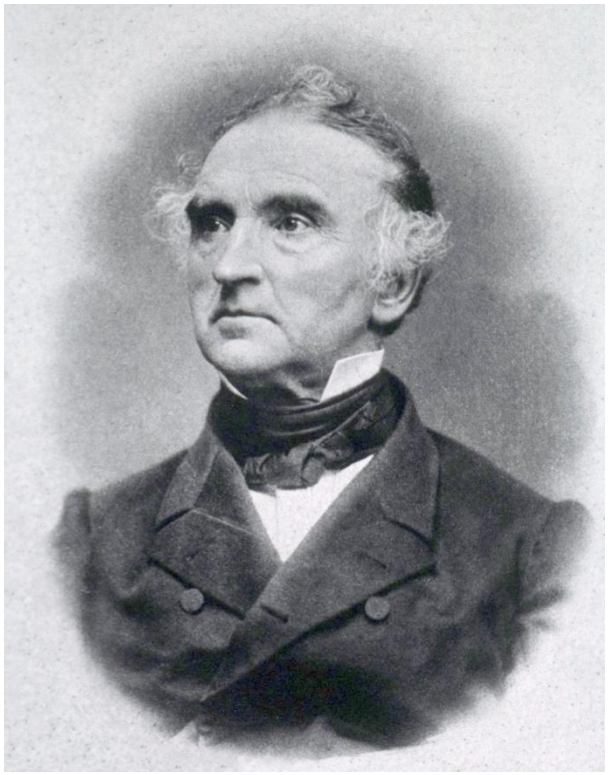
History of Sports Nutrition

NUTD 337

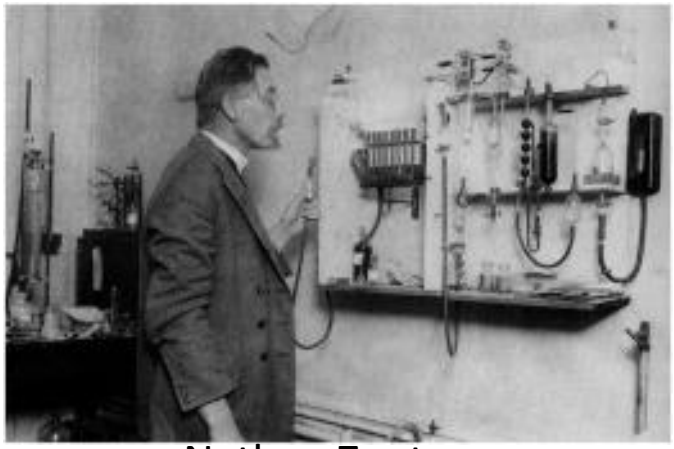
What fuel does the muscle use?

- 1842 protein as muscular fuel
- 1866 theory was nullified



Justus Von Leibig

- Zuntz 1901
- Krogh & Lindhard 1920



Nathan Zuntz

Eureka its glucose!

- Levine & Colleagues 1924
  - The Boston Marathon participants
  - Glucose measurement decline after marathon

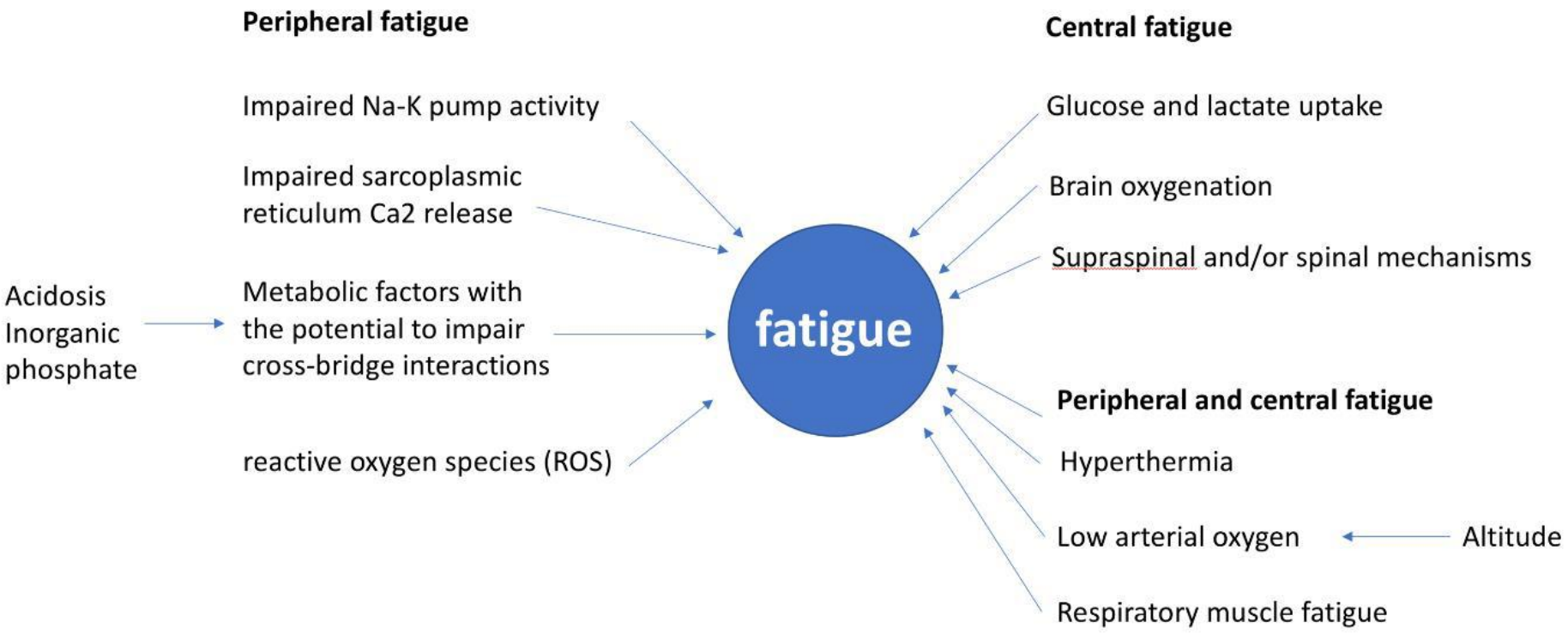
- Dill, Edwards, & Talbot 1932
  - The dogs Sal & Joe experiment
- Jonas Bergström and Eric Hultman
  - Muscle biopsies on each other

Understanding fatigue

Types of fatigue

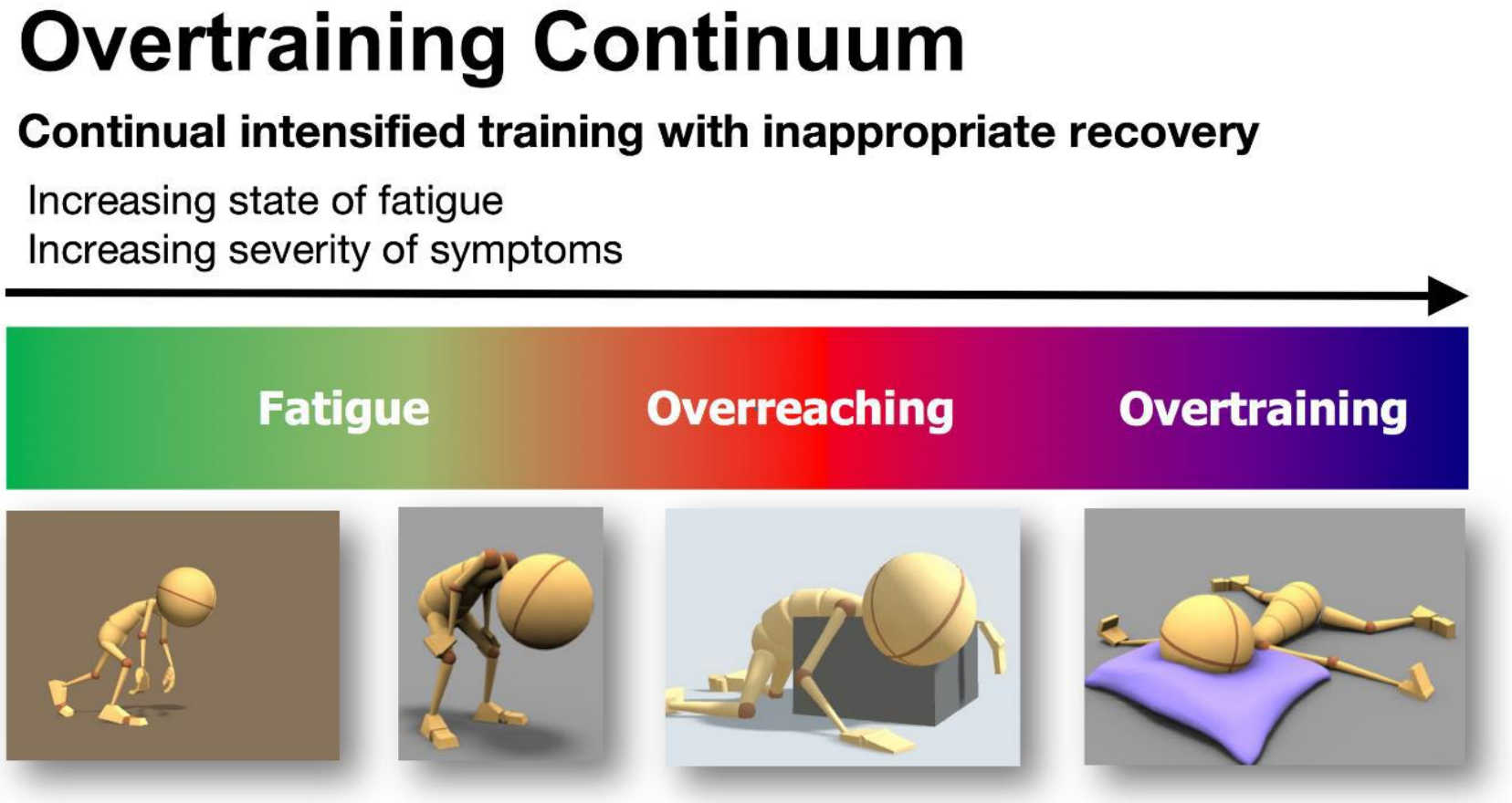
- Acute fatigue
  - We all get it
- Chronic fatigue
  - Need rest and nutrition
- Overreaching ☺
  - Rest and nutrition then improvement
- Overtraining
  - Mental and physical symtpom ☹

How does fatigue work



Source: several source refer to author

Fatigue: where do you want to go?

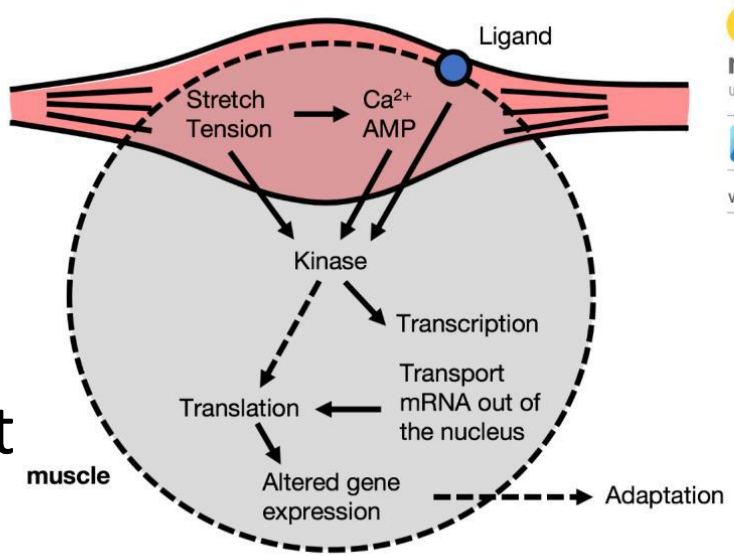


Source: Jeukendrup 2015a, http://bit.ly/2S3Ckuf

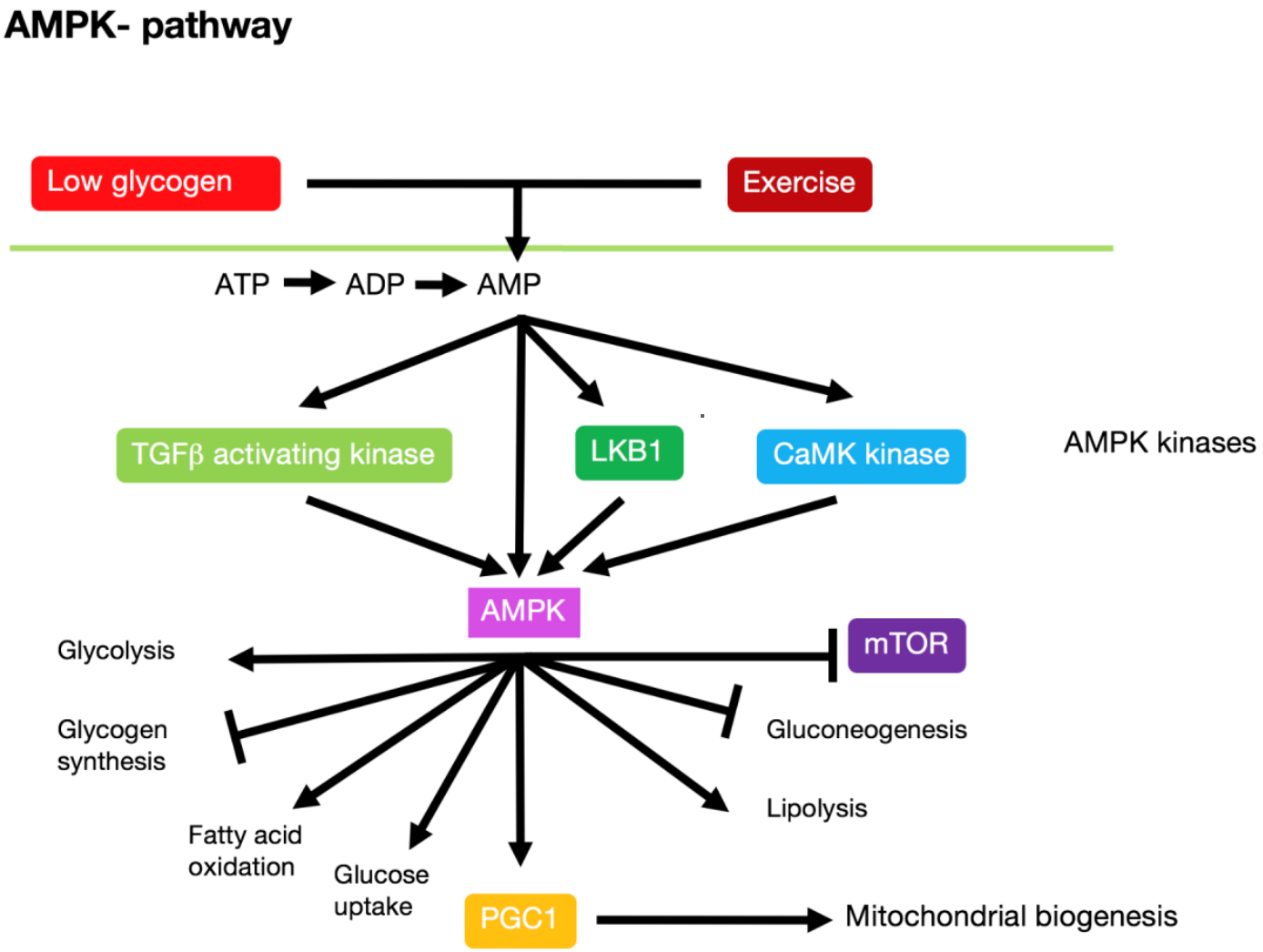
Signals of change

Primary signals

- Types of Signal
  - Mechanical Signal
    - Lifting weights
  - Neuronal Activation
    - Action potential
  - Hormonal adjustment
    - Testosterone increase
  - Metabolic disturbance
    - ROS generation

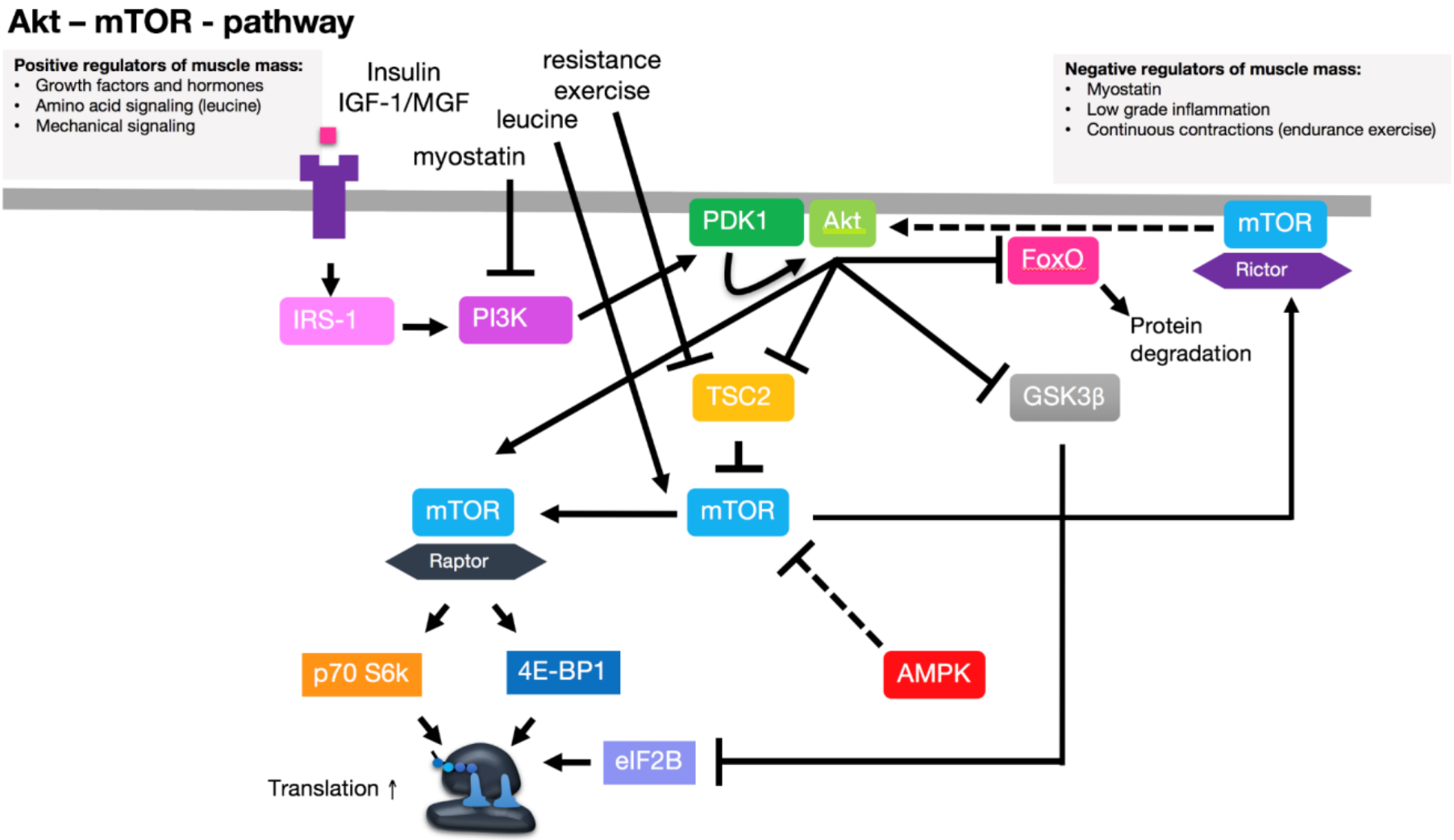


Secondary Signals



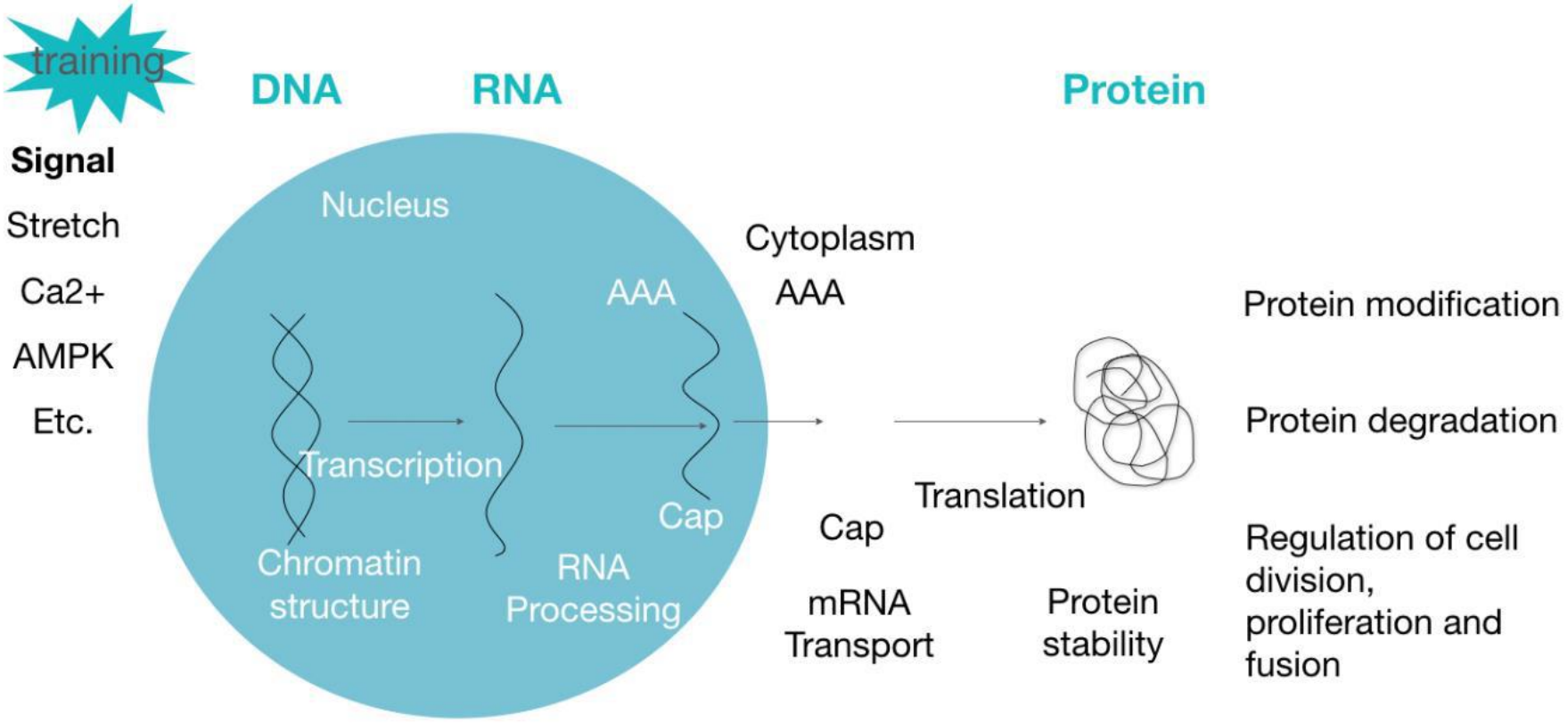
Source: Jeukendrup and Geelson 2018

Secondary Signal continued



Source: Jeukendrup and Geelson 2018

The big picture



Source: Jeukendrup and Geelson 2018

Optimizing Recovery & Protein Synthesis

Optimizing Recovery & Adaptations

- Rehydration
  - Important to sustain performance
  - >2% loss of body mass reduces performance
  - Essential for recovery

- Optimizing Protein Synthesis
  - Long term training adaptations
  - With regular training hypertrophy can be achieved

Rehydration

Volume

- Weight before training
  - 80 kg
- Weight after training
  - 79.2 kg
- Volume
  - 150% of weight lost
- Amount to be consumed
  - 1.5x0.8=1.2 L of fluid
- Check Urine color

Urine color indicates hydration status

Source: https://www.usada.org/resources/nutrition/fluids-and-hydration/

Fluid Content

Sodium

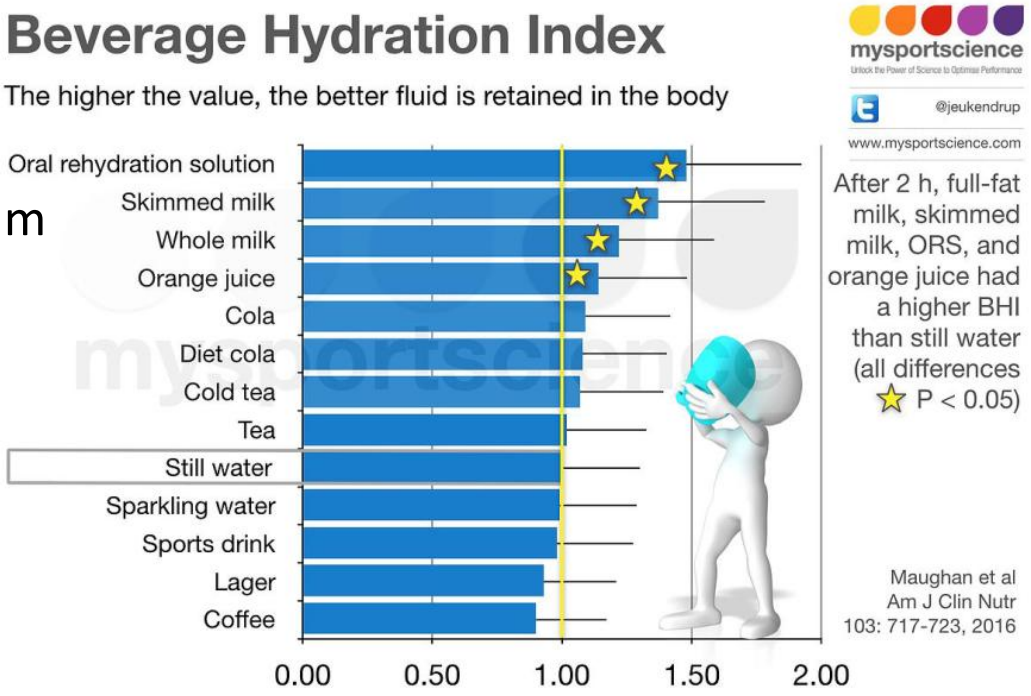
Carbohydrates

Increase Renal water reabsorption	Reduces Urine output	increases insulin	Insulin increase renal sodium reabsorption
Restores plasma volume	Restores whole body fluid balance	Draws water into cells	Reduce renal water excretion

Fluids

Fluid types

- Coconut water
  - Only hydrating with sodium enrichment
- Skimmed milk
  - Reduced urine output

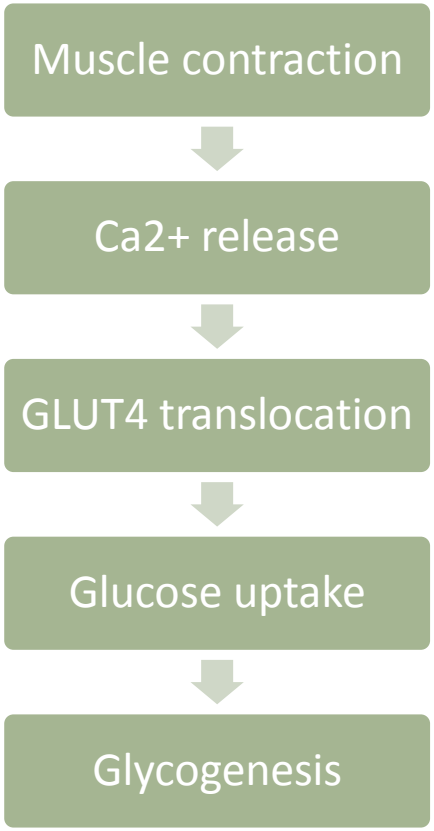


Skimmed and whole milk proved to be good hydration fluids in addition to their protein content that can enchance MPS

Source: Jeukendrup, 216b, http://goo.gle/Q6nnJV

Glycogen restoration: Rapid Phase

Rapid Phase glycogen synthesis

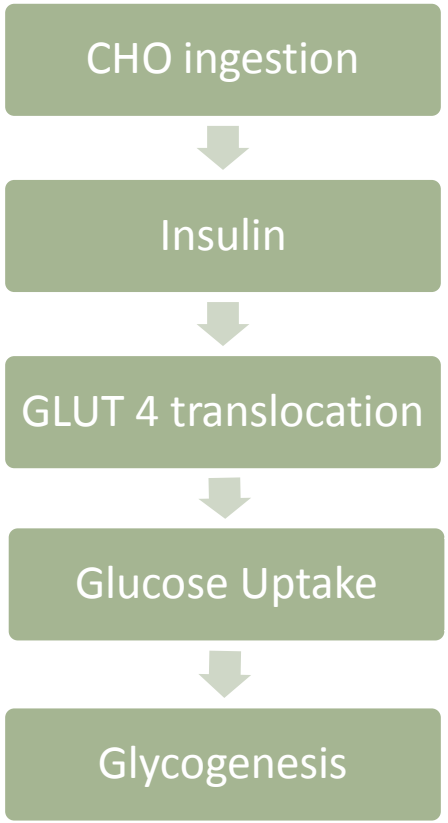


Rapid Phase

- Exercise induced
- Insulin independent
- Ca2+ release in muscle contraction
- Active Glycogen Synthase
  - I-Form (D-form inactive)
  - Glycogen low
  - Glucose transport by GLUT4
    - Across the Sarcolemma

Slow Phase (insulin-dependent)

Slow Phase glycogen synthesis



Slow Phase

- Post Exercise
- Insulin dependent
  - Circulating insulin
    - CHO ingestion important
- Glycogengenesis
  - HIGH IF GLYCOGEN LOW
  - LOW IF GLYCOGEN HIGH
- Glycogen restoration
  - 24 HOURS
    - Pre-exercise glycogen stores

CHO ingestion

Timing

- Immediately post exercise
  - ↑ Glycogen synthesis rate
- A delay of CHO ingestion
  - ↓ Glycogen stores

Glycogen synthesis rate can improve with the co-ingestion of CHO with caffeine or protein but only if ingested CHO amount is suboptimal if ingested CHO amount is optimal Caffeine and protein do not have an effect on Glycogen synthesis rate.

Amount & Type

- 70-90 g first hours
  - First hours post exercise
- Glucose & Sucrose
  - MAX Glycogen replenishment
  - Direct delivery to muscle cells
- Fructose
  - To liver first where it is stored
  - Not all delivered to muscle cells

Optimizing Protein Synthesis

Net Protein Synthesis (NPS)= *protein breakdown (PBD) + synthesis (PS)*

PBD>PS=-ve NPS

Muscle Protein Synthesis (MPS)

Adaptation

PS>PBD=+ve NPS

Muscle Protein Synthesis (MPS)

Adaptation

Max MPS

20 g for smaller muscle group trained

40 g for larger muscle group trained

Protein amount, type & timing matter!

Protein quality

Type	Digestion rate by GI	Rate of MPS after 3 hrs
Whey	Fastest	Highest
Soy	Fast	High
Casein	Slow	Lowest

Whey or Soy can be consumed immediately within the hours after exercise and through out the day

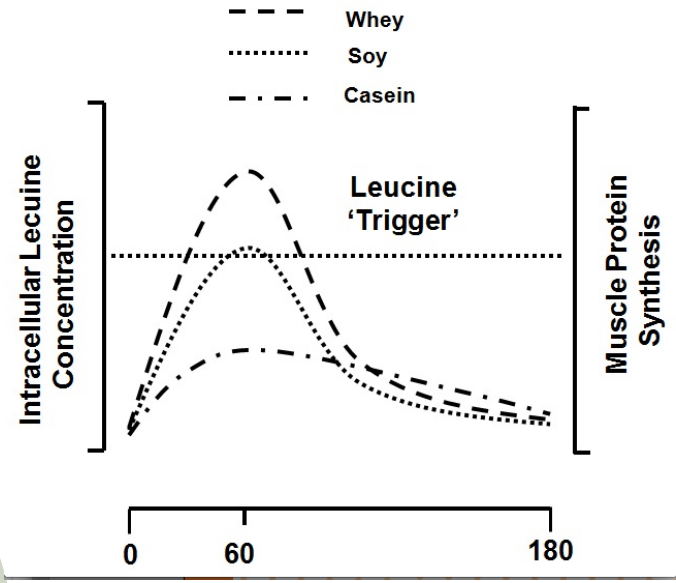
Casein can be consumed at night time

Amount & Timing

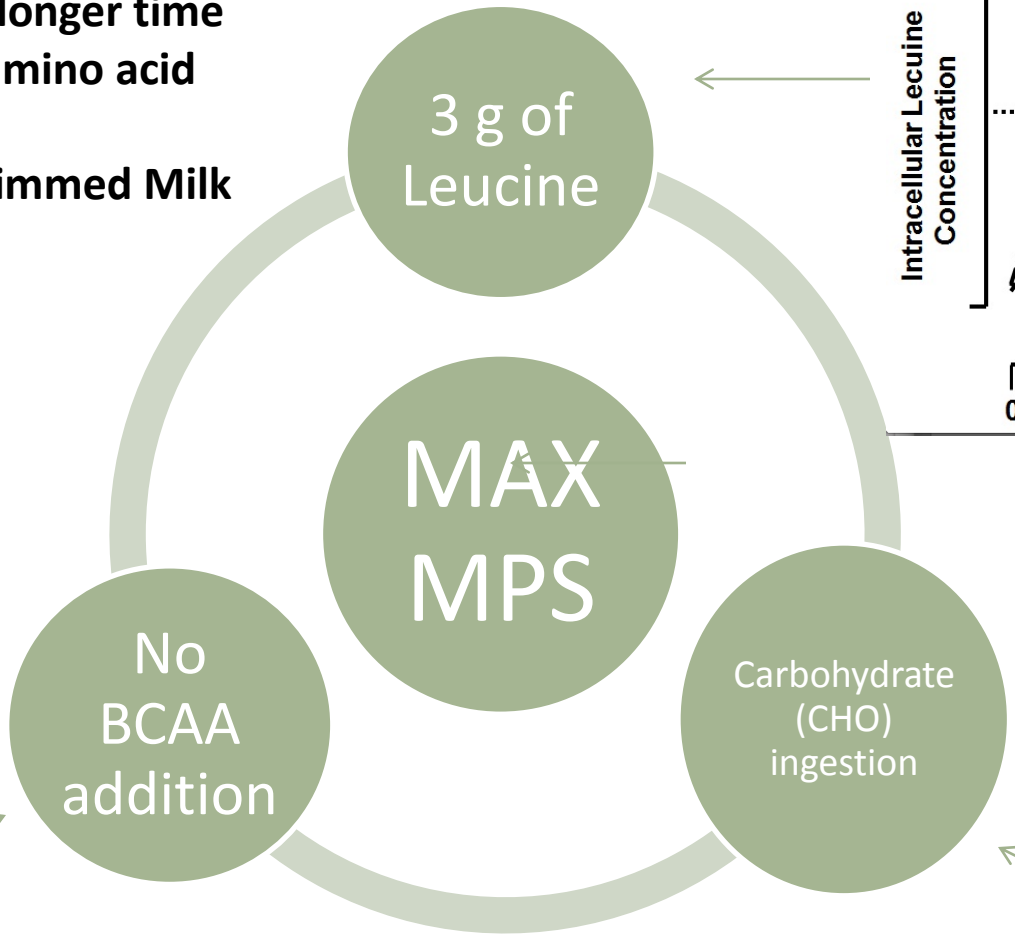
- For Max MPS
  - 0.4 g/ kg BW /meal of protein over
  - 24 hrs (anabolic window) of which
  - 0.6 g/kg BW/meal pre-sleep
- Post Exercise
  - 20 g protein/meal for smaller muscle group
  - 40 g protein/meal for large muscle group

Amino Acids and other nutrients!

Fat has no effect on MPS but it sustains MPS for longer time due to reducing amino acid delivery
MPS: Whole > Skimmed Milk



Leucine trigger: At higher Leucine concentration (3 g) MPS is stimulated. Whey (highest Leucine Concentration)
Source: Tang, et al. 2009, J. Appl. Physiol. 107: 987-992.



Isoleucine + Valine inhibit Leucine absorption

CHO increase insulin which increase amino acid uptake for MPS

Applications & wrap up

Ingest good quality proteins in your meals, snacks, & Post exercise shake/smoothie

- 3 g of Leucine in your protein
- 10g of essential amino acid in your protein

Eat at regular interval every 3-4 hours

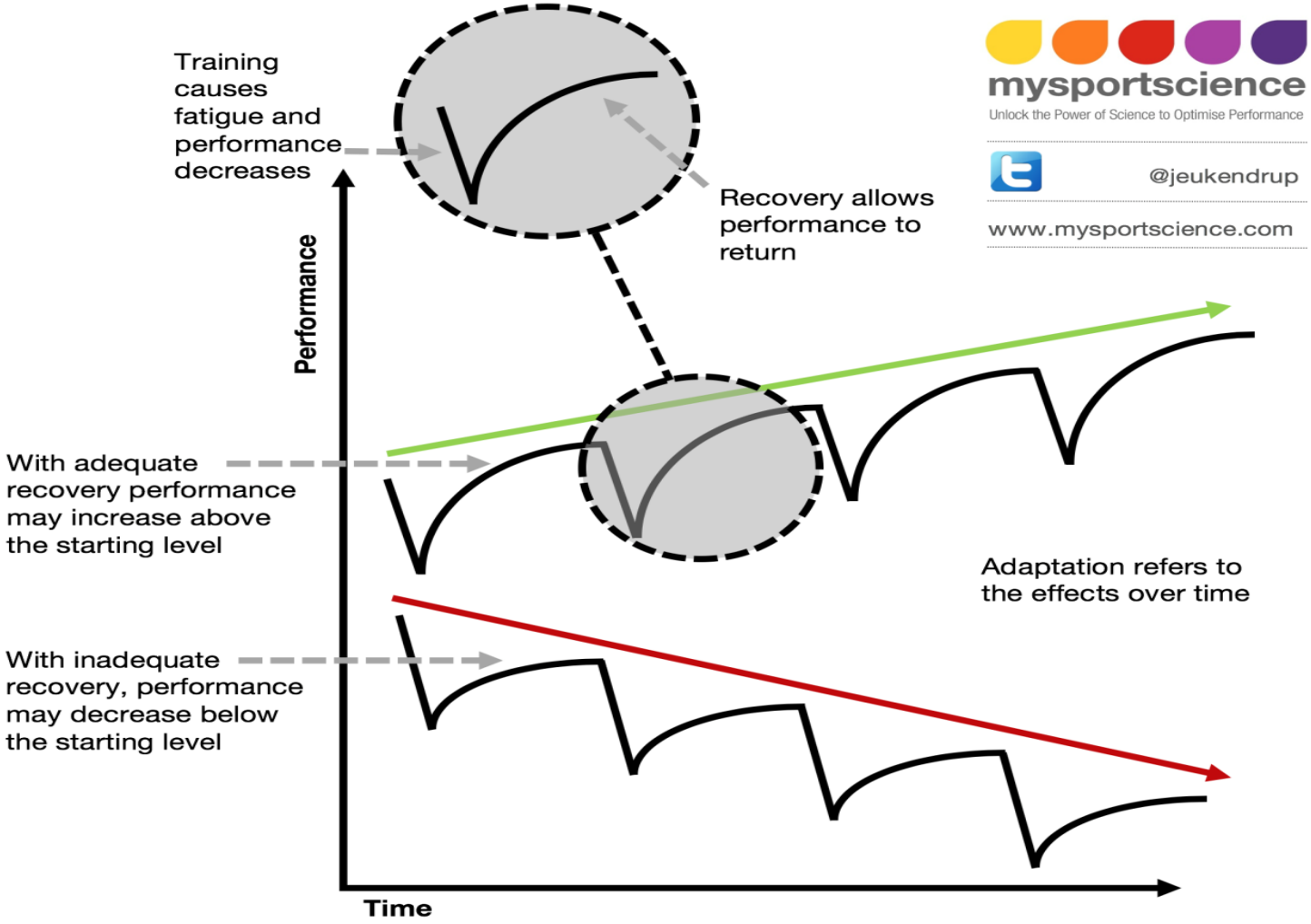
- Don't forget to ingest 0.6 g/kg BW protein pre-sleep if dinner is early
- Pre-sleep should include mainly casein protein to sustain amino acid supply and delivery at night
  - A milk based smoothie with the inclusion of 20-40 gram of Casein is a great delicious way to have a pre-sleep snack/meal

Hydrate and Rehydrate

- Weigh before training/match → weigh after training/match
- Drink 1.5 L for every kg lost after training/match in the next hour
- Include sodium (61mmmol/l) & CHO (10%) in your water (keep temperature <10 Celsius)
- Keep drinking hydrating fluids through the day
- Make sure your urine color is light to clear

Adaptations

The picture



Source: Asker J, 2018

Training Adaptation

- No better training
- Both important
- Adaptations vary
- Focus on goal

Table 1: typical adaptation after endurance and after strength training.

	Endurance training	Strength training
Capillary density	++	
Muscle glycogen	++	++
Number of mitochondria	++	+
Mitochondrial density	++	+
Resting ATP	_	+
Resting PCR	_	+
Glycolytic enzymes	_	+
Phosphofructokinase	_	+
Oxidative enzymes	++	-/+
Succinate dehydrogenase	++	+
Citrate synthase	++	+
HAD	++	+
Maximum cardiac output	++	+
Maximum oxygen uptake (VO_2max)	++	+
Maximum heart rate	_	_
Plasma volume	++	
Muscle fibre size	_	++
Fat oxidation	++	+

Source: (Jeukendrup & Gleeson, 2018).