Let's Excel Together

CANADIAN ACADEMY OF SPORTS NUTRITION

Lecture 7:

Energy Systems in The Body

(Part 2)

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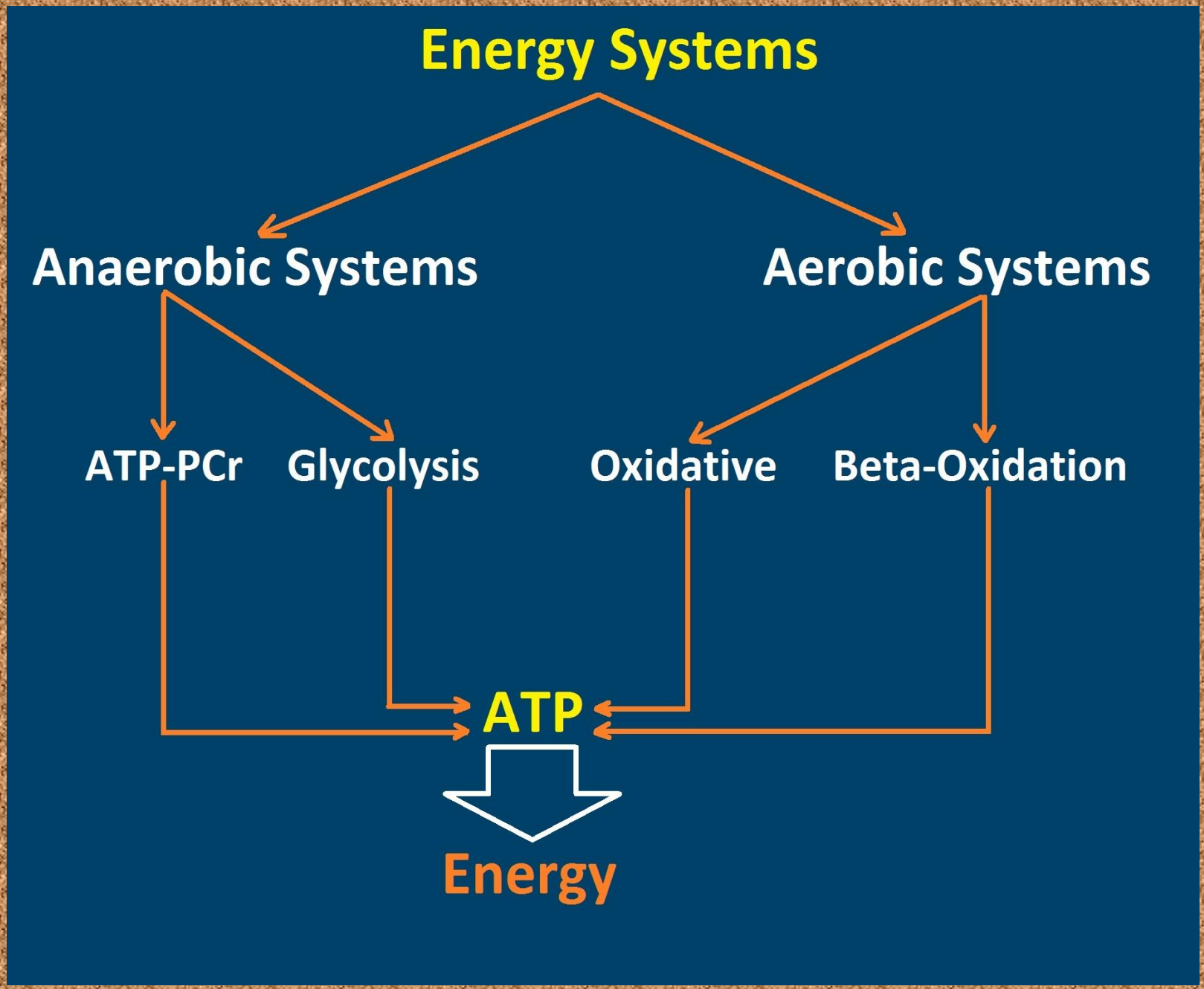
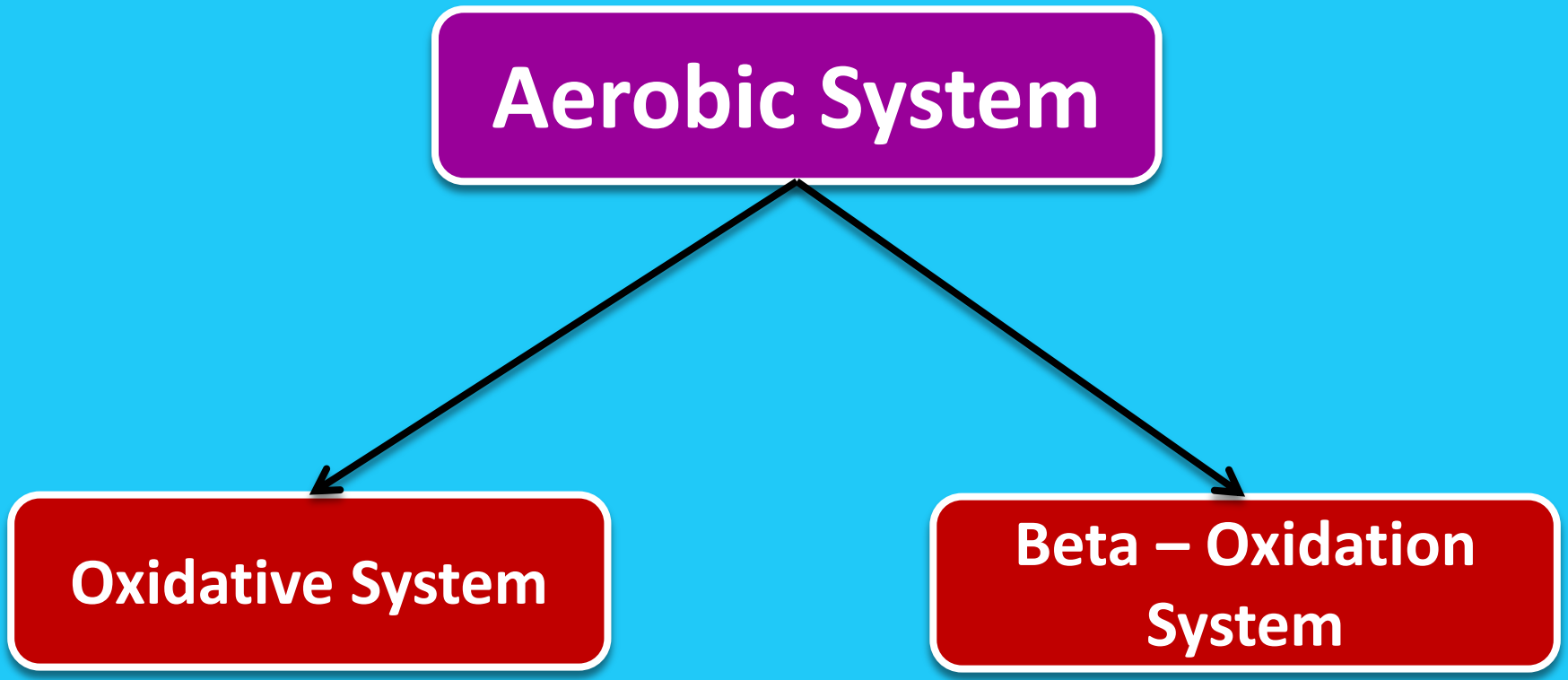

Energy Systems
Anaerobic Systems
Aerobic Systems
ATP-PCr
Glycolysis
Oxidative
Beta-Oxidation
ATP
Energy

Aerobic System:

- **Also called as the "long – term energy system", aerobic system is the dominant energy system in exercise lasting more than 2 – 3 minutes.**

- **When a physical activity lasts longer than 2 – 3 minutes, the aerobic system plays an important role in providing ATP in order to continue exercising.**

- **To produce ATP through the aerobic system, the body uses oxygen.**


Aerobic System
Oxidative System
Beta – Oxidation System

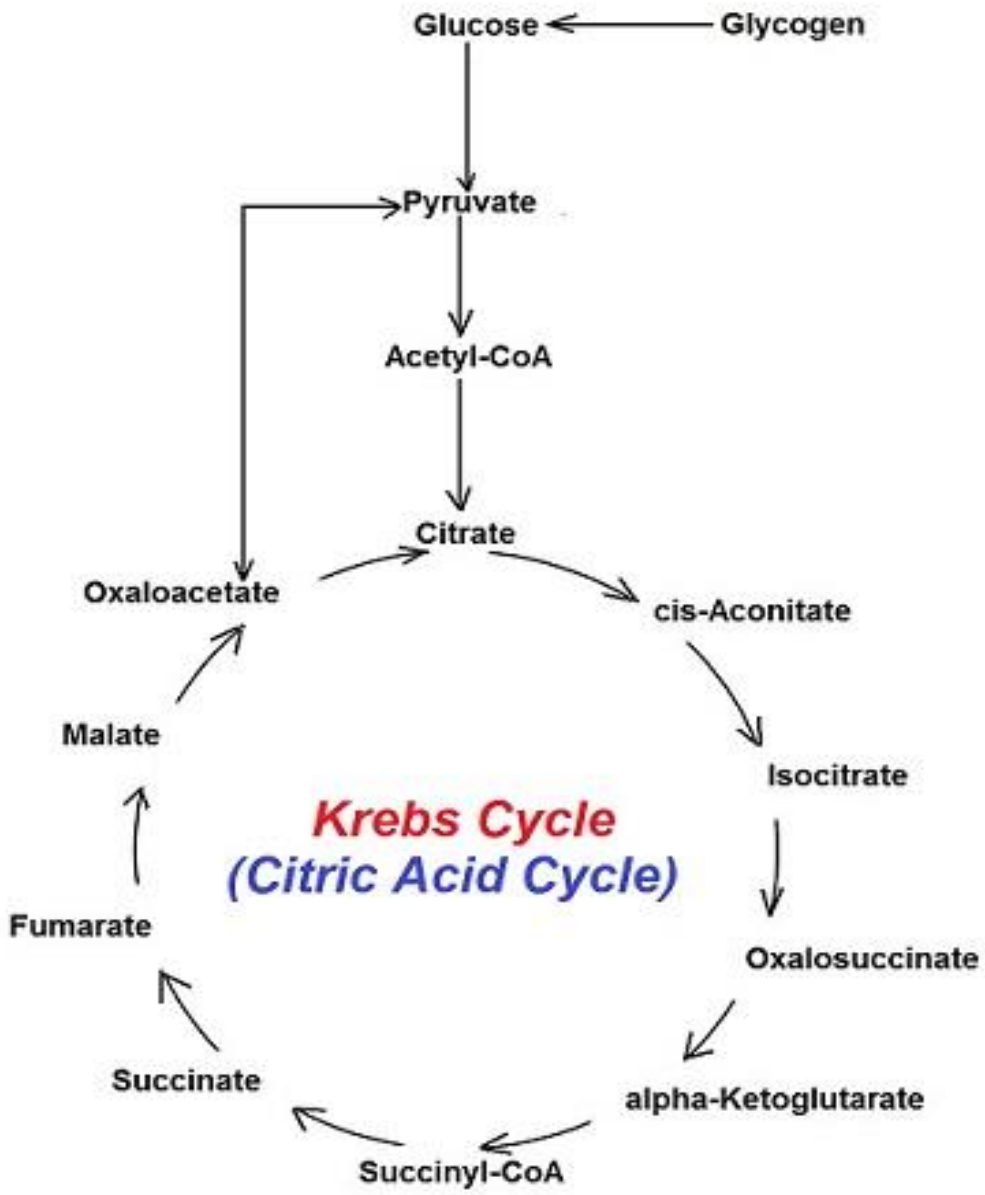
Oxidative System:

- Also called "aerobic glycolysis", "Krebs cycle", "Citric acid cycle" and "Tricarboxylic acid cycle (TCA)".

- This system is the dominant energy provider in an exercise of more than 2 – 3 minutes in duration and moderate intensity.

- **Using oxygen, the body breaks down glucose or glycogen through this system to generate enough ATP.**

- **One molecule of glucose yields to 36 – 39 ATPs in citric acid cycle.**


Glucose
Glycogen
Pyruvate
Acetyl-CoA
Citrate
Oxaloacetate
cis-Aconitate
Isocitrate
Oxalosuccinate
alpha-Ketoglutarate
Succinyl-CoA
Succinate
Fumarate
Malate
Krebs Cycle
(Citric Acid Cycle)

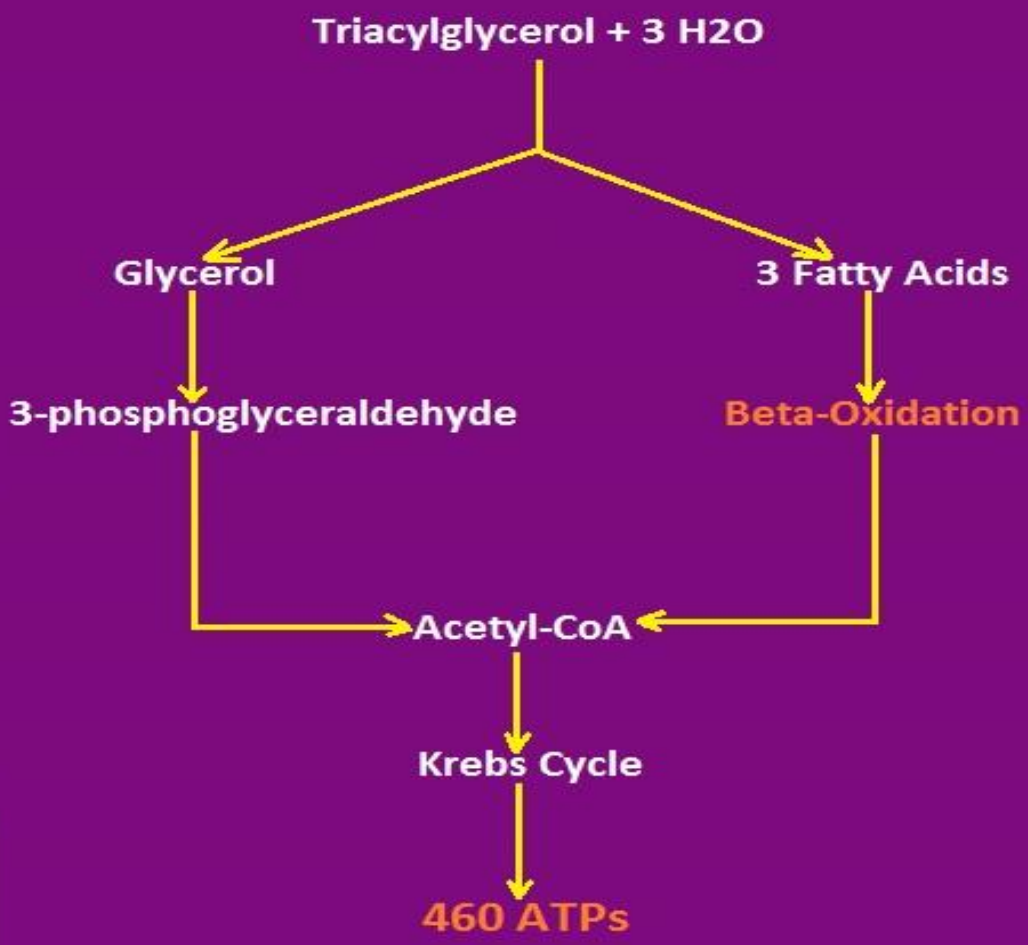
Beta – Oxidation System:

- Also called "*Fatty Acid Oxidation*". This system is the main source of energy for an exercise more than 2 – 3 minutes in duration and low intensity.

- Using oxygen, the body breaks down triacylglycerol (stored in the muscles and adipose tissues) to fatty acids. Then fatty acids break down to acetyl – CoA via beta – oxidation. Finally, acetyl – CoA enters into the Krebs cycle to generate ATP.

- This system generates 460 ATPs from metabolizing one molecule of triacylglycerol.

Beta – Oxidation System:



Sports with Dominating Aerobic System:

a) Athletics:

- *1500 m.*
- *5000 m.*
- *10000 m.*
- *Marathon.*
- *20 km walk.*
- *50 km walk.*
- *3000 m steeplechase.*

b) Biathlon.

c) Bobsleigh.

d) Boxing.

e) Canoe/Kayak Sprint: *men`s events (C-1 1000 m canoe single, C-2 1000 m canoe double, K-1 1000 m kayak single, K-2 1000 m kayak double, and K-4 1000 m kayak four).*

f) Cycling:

- Road cycling.

- Track cycling.

- Cross – county cycling.

g) Modern pentathlon.

h) Rowing.

i) Skating:

- Speed skating (3000 m, 5000 m, 1000 m, team pursuit).

- Short track speed skating (5000 m relay).

- Figure skating (all events).

j) Skiing: ***cross – country skiing (10 km, 15 km, 4X10 km relay, team sprint, 7.5 km + 7.5 km skiathlon, 15 km + 15 km skiathlon, 30 km, 50 km).***

k) Swimming:

- Backstroke swimming (200 m).

- Breaststroke swimming (200 m).

- Butterfly swimming (200 m).

- Freestyle swimming (200 m, 4 x 100 m relay, 400 m, 800 m, 1500 m).

- Medley swimming (200 m individual, 4 x 200 m relay, 400 m individual).

- Synchronized swimming (duet, team).

- Marathon 10 km.

l) Triathlon.

Energy Map in the Body:

- **Energy map is the design of metabolic reactions of the energy systems and their interrelationships and connections to each other.**

- **On the energy map, every energy system is considered an "energy zone or energy district".**

- **The energy map is composed of 5 energy zones :**

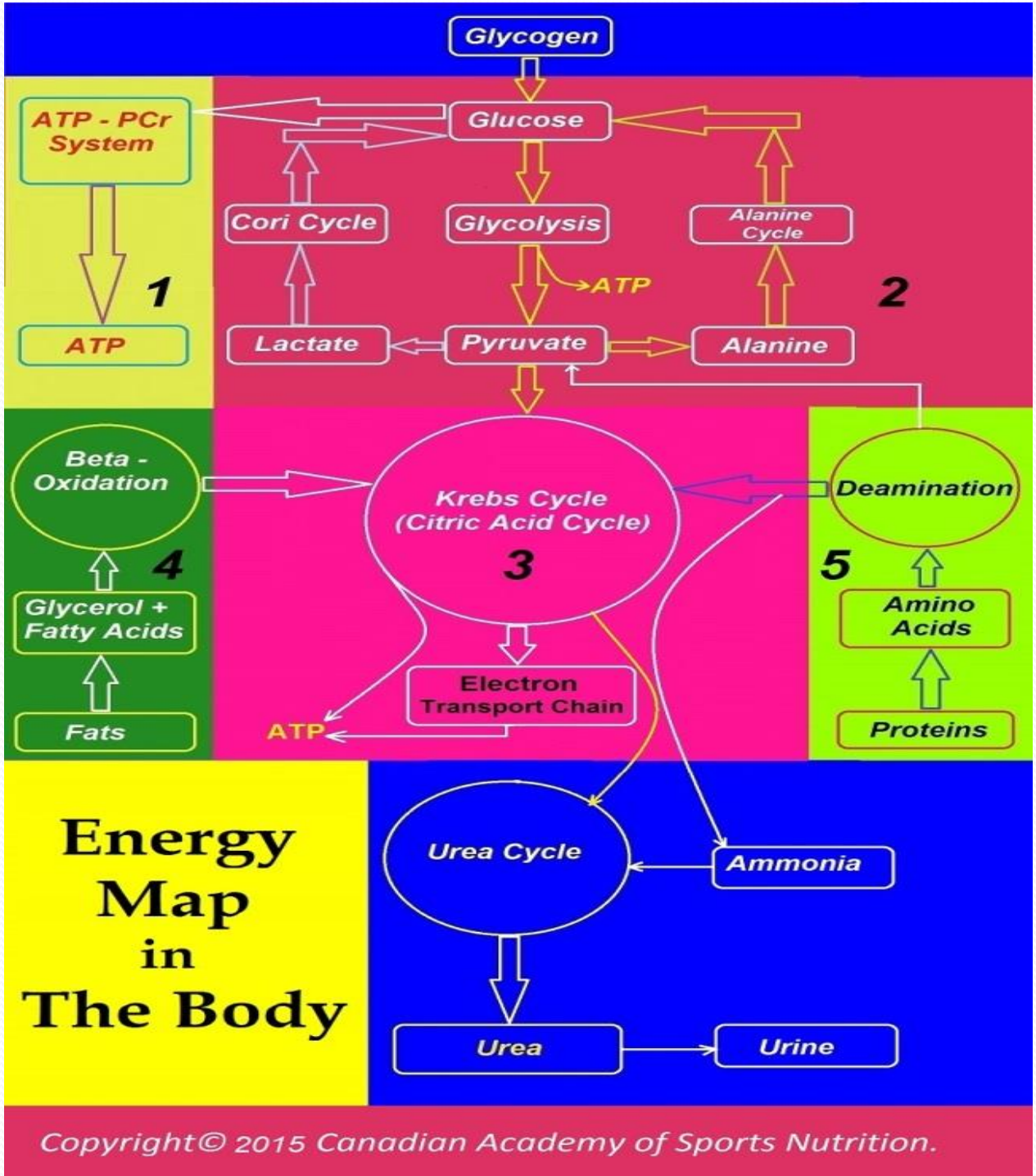
Zone 1: ATP – PCr system.

Zone 2: Anaerobic Glycolysis.

Zone 3: Krebs Cycle.

Zone 4: Fatty Acids Oxidation.

Zone 5: Protein Breakdown.


Glycogen
ATP - PCr System
Glucose
Cori Cycle
Glycolysis
Alanine Cycle
ATP
1
2
ATP
Lactate
Pyruvate
Alanine
Beta - Oxidation
Krebs Cycle (Citric Acid Cycle)
Deamination
4
3
5
Glycerol + Fatty Acids
Amino Acids
Electron Transport Chain
Fats
ATP
Proteins
Energy Map in The Body
Urea Cycle
Ammonia
Urea
Urine
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Advantages of Energy Map:

- 1) It shows the interrelationships of the energy systems.
- 2) It helps you find the dominant and non – dominant energy systems.
- 3) It demonstrates how the order of energy zones changes based on intensity and duration of the sport or exercise you are involved in it.
- 4) It shows that which energy system should be manipulated first.

Alanine Cycle (Glucose – Alanine Cycle):

- **It functions very closely with glycolysis. During the alanine cycle, the pyruvate produced by glycolysis is converted to alanine in the muscles and then carried to the liver wherein converts to glucose.**

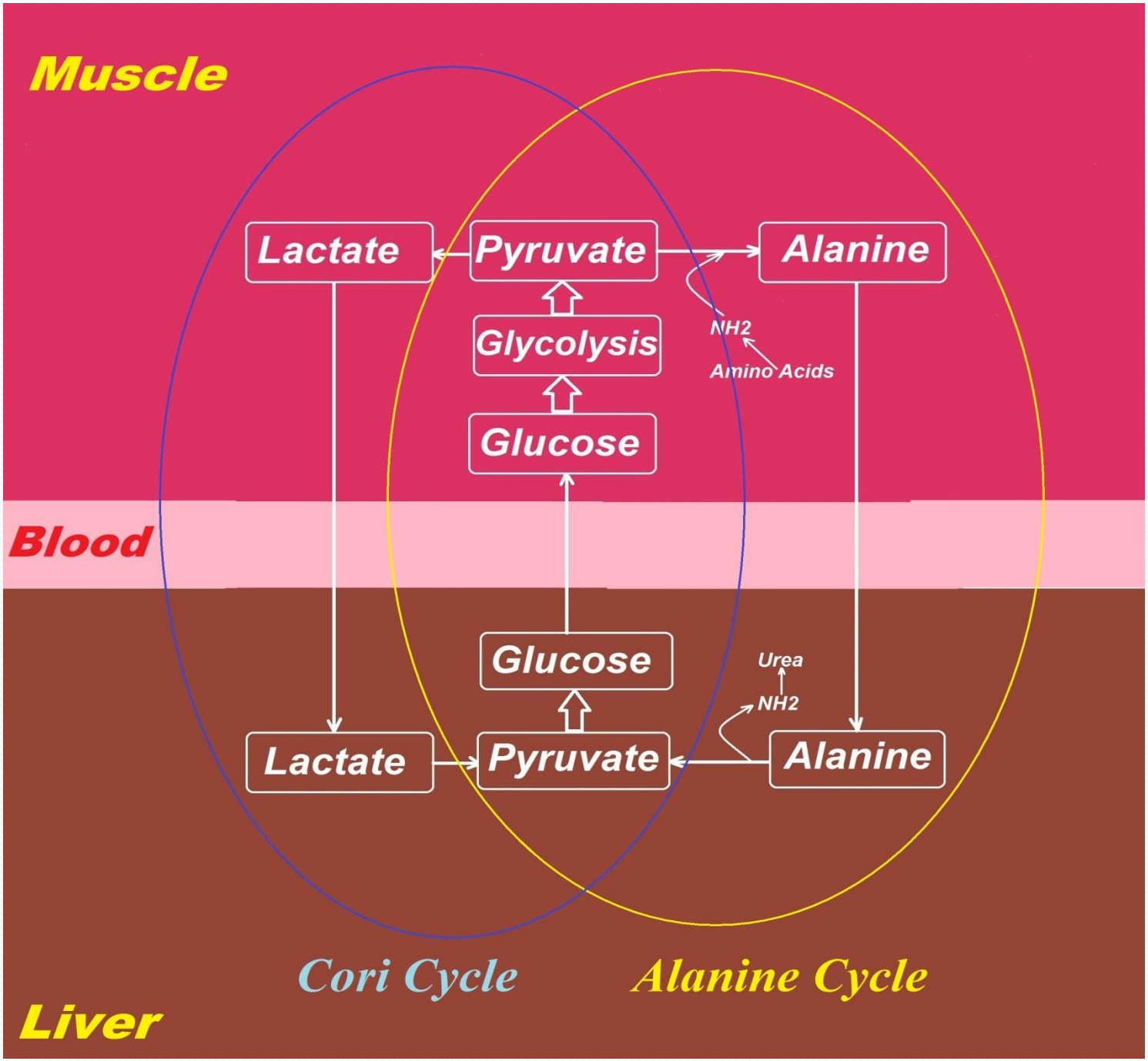
- **As intensity and duration of exercise increase, alanine may indirectly involve in providing energy. The alanine cycle can generate up to 15% of total energy required for an exercise.**

- **During a prolonged exercise or training session, the alanine – glucose cycle would be responsible for up to 45% of glucose released by the liver.**

Cori Cycle (Lactic Acid Cycle):

- **This cycle also works very closely with glycolysis.**

- **During this cycle, the pyruvate produced by glycolysis is converted to lactic acid in the muscle and then lactic acid is carried to the liver wherein converts to pyruvate and then to glucose.**


Muscle
Lactate
Pyruvate
Alanine
Glycolysis
NH2
Amino Acids
Glucose
Blood
Glucose
Urea
NH2
Lactate
Pyruvate
Alanine
Cori Cycle
Alanine Cycle
Liver

Protein Breakdown:

- **Proteins are not usually considerable sources of energy during an exercise.**

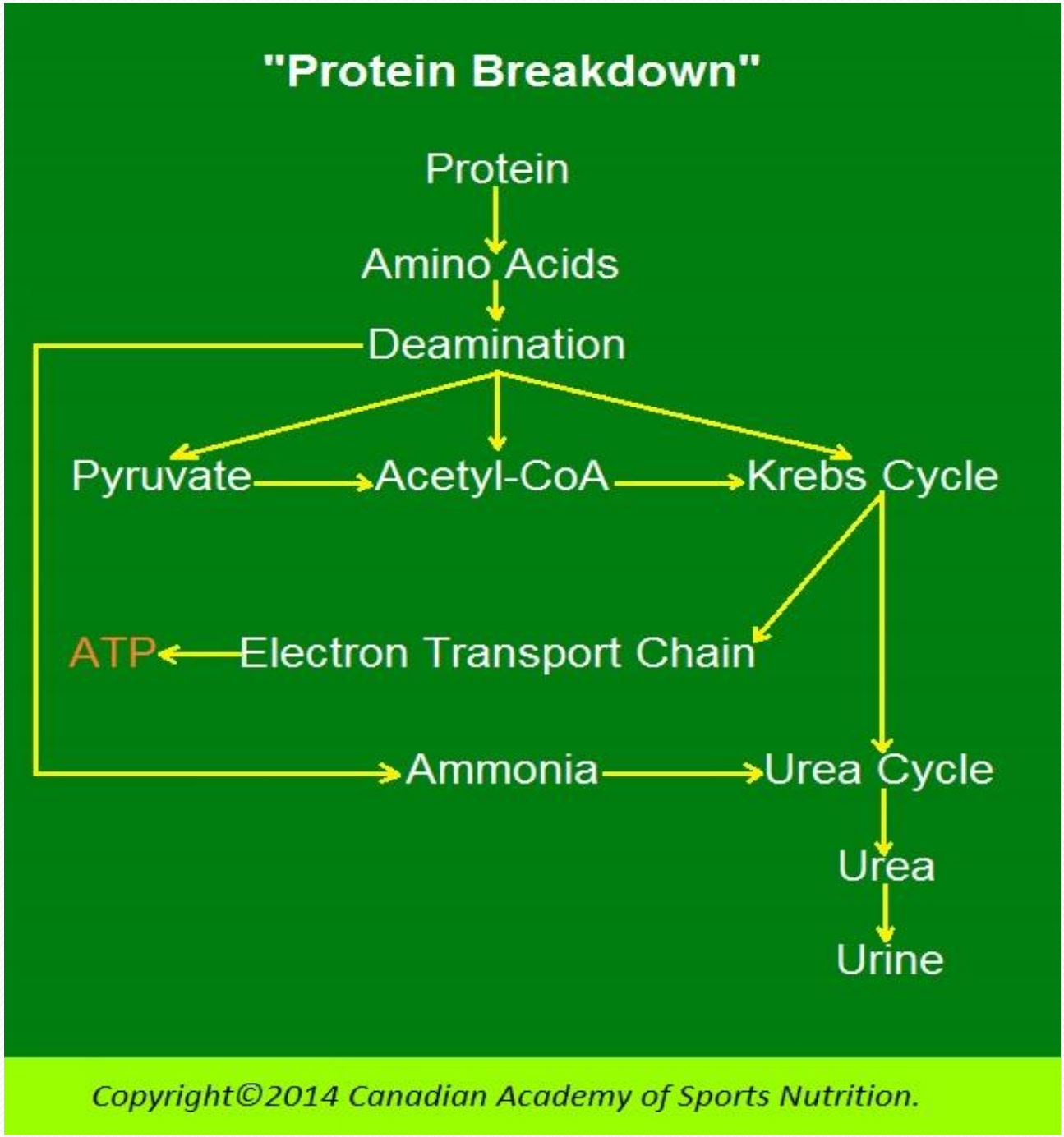
- **In people with a well – balanced diet, protein breakdown accounts for 2 – 5% of total energy required by the body at rest.**

- **As exercise continues, glycogen stores are depleted.**

- **During endurance exercise, prolonged training session, or training 7 days a week, when glycogen reserves are diminished, the body breaks down fat and then protein to sustain glucose output of the liver.**

- **In endurance sports, such as marathon or ultra-marathon, when the aerobic system is exhausted to provide energy, the body would use protein breakdown to generate energy. Under these circumstances, the body would consume the protein in the muscles. The protein in the neural and connective tissues remains relatively "*untouched*" and will not be recruited for energy production.**

- **In regular exercise and sports competitions, protein does not play a role in generating energy .**


"Protein Breakdown"
Protein
Amino Acids
Deamination
Pyruvate
Acetyl-CoA
Krebs Cycle
ATP
Electron Transport Chain
Ammonia
Urea Cycle
Urea
Urine
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Homework:

- **1) Describe the Lactic Acid Cycle.**

- **2) Describe the Beta – Oxidation energy system and list at least five sports in which this system is the main ATP provider.**