Nutritional Biochemistry:
Integrated Approach to Cellular Nourishment
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Session 1 – Our Cellular Nature, Essential Biochemistry

I. Basic language of biochemistry – structure and function 30 min

A. The Elemental Self

1. Life's essential ingredients: atoms, electrons, elements, the Spark.
   Carbon **H**ydrogen **O**xygen **N**itrogen **S**ulfur, **P**hosphorus + micro

B. Molecules bond, the ultimate embrace for life

- Kinds of relationships -
  - "Magnetic" – opposites attract, charged, electrical changeable = ionic
  - Stable and strong, electrically neutral = covalent
  - Flexible yet building structure = hydrogen bonds
- Structural components - polymers, stringing us along
- Catalysts and regulators - enzymes and mineral salts, hormones, cytokines

C. Molecules for Life: Right and left-handed

- Geometrical and functional differences between biological and synthetic biochemicals, a quirk or safeguard of nature?
- Three-dimensional shape essential for function

D. Water, unique for life - our watery and salty nature

Slippery qualities built into the molecule
Acid, Bases, and pH
Cellular water, water we drink

II. Cellular Architecture & Nutrition 2 hour

A. What is a cell?

1. A cell is the smallest functioning unit of a living organism and carries out the basic functions of life including reproduction. Just like us.
2. The size and health of a cell is limited by the nutrients it can take in and how well it gets rid of its wastes.
3. Cells exchange molecules with its environment through diffusion, active transport, ingestion, and cellular 'eating'

B. **How cells work – What's necessary for life**

1. Ability to grow, metabolise, reproduce, transform energy, intelligence.
2. Structural integrity, growth, reproduction, diagnosis and repair
3. Cellular community strategies, cooperation, communication - receptors
4. Cell building requirements - feedback and balance

C. The architecture of life – molecules into cells - bonding

1. Cell membranes – Creating the Container for life

a. **Forming a container** with fluid resilient surface that protects, defends and defines the cell self. Molecular Knowledge

b. Functions

1. Holding things in, protecting
2. Insulation, forming boundaries, identity
3. Barriers, permeability, flexibility, discrimination

c. Chemical makeup of our cellular boundaries influenced by DIET

1.Fatty acids - linoleic, linolenic, stearic

Fat-loving and water-'fearing' molecules

2. Proteins, glycoproteins, glycolipids, receptors, information,

a. Identity, markers of distinction, antigenic identity
b. Channels for flowing through other molecules
c. Pumps and grumps

3. Cholesterol

a. Important ingredient of all cell membranes. Steroids, we make or drugs we take, like cortisol, hydrocortisone, prednisone, change the flexibility of the membrane and how information is transmitted

2.Eating the best fats to keep our membrane strong and flexible

Fats and fluidity, Formation and recycling

- EFFECTED BY STEROIDS, free radicals, Omega 3 Fatty acids
- Foods to feed our cells - fatty acids for membrane integrity
- Sources for feeding our membranes:

Fatty fish, cold water, walnuts,
Omega 3 vs. omega 6 - here or in fat
Construction sites
Turnover and recycling

What can damage the cellular protection?

Oxidants and free radicals
Molecular extortion
Cooling the fires - antioxidants - the basics

3. Cellular Muscle & Deep Intelligence - the Cytoskeleton

1. Tension and microfilaments
2. Cellular decision-making - grow, stop, or die
3. Movement and reducing tension as cellular self-care
4. EFFECTED BY stress, tension

4.Mitochondria -Energy banks (details Session 2)

1. Unique structures inherited from mothers and the past
2. Carbohydrate sources and the breath of life
3. Nutrient requirements – glucose, oxygen, CoQ10, B vitamins
4. EFFECTED BY free rad, nutrient depletion, oxygen levels

5. Protein Producers - (Details Session 3)

1. Nutrient requirements
2. Protein functions – structural, catalysts, modifiers, identity, immune
3. EFFECTED BY free rad, nutrient depletion
4. Genes – Inherited intelligence and Reproduction
   DNA structure, the triad, mutations and repair– nutritional support
   AFFECTED BY FREE RAD, stress

6. Cellular detox– lysosomes

1. Recycling, dismantling and dissolution

II. Experiential - Our cellular nature - getting in touch, boundaries & movement

Reading assignments:
Bland, *Clinical Nutrition*: chapter 4 on Fats – fats and cell membranes, fatty acids

Recommended supplemental reading (Your choice):
McGee's *On Food and Cooking*: Appendix – A Chemistry Primer p 811- 816; Chapter 15 The Four Basic Food Molecules p 792-809
Rita Mary King. *Biology Made Simple*. Chapter 3. The Living Cell. P 17-23

Session 2 How Sweet it is, Revving Up

IV. Mitochondria: from Molecule to Energy 1.5 hr

A. Mitochondria - sweet action - the crypts and contortions

1. Out-Sourced Energy Producers

a. Genetic origins, the mother, circles of DNA
b. Electron dance and oxidative phosphorylation
c. Oxidation and reduction - explain electron stealing
Oxidized - take an electron from another
d. Glucose utilization - sugar as fuel
e. Organization and collaboration
f. Plants as carbohydrate constructors

B. ATP production - fuel source

1. Carbohydrate consumed to produce ATP – glucose-fructose
2. Starch and amylase - neutral to sweet - Taste
Tasting sweet - the primary connection - energy & the mother
Mouth and nurture
3. Other essential components: oxygen, magnesium, coenzyme Q10
4. Free radical production, a by-product (details in Class 4)

C. **ATP utilization – muscles, brain, cellular requirements**

1. Muscle contraction
2. Neuronal replenishment
3. Protein and DNA synthesis, repair mechanisms, etc
4. Overexertion uses up energy and sugar
5. Out of balance

D**. Compromised ATP production**

1. Muscle stress and tension – oxygen uptake
2. Mitochondrial damage and disease
3. Cholesterol-lowering drugs
4. Sleep deprivation
5. Consequences

V. Sugar Shack - Carbohydrate Basics

A. All carbohydrates are made of simple 5 or 6-carbon sugars: glucose, fructose, galactose, mannose, fucose or 5 carbon sugars, ribose, deoxy ribose
B. Carb foods
C. Di- and oligo saccharides: lactose, sucrose, maltose
D. Complex chains – starch from plants, glycogen animal polysaccharide, GAG
E. Fiber & function soluble and insoluble, cellulose and gums
F. Carnitine and creatine
G. Add-ons to other molecules – glycolipids, glycoprotein, lectins – often changes the antigenicity, recognition of the molecule
H. Functions: energy metabolism, DNA/RNA structural component, antigenicity

VI. Exercises to spare and cultivate energy - the east and the west, bodymind

A. Mind-body Practices for Energy Balance
- Qigong – evidence for stress-relief – simple 10 minute practice
- Progressive relaxation and meditation – decrease muscle tension, improve oxygen uptake
- Body awareness energy maps tracking – homework for next 3 weeks

Reading assignments:
Bland, *Clinical Nutrition*: Chapter 2 Carbohydrates; Chapter 8 Energy

Recommended supplemental reading (Your choice)
Rita Mary King. *Biology Made Simple*. Chapter 10. Animal form and homeostasis. P 80-84
McGee p 803-805
Goldberg Chapters 2 and 3 – The Main Powerhouse and Carbohydrateland

Session 3 – Growing and Building our Cells, our Selves

VII. Protein Synthesis **2 hr**

A. Amino acid building blocks (the basic 20)

1. Those made internally - non-essential
2. Essential required from outside must be obtained from food: leucine, isoleucine, valine, lysine, phenylalanine, tryptophan, threonine, and methionine.
    a. **Biological synthesis produces L-for**m that is the only geometric configuration that can be used to make proteins. Chemically synthesized amino acids (synthetics) are a mixture of D & L forms. The only D form humans can use and transform to L-forms are methionine and phenylalanine.

B. Amino acids are both building blocks for proteins and neurotransmitters
C. Proteins are chains of 20 simple amino acids, 8 essential.
D. Construction site for building protein chains: Ribosomes
    1. Genes, DNA & RNA instruction manual
    2. Methylation - methionine and cysteine
    3. Adding 3-dimensional design to the scheme

E. Nutritional requirements: B1, B2, B6, B12, DNA, RNA, energy

F. Proteins as structural components of the body – collagen and keratin
G. Specialized proteins: antibodies, cytokines, antioxidant enzymes, insulin
H. Proteins as enzymes – how enzymes function as catalysts – lock and key relationships. Cofactors: minerals and vitamins
I. Proteins as lectins – carbohydrate binding and pattern recognition
J. Cooking and digestion denatures proteins – breakdown and/or changing shape.
K. Soy (GMO), wheat and rice proteins

VIII. Fats R Us **1.0 hr**

A. Simple building blocks are fatty acids, not water soluble – short and long chains, essential and non-essential triglycerides
B. Saturated and unsaturated fatty acids – cis vs. trans
C. Sterols – cholesterol (animal origin) and steroid hormones and plant sterols
E. Role in inflammation – arachadonic acid, prostaglandins, leukotrienes

Reading assignments:
Bland, *Clinical Nutrition*: Chapter 3, Proteins and Amino Acids; The rest of Chap 4 FATS.

Recommended supplemental reading (Your choice)
McGee, p 805-809
Goldberg, Chap 5 amino acids

Session 4 Stress, the Senses and Pleasure

IX. Oxidative stress and Antioxidants **1.5 hr**

Follow-up on energy maps – what was learned

A. Oxidative stress – free radical production
   1. What is a free radical?
   2. Environmental sources

B. Free radical production during energy synthesis

C. Free radical production during immune responses

D. Benefits and functions of free radicals
   1. Signal messengers
   2. Microbial killing

E. Natural defenses against free radicals
   1. Inborn scavengers: lipoic acid, coenzyme Q10, some proteins
   2. Nutrients as protectors: Vits A, C, E, Selenium, polyphenols, flavonoids

F. Dangers of free radicals
   1. DNA damage
   2. Skin damage, protein denaturing, wrinkles and radicals
   3.

X. Shaping Taste – The chemistry of our Senses

A. Tasting Molecules, Receptors and Perception

XI. Sharing our biochemical nutrients **0.5 hr**

A. Changing our biochemistry in relationships
   1. Pleasure and satiety – endorphins and oxytocin
   2. Nourishment is more than biochemicals

Reading assignments:
Bland, *Clinical Nutrition*: Chapter 3 section on oxidative stress

Recommended supplemental reading (Your choice)
Miriam Weinstein's book

Required Book

Clinical Nutrition: A Functional Approach by Jeffrey Bland et al. For more scientific and molecular perspectives about nutrition. Good biochemical explanations

Reading List of Recommended Books

On Food and Cooking: *The Science and Lore of the Kitchen* by Harold McGee. Chapter 15, the Four Basic Food Molecules. This is a MUST for the inquisitive cook and alchemist looking for entertaining explanations of the chemistry of what we eat.

Clinical Biochemistry made ridiculously simple. Stephen Goldberg, MD. 2004 Believe it or not a sometimes silly look into the chemistry of life.

Biology Made Simple. Rita Mary King, Made Simple, Broadway Books 2003. Very basic, well-explained essentials of cellular biology, energy and metabolism, genes and a lot more. Puts the cellular universe into a reality, out of abstraction

The Surprising Power of Family Meals*: *How eating together makes us smarter, stronger, healthier and happier. Miriam Weinstein 2005 Steerforth Press. The social alchemy of food, sharing with one another. The potency of family & community.
Body & Self. *Elements of Human Biology, behavior and health*. George Block. William Kaufmann Inc, Los Altos, CA 1985. Likely to be out of print but valuable information, detailed human physiology, readable.
The Way Life Works: *Everything you need to know about the way all life grows, develops, reproduces and gets along.* Mahlon Hoagland and Bert Dodson. Times Books 1995. A wonderfully illustrated book that offers almost a child's eye view of the amazing process of life. Written by a scientist who makes simple the cellular and ecological complexities of life.