ENZYMES:
UNLOCKING HEALTH

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ENZYMES are proteins that accelerate chemical reactions (at least 1 million times quicker than rate w/o enzyme)

Without enzymes, it would take approximately 78 million years to make DNA and RNA in water

In enzymatic reactions, the molecules at the beginning of the process are called **substrates**, and the enzyme converts them into different molecules called **products**.

Enzymes are extremely **selective** for their substrates
Enzymes **lower the activation energy** of reactions

- **a.** Energy of activation when an enzyme is not present
- **b.** Energy of activation when an enzyme is present
Enzyme activity increases as substrate concentration increases because there are more collisions between substrate and the enzymes.

- Maximum rate is achieved when all active sites of an enzyme are filled continuously with substrate.
a. Degradation: The substrate is broken down to smaller products.

b. Synthesis: The substrates are combined to produce a larger product.
3D DIAGRAM

a. Before substrate binds
b. After substrate binds
An enzyme's name is often derived from its substrate, or the chemical reaction it catalyzes, with the word ending in –ase.

Examples:
- Lactose + Lactase → Glucose and Galactose
- Sucrose + Sucrase → Glucose + Fructose
- Amylases degrade Carbohydrates
- Lipases degrade Fats (lipids)
- Proteases degrade Protein
- Some exceptions…e.g. trypsin, pepsin, rennin are all protein digesting enzymes
INFLUENCING ENZYMES

FACTORS AFFECTING RATE
FACTORS AFFECTING RATE

- TEMPERATURE
  - All enzymes have an **optimum temperature range**
  - The rate of an enzyme-catalyzed reaction increases as the temperature is raised
  - A 10°C rise in temperature will increase the activity of most enzymes by 50 to 100%
  - A 1 or 2°C may introduce changes of 10 to 20%
  - Many enzymes are **adversely affected by high temperatures** most animal enzymes rapidly become denatured at temperatures above 40°C
Figure 13
Effect of temperature on reaction rate
FACTORS AFFECTING RATE

- **TEMPERATURE**
  - Sub-Clinical Hypothyroid - Lowered function of the thyroid gland can result in profound physiologic effects throughout the body, due to the effects of lowered temperature on enzyme function.

  ![Table 1](image)

  **Table 1**
  **Hypothyroid S/Sx’s**
  - fatigue, lethargy
  - weight gain
  - dry, coarse skin
  - cold intolerance
  - swelling of hands
  - legs and face
  - chronic infections
  - postanasal drip
  - weakness
  - muscle cramp
  - arthralgias
  - parasthesia
  - memory loss
  - carpal tunnel syn.
  - constipation
  - dysglycemia
FACTORS AFFECTING RATE

- **TEMPERATURE**
  - Enzymes cannot tolerate the high temperatures used in cooking, baking, microwaving, canning, and pasteurizing. These methods all produce heat of **118°F or higher which destroys the enzymes**.
  - The over processing and refinement of our food supply results in the deactivation and/or removal of all food enzymes.
  - **Food enzymes** - occur in raw food and, when present in the diet, **begin the process of digestion**.
FACTORS AFFECTING RATE

- **pH**
  - Enzymes function most effectively at a **specific pH**
  - **Pepsin**, the protein-digesting enzyme secreted by the cells of the stomach lining, functions optimally at a **pH of 2**
  - **Trypsin**, a protein-splitting enzyme secreted by the pancreas, functions optimally in an alkaline medium at a **pH of 8.5**
  - Most **intracellular enzymes have pH optima near neutrality** and do not operate successfully in an acid or alkaline medium
  - A major shift from the enzyme's optimal pH range may irreversibly inactivate the enzyme.
FACTORS AFFECTING RATE

- **pH**
  - **Blood plasma** is slightly alkaline with a normal **pH range of 7.35 to 7.45**
  - Plasma pH levels below 6.9, and above 7.8, are fatal
  - Levels below 7.35 and above 7.45 can result in physical symptoms, psychological changes, and performance deficits.
  - The **pH of cells plays a critical role in their function**; close regulation is required
  - pH is very important because pH controls the speed of our body's biochemical reactions
  - A major shift from the enzyme's optimal pH range may irreversibly inactivate the enzyme.
FACTORS AFFECTING RATE

- pH
  - Factors affecting physiologic pH:
    - Diet i.e. acid or alkalinizing food
    - Breathing i.e. short, shallow breathing increases acidity
    - Medication
    - Infection i.e. bacterial, viral, fungal
    - Stress i.e. increased cortisol and epinephrine increases acidity
    - Dehydration i.e. increases acidity
    - Electrolyte imbalances
    - Vitamin and Mineral deficiencies
### FACTORS AFFECTING RATE

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Effective pH range</th>
<th>Active in</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromelain</td>
<td>4.0 to 9.0</td>
<td>Entire digestive tract</td>
<td>Contains several proteolytic enzymes. Works synergistically with pancreatic enzymes.</td>
</tr>
<tr>
<td>Papain</td>
<td>3.0 to 10.5</td>
<td>Entire digestive tract</td>
<td>Wide array of proteolytic enzymes.</td>
</tr>
<tr>
<td>Peptidase</td>
<td>3.25 to 7.5</td>
<td>Entire digestive tract</td>
<td>Works synergistically with pancreatic enzymes.</td>
</tr>
<tr>
<td>Protease AM</td>
<td>4.0 to 11.0</td>
<td>Bloodstream (when taken on empty stomach)</td>
<td>High fibrinolytic activity allows it to significantly reduce soreness and stiffness.</td>
</tr>
<tr>
<td>Protease 3.0</td>
<td>2.75 to 4.7</td>
<td>Stomach</td>
<td>Works synergistically with pepsin secreted by the pancreas.</td>
</tr>
<tr>
<td>Protease 4.5</td>
<td>2.75 to 6.25</td>
<td>Stomach and pylorus</td>
<td>A mixture of acid, neutral and alkaline proteases. Works synergistically with pepsin secreted by the pancreas.</td>
</tr>
<tr>
<td>Protease 6.0</td>
<td>2.75 to 7.0</td>
<td>Entire digestive tract</td>
<td>A mixture of acid, neutral and alkaline proteases. Works synergistically with pepsin secreted by the pancreas.</td>
</tr>
<tr>
<td>Proteases from A. melleus and A. oryzae</td>
<td>4.0 to 9.0</td>
<td>Upper stomach and small intestine</td>
<td>This combination is an alternative to Serrapeptidase. Shown to significantly inhibit inflammatory responses that result from injury.</td>
</tr>
<tr>
<td>Proteases from A. niger and A. oryzae</td>
<td>2.75 to 6.0</td>
<td>Entire digestive tract</td>
<td>Break down all milk proteins, including caseins and beta lactoglobulins. Work synergistically with lactase and protease to digest dairy products.</td>
</tr>
</tbody>
</table>
Co-Enzymes

- Organic, non-protein molecules that carry chemical groups between enzymes, without which the enzyme could not function.
- **Vitamins often act as co-enzymes**
- Most coenzymes are found in a huge variety of species, and some are universal to all forms of life.
## FACTORS AFFECTING RATE

<table>
<thead>
<tr>
<th>Coenzyme</th>
<th>Vitamin</th>
<th>Additional component</th>
<th>Chemical group(s) transferred</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{NAD}^+ \text{ and } \text{NADP}^+$ [5]</td>
<td>Niacin ($B_3$)</td>
<td>ADP</td>
<td>Electrons</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Coenzyme A [9]</td>
<td>Pantothenic acid ($B_5$)</td>
<td>ADP</td>
<td>Acetyl group and other acyl groups</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Tetraphydrofolic acid [10]</td>
<td>Folic acid ($B_9$)</td>
<td>Glutamate residues</td>
<td>Methyl, formyl, methylene and formimino groups</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Menaquinone [11]</td>
<td>Vitamin K</td>
<td>None</td>
<td>Carbonyl group and electrons</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Ascorbic acid [12]</td>
<td>Vitamin C</td>
<td>None</td>
<td>Electrons</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
</tbody>
</table>
Tryptophan → Serotonin

L-tryptophan

- Tryptophan 5-monooxygenase
  - 5-Hydroxytryptophan
    - B6 → Serotonin
    - SAM → Melatonin
      - other metabolites
  - N-Formylkynurenine
    - Kynurenine
      - 3-Hydroxykynurenine
        - B6 → Xanthurenic acid
          - 3-Hydroxyanthranilic acid
            - carboxymuconic aldehyde intermediate
              - Picolinic acid
              - Quinolinic acid
                - Nicotinic acid (Niacin)
## FACTORS AFFECTING RATE

<table>
<thead>
<tr>
<th>Coenzyme</th>
<th>Chemical group(s) transferred</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenosine triphosphate [14]</td>
<td>Phosphate group</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>3’-Phosphoadenosine-5’-phosphosulfate [16]</td>
<td>Sulfate group</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Coenzyme Q [17]</td>
<td>Electrons</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Tetrahydrobiopterin [18]</td>
<td>Oxygen atom and electrons</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Cytidine triphosphate [19]</td>
<td>Diacylglycerols and lipid head groups</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Nucleotide sugars [20]</td>
<td>Monosaccharides</td>
<td>Bacteria, archaea and eukaryotes</td>
</tr>
<tr>
<td>Glutathione [21][22]</td>
<td>Electrons</td>
<td>Some bacteria and most eukaryotes</td>
</tr>
</tbody>
</table>
Another type of cofactor is an inorganic metal ion called a metal ion activator. The major reason for the nutritional requirement for minerals is to supply such metal ions as Zn$^{+2}$, Mg$^{+2}$, Mn$^{+2}$, Fe$^{+2}$, Cu$^{+2}$, K$^{+1}$, and Na$^{+1}$ for use in enzymes as cofactors.
ESSENTIAL FATTY ACIDS

Omega-3 fatty acids
- Linolenic Acid
  - (flax, walnut, soy, pumpkin, algea)
  - Δ6 desaturase
    - (B6, Mg, Zn, B3, C)
  - Stearidonic Acid
    - elongase
    - (B6)
  - Eicosatetraenic Acid
    - Δ5 desaturase
      - (Zn, B3, C)
  - Eicosapentaenoic Acid (EPA)
    - (cold water fish, wild game)
      - cyclo-oxygenase
      - 5-lipoxygenase
        - PGE3 series
        - Ciupanodononic Acid
          - Leukotrienes
            - Δ4 desaturase
  - Docosahexaenoic Acid (DHA)
    - (cold water fish, algea)

*Inhibited by ETOH, saturated fats, trans-fatty acids/hydrogenated fats, caffeine, diabetes and old age.
Digestion

- Starts with the sight and smell of food.
- Saliva, is secreted in the mouth, gastric acid in the stomach and digestive enzymes in the intestine by the pancreas.
- **Enzymes breakdown food into particles that can be used by our bodies.**
- Also **release coenzymes** from food.
- The pancreas is designed to secrete only enough enzymes to finish the job that was begun in the mouth and stomach.
DIGESTION

- **CHEWING**...mechanically breaks down food
  - Salivary amylase in saliva digests starches
  - Pepsin in the stomach digests proteins
  - Pancreas secretes:
    - **Amylases** (maltase, lactase, sucrase etc.) to digest carbohydrates
    - **Lipases** to digest fats
    - **Proteases** Trypsin, chymotrypsin to digest proteins
  - All are pH dependant
Improper digestion results in disease

I. Partially digested proteins pass into the bloodstream. The body does not recognize these proteins, so it launches an attack from the immune system in the form of an allergic reaction or inflammatory response.

II. Undigested food gets metabolized by putrefactive bacteria in the colon and the metabolites are absorbed.

III. An overtaxed pancreas does not function very well therefore decreased production of enzymes and decreased release of bicarbonates to buffer acidic pH of cells.
Digestion can be improved and manipulated by supplementing digestive enzymes. Porcine or bovine pancreatic enzymes are similar to human pancreatic enzymes therefore they function similarly. Relieves the burden from an underactive pancreas e.g. pancreatitis. Increases rate of product production. Plant and/or fungal based enzymes can also be supplemented to digest proteins.
Can supplement enzymes not normally found in humans e.g.:

- **Cellulase degrades cellulose**, an indigestible carbohydrate in humans

- **Alpha Galactosidase** is the enzyme responsible for the breakdown of non-digestable oligosaccharides normally found in **legumes** e.g. galactooligosaccharides, raffinose and stachyose, all found in soy

- **DPP IV enzymes** (fungal source) prevents the activation of the immune system by breaking down **dietary peptides** from food
APPLICATIONS

MANIPULATING INFLAMMATION
Inflammation

- Proteolytic (protein digesting) enzyme have anti-inflammatory, antiedemic, and fibrinolytic effects
- Also thought to decrease pain by inhibiting release of bradykinin and other factors from inflamed or damaged tissue
- Inhibit platelet aggregation
- Every chronic degenerative condition is a result of an inflammatory process on a cellular level
Cardiovascular Disease (CVD)

- The liver produces fibrinogen (fibrin) which is involved in blood clot and arterial plaque (thrombi) formation
- Plasminogen (plasmin), another enzyme produced by the liver breaks down fibrin.
- As the balance between fibrin and plasmin is disrupted, the risk of CVD increases substantially
- Fibrinolytic drugs are given after a heart attack to dissolve the thrombus blocking the coronary artery
Serratio Peptidase

- A proteolytic enzyme extracted from the silk worm
- **Anti-inflammatory, antiedemic, and fibrinolytic effects**
- Inhibits release of bradykinin, a potent endothelium-dependent vasodilator, causes contraction of non-vascular smooth muscle, increases vascular permeability and also is involved in the mechanism of pain
Nattokinase

- Fibrinolytic enzyme derived from a Japanese food called natto (fermented soy beans)
- Nattokinase has **fibrinolytic activity that is 4-times more potent than plasmin**
- Its average activity is about 40 CU (plasmin units) /gram
- Reduces vessel wall thickening following endothelial injury.
- Also seems to cause lysis of thrombi that form at the vessel wall
Other proteolytic enzymes have shown benefit with cardiovascular disease via their anti-inflammatory, antiedemic, and fibrinolytic effects

- Lumrokinase from Earthworms
- Bromelain from Pineapple
- Papain from Papaya
- Trypsin and Pepsin from animal source
- Etc.
Linus Pauling and Mathias Rath

“A common patho-mechanism of all cancers, which is the degradation of the surrounding connective tissue, as a precondition for cancer metastasis”

- Cancer cells produce **collagenase which breaks down collagen** and allows cancer to metastasize
- Vitamin C, the amino acids L-lysine and L-proline and a green tea extract known as Epigallocatechin Gallate (EGCG), that works synergistically to stop the spread of cancer cells through connective tissue.
Unitarian Trophoblastic Theory of Cancer

- Scottish embryologist John Beard in 1902 published a monograph entitled The Enzyme Therapy of Cancer
- We begin life as a single cell
- Cell divides and some cells become the placenta, attach to the uterine wall during pregnancy
- **Placenta cells resemble cancer cells**
- Malignant cancers act in the same way that placenta cells act; they attach to the uterus and "eat" through it to obtain a blood supply
- **Placenta stops growing on day 56 of development the same day as the fetus pancreas begins producing digestive enzymes**
Beard observed Trophoblasts (placenta-like cells) throughout the body. These cells do not differentiate into specific tissue, but lie dormant. Beard called these cells "germ" cells.

Theorized that as we age, the germ cells are likely to receive a signal that causes them to begin growing (environmental influences).

As this "false-placenta" begins growing, unchecked, it becomes the malignant mass which the medical community calls cancer.
The pancreas produces the protein dissolving enzymes **trypsin** (and **chymotrypsin**) that prevents germ cells from becoming malignant. Should the output of pancreatic enzymes decline, any malignant cancer cells that begin dividing will grow out of control. All **trophoblast** cells produce a unique hormone called the **Chorionic Gonadotrophin Hormone** (CGH) which is easily detected in urine. If a person is either pregnant or has cancer, a simple CGH pregnancy test should confirm either or both.
Dr. William D. Kelley (1963) diagnosed with pancreatic cancer (95% fatality rate).

Cured his own cancer and hundreds more using Beard’s protocol.

In the 1980s, Dr. Nick Gonzalez was sent by the Sloan-Kettering cancer center to "debunk" Kelley's claim of a 100% pancreatic-cancer cure rate.

After reviewing more than 500 of Kelley's patient records, Gonzalez became a believer.
Dr. Gonzalez was awarded a $6 million grant from the National Institutes of Health to continue the study of enzyme therapy for pancreatic cancer.

- Dr. Kelly died in 2005
- Dr. Gonzalez is practicing in New York.
- [http://www.dr-gonzalez.com/index.htm](http://www.dr-gonzalez.com/index.htm)
**Dr. Gonzalez Protocol:**

- He uses 45 grams of purified proteolytic enzymes (pancreatic enzymes) other nutritional supplements and detoxification methods (coffee enemas) in his protocols
- 130-175 capsules a day
- Initial evaluation (2 sessions) $3600
- Cost of Supplements $750 per month
- Require all patients to return every six months for a repeat physical exam and assessment of their nutritional status $750.00
A 2-year, unblinded, 1-treatment arm, 10-patient, pilot prospective case study was used to assess survival in patients suffering inoperable stage II–IV pancreatic adenocarcinoma treated with large doses of orally ingested pancreatic enzymes, nutritional supplements, "detoxification" procedures, and an organic diet.

11 patients entered into the study, 9 (81%) survived one year, 5 (45%) survived two years, and at this time, 4 have survived three years.

These results are far above the 25% survival at one year and 10% survival at two years for all stages of pancreatic adenocarcinoma.
Many drugs mechanism of action is the result of selectively inhibiting enzymes

- **NSAIDS** for pain e.g. Ibuprofen, ASA, Naproxen – Inhibit COX-2 enzymes
- **PPI’s** for gastric reflux e.g. – Losec®, Prevacid®, Nexium®, Pariet® irreversibly blocking the hydrogen/potassium adenosine triphosphatase enzyme system
- **SSRI’s** for depression e.g. Celexa®, Prozac® inhibit enzymes and prevent the re-uptake of Serotonin
- **ACE Inhibitors** for hypertension and congestive heart failure e.g. Vasotec®, Altace® inhibit Angiotensin Converting enzyme
- **Statins** Inhibit cholesterol synthesis e.g. Lipitor®, Zocor® inhibit HMG-CoA reductase inhibitors
- **Cyanide** almost instantly starves the body of energy by inhibiting the enzymes in mitochondria that make ATP.

- **Methanol** toxic by its breakdown by the enzyme alcohol dehydrogenase in the liver by forming formic acid and formaldehyde which cause permanent blindness by destruction of the optic nerve. Antidote = Ethanol.

- **Antibiotics** inhibit enzymes in bacteria which result in the inability to replicate (bacteriostatic) or death (bacteriocidal).
CONCLUSION

MANIPULATING

HEALTH
WHAT CAN WE DO?

- **Eat more raw food**: fruit, vegetables, legumes, seeds, nuts, etc. to maximize intake of enzymes and maintain a neutral pH.
- **Eat adequate protein** (provides building blocks of enzymes).
- **Cook only on low heat**
- **Eat only pH neutral or alkaline forming foods**: avoid overly processed refined foods.
- **Decrease Stress**
- **Exercise moderately** (increases internal temperature).
- **Breathe** slowly and deeply.
- **Stay hydrated**.
What Can We Do?

- **Address underlying thyroid disorders** – supplement iodine, tyrosine, glandulars and avoid flouridated water/toothpastes

- **Monitor basal metabolic temperature** first thing upon waking and record. If consistently below 36.1 °C (97.0 °F) to 37.8 °C (100.0 °F) address thyroid insufficiencies

- **Ensure optimal stomach pH**. Supplement Betaine Hydrochloride as needed

- **Avoid exposure to environmental toxins**. Perform a cleansing protocol once or twice yearly
WHAT CAN WE DO?

- Use medications to control crisis, not to manage symptoms. **Address the underlying cause of disease** whenever possible.
- **Take vitamin and minerals** supplements to ensure adequate intake.
- **Supplement digestive enzymes** during meals to facilitate digestion and between meals to minimize inflammation.
WHAT CAN WE DO?

- We all are the cumulative result of the food we eat, the genetics which we inherit, and the environment to which we are exposed. All of these, including genetic (epigenetics), can be consciously manipulated to change the course of our health.
- Our bodies have innate capacity to heal and a desire to be in a state of wellness. If given the correct environment (nutritional and environmental) in a balanced state, anything is possible.
- Food, shelter, water and love are all people need to survive, yet a disproportionate amount of time and income are spent on other things; Only 6% of Canadians disposable income is spent on food.
- The over-processing of our food supply and poor agricultural practices contribute significantly to the increase in chronic/degenerative disease. Support ethical companies.
- Over indulgence in food increases stress on the body (decreased caloric intake = increased longevity).
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The information herein is provided to encourage people to make informed, logical decisions regarding their health care. The nutritional supplements listed above should be taken only under the supervision of a knowledgeable health care professional. If you are taking any prescription medications, please speak with a nutritionally oriented doctor or pharmacists to limit potential interactions.

Please be aware that this information is provided to supplement the care provided by your physician. It is neither intended nor implied to be a substitute for professional medical advice. CALL YOUR HEALTHCARE PROVIDER IMMEDIATELY IF YOU THINK YOU MAY HAVE A MEDICAL EMERGENCY. Always seek the advice of your physician or other qualified health provider prior to starting any new treatment or with any questions you may have regarding a medical condition.