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LIFELONG MUSCLE HEALTH THROUGH NUTRITION AND ADAPTIVE CHALLENGES

PHILOSOPHICAL CONTEXT

- Environmental exposure prompts movement on the Biological Spectrum.
- Optimal environmental “dose” depends upon internal capacity.
- Muscle health depends upon regular exposure to tension.

SARCOPENIA

- Sarco = flesh/muscle; Penia = poor
- Characterized by progressive and generalized loss of skeletal muscle mass and strength.
    - 0.8% skeletal muscle loss per year from the fifth decade of life (50+)
- Sarcopenia is strictly correlated with physical disability, poor quality of life, and death.
- Results in:
    1. **Chronic Metabolic Disease**
        i. Fatty Organ Disease
    2. **Reduced Functional Capability**
- **Fast Twitch** muscle fibers are preferentially targeted (***lost***)
    - *Loss of Strength*
    - *Loss of Speed*
    - *Loss of Control*
- Increased **likelihood of falls**
    - ↓ probability of recovery
    - ↑ dependence on others
    - ↓ quality of life
    - ↑ comorbidities
    - ↓ average life expectancy

UNDERSTANDING SKELETAL MUSCLE

- Preserving muscle means ***promoting regular protein synthesis***

MAMMALIAN TARGET OF RAPAMYCIN (MTOR)

- Protein complex that senses cellular conditions (nutrients, redox state, growth factors, energy charge, and mechanical tension) and **controls protein synthesis**
- Responsive to:
    - **Nutrients** (amino acids)
    - Mechanical **Tension** (eccentric muscle actions)
    - Growth Factors (e.g., IGF-1)
- **Coincidence Detector**: Activates when both tension and nutrients are present.

SATELLITE CELLS

- Stem cell on the periphery of skeletal muscle cells
- Mechanical strain results in their activation:
    - Chemical signaling – growth and repair
    - Proliferation – division (more satellite cells)
    - Fusion and Differentiation (**add nuclei** to existing muscle fibers)

- **Myonuclear Domain**
    - A given myonucleus in the muscle fiber syncytium can only transcriptionally govern a finite jurisdiction.
    - More nuclei = ↑ protein synthesis = HYPERTROPHY
- Satellite cell-mediated myonuclear accretion is **required** for overload-induced hypertrophy.
- **DOMS** is likely needed to induce myonuclear accretion.

TENSION (ADAPTIVE CHALLENGE)

MECHANOTRANSDUCTION

There is a "continuous physical link between the **extracellular matrix**, **cytoskeleton**, **sarcomere**, and **nuclear matrix** as a means to rapidly regulate gene expression following a mechanical stimulus."

There are several Mechanotransducing Pathways:

- **GPCR** (G-Coupled Protein Receptors)
- **DAG** (Dystrophin-Associated Glycoprotein Complexes)
- **α7β1** (Alpha7β1 Integrin)
- **SAC** (Stretch Activated Channels)
- **MAPK** (Mitogen Activated Protein Kinases)

Mechanical Stimulus → mTORC1 → Protein Synthesis

ECCENTRIC MUSCLE ACTIONS

- DEFINITION: Muscle force is less than the resistance resulting in the ***muscle lengthening.***
- Fewer muscle fibers recruited
    - Recruits **more FT** fibers
    - Recruits **less ST** fibers
    - **↑mechanical force** by the **working fibers (FT)**.
- Recruitment of rapidly contracting fibers having a short relaxation time is most appropriate for better control of fast movements.
- **Eccentric Actions** Result in:
    - **Increased protein synthesis**
    - Increased mTORC1 signaling
    - Increased satellite cell activation
    - Increased muscle membrane integrity
    - Increased **DOMS**

DOMS (DELAYED ONSET MUSCLE SORENESS)

- Unaccustomed exercise, predominantly ***eccentric muscle actions***, results in mechanical muscle damage
- Factors leading to skeletal muscle damage:
    - Longer ***duration*** (number or repetitions)
    - Higher ***intensity*** (greater percentage of maximal **eccentric loading**)
    - Higher exercise intensity seems to have more influence than duration of exercise.
- Disrupted Calcium Homeostasis
    - Calcium activated proteases; Lysosomal proteases
    - ROS production
    - Cytokine release

- Neutrophil and Macrophage activation → inflammation
- Cytokines from immune cells play a key role in **satellite cell activation**/recruitment
- Lactic Acid is **NOT** a significant contributor to DOMS

FASTING AND SATELLITE CELLS

- Fasting causes muscle SCs to enter a **deep quiescent state.**
- Deep Quiescent State (DQS)
  - Smaller cell size
  - Less mitochondrial content
  - Less oxygen consumption
  - Less RNA content
- Delayed ROI (return on investment)
  - Lasts for 72 hours after feeding (delayed muscle regeneration)
  - **Enhanced resilience** to nutrient, cytotoxic, and proliferative stress
- Deep Quiescent State Results from:
  - Fasting;
  - Ketogenic Diet or;
  - **Feeding BHB** (Beta Hydroxybutyrate)

NUTRITION

PROTEIN

Window of Opportunity: **48 hours** after exercise = ↑ sensitivity to leucine

AMOUNT

The amount is the ideal to maximize protein synthesis for hypertrophy, not an amount to prevent disease.

Adults

- Young: 0.24 g/kg body mass
- Old: 0.40 g/kg of body mass
- **Young: 0.25 g/kg lean body mass**
- **Old: 0.60 g/kg of lean body mass**

220lbs = 100kg
100kg (.75 lean) = 75kg lean body mass
0.25(75) = **20 grams of protein (per meal)**
0.6(75) = **42 grams of protein (per meal)**

QUALITY

Certain Amino Acids are critical for stimulating mTORC1:

- **Leucine**
- Methionine
- Arginine
- Glutamate/Glutamine

Maximal mTORC1 Activation (meal)

- >2.2g leucine younger adults
- >2.5g leucine for older individuals

Upper Limit for **leucine** is over 500 mg/kg/d (38 g/d for a 75 kg person)

AVAILABILITY

PDCAAS – protein digestibility-corrected amino acid score
DIAAS – digestible indispensable amino acid score
EAA-9 – essential amino acid 9 score

ANTINUTRIENTS

- Natural or synthetic compounds that interfere with the absorption of nutrients.
  - Drugs, Chemicals, Dietary Fiber, Proteins, Overconsumption of nutrients

EXCESSIVE PROTEIN

Consumption of 2g/kg (bodyweight)/day is safe for healthy adults.
Tolerable upper limit of 3.5 g/kg(bodyweight)/day for well-adapted persons.

UNBALANCED DISTRIBUTION

Most adults >60% of daily protein consumed during a single evening meal and ≤ 15 g at breakfast.
Overnight fast = Breakfast starts with negative net protein balance.

ADDITIONAL ONLINE CONTINUING EDUCATION

- INTERMITTENT FASTING
- GUT MICROBIOTA
- GLUTEN AND CELIAC DISEASE

https://palmerce.learningexpressce.com/index.cfm?eventTypeID=0&categoryIDs=&q=weinert

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Amino Acid Profiles from food sources (tables)