bifido longum in h2
- Nerve cell resiliency
- decrease in apoptosis

- fMRI
  - on the faculty and...
• fMRI
  • one month consumption of fermented foods with bifidobacteria, lactobacillus, and lactococcus
  • fermented dairy product
  • Increased brain activity in emotion and sensation centers
  • Indirect, but strong correlation

• increased magnesium and minerals for out health
• Probiotics in chow
  • Increased omega-3 levels in mice
  • therefore, helps with synapses and brain health
  • anti-inflammatory FA like Gamma-linolenic acid
  • increased magnesium and zinc, essential minerals for out health
Autism

Altered Gastrointestinal Function

Possibly Explanation
GLYCEMIC CONTROL

BIFIDO =

LPS
What am I?
-LPS are large molecules found on the outer membrane of Gram Negative Bacteria
What do I do?
- In high quantities, the LPS can cause septic shock in our bodies, or a massive immune response that can lead to death
- Could potentially be a triggering factor in obesity and diabetes
- Studies found LPS levels in the blood rose with a HFD
LPS In the Blood

- In copious amounts LPS, which is an endotoxin, can cause your body to go into septic shock and you will die.
- Septic shock is when your immune system overreacts to the point where you die.
- In low amounts LPS can cause inflammation.
- LPS can also be used as a marker for leaky gut.
- LPS lowers the available tryptophan (an amino acid) and Zinc in the body negatively influencing neurotransmission.

- Studies found a HFD
LPS and depression
It theorized that depression causes leaky gut, but what if it were the other way around?
- LPS lowers the available tryptophan (an amino acid) and Zinc in the body leading to a decrease in accessibility to neuron terminals
- Bifidobacteria prevent efflux of LPS into systemic circulation
- Bifidobacteria increase nerve cell residency in stressful conditions
LPS = lipidpolysaccharide endotoxin released and in circulation during diabetes

In conclusion, it seems as though...

Probiotics can help with gut health to act on mechanisms already discussed in this class like omega-3 regulation and glycemic control, etc.
In conclusion, it seems as though...

Probiotics can help with gut health to act on mechanisms already discussed in this class like omega-3 regulation and glycemic control as well as new mechanisms like direct communication through the vagus nerve to influence NT release.
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Diet is an integral part of the health of both the brain and body.

Potential therapeutic methods to treat psychiatric and mild mental disorders.

More research!
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Other evidence and research...

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  - increase in BDNF
  - BDNF is low in depression
  - decrease lipid peroxidation

& Bifido longum in h20
- Germ Free mice treated with Bifido
  - increase in BDNF
  - BDNF is low in depression
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