Energy systems

Level 2 Anatomy and physiology
for exercise and fitness instructors

Learning outcomes

By the end of this session you will be able to:

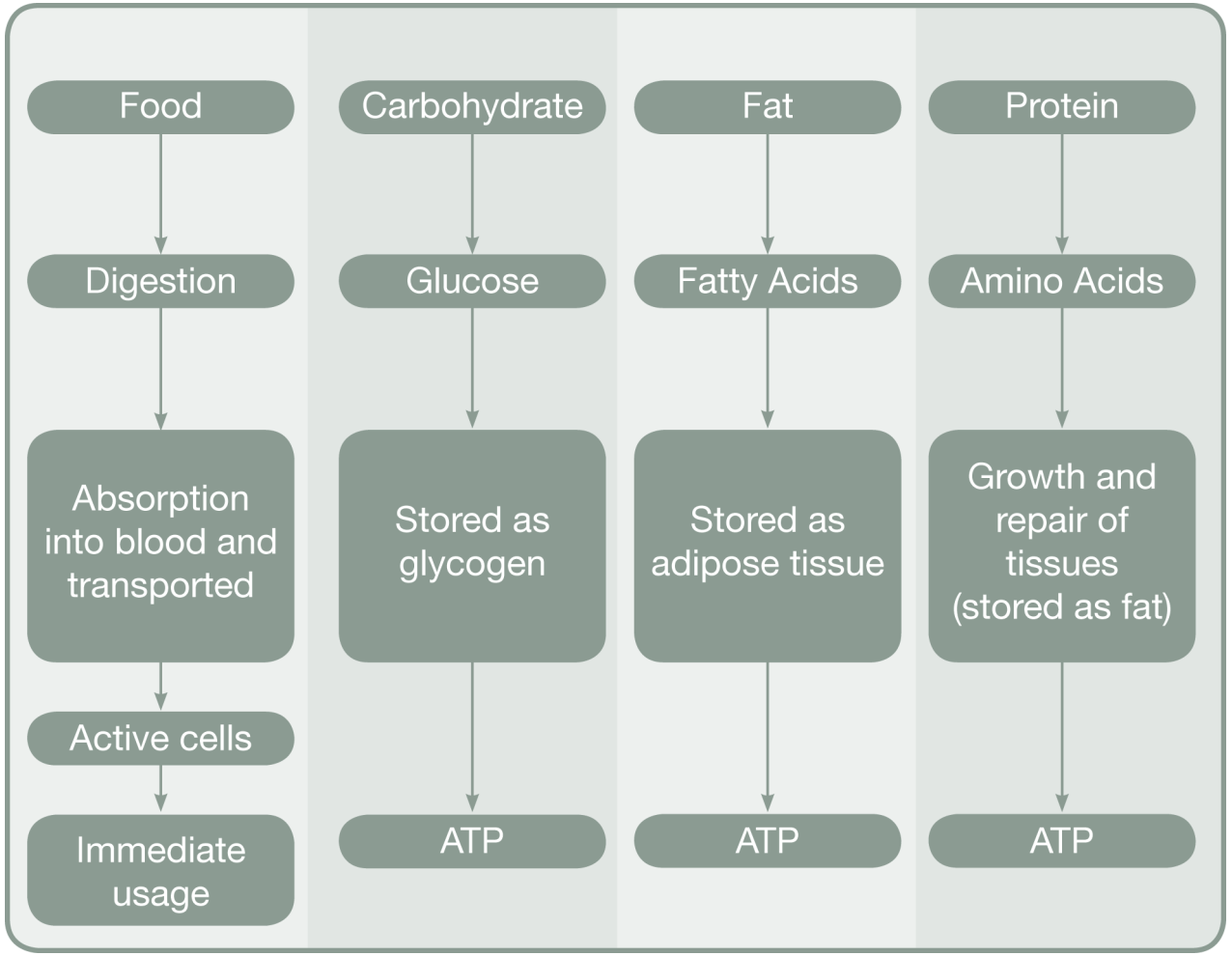
- Describe how carbohydrates, fats and proteins are used in the production of energy
- Explain the use of the three energy systems during exercise

Energy

Energy comes from the food we eat

- Carbohydrate - stored in muscle and liver cells in the form of glycogen
- Fat - stored as adipose tissue
- Protein - used as the building material for growth and repair

Energy


Food
Digestion
Absorption into blood and transported
Active cells
Immediate usage
Carbohydrate
Glucose
Stored as glycogen
ATP
Fat
Fatty Acids
Stored as adipose tissue
ATP
Protein
Amino Acids
Growth and repair of tissues (stored as fat)
ATP

Carbohydrate

- Stored in muscles and liver cells in the form of glycogen
- Glycogen is broken down into glucose, the fuel that can be used by all tissues in the body
- Carbohydrate should provide around 50 to 60 % of total energy

Fat

- Stored beneath the skin (adipose tissue)
- Serves not only as a fuel store but also as insulation to prevent heat loss
- Composed of triglyceride molecules that are broken down in to fatty acids to release energy
- Fats should provide about 30% of total energy

Protein

- Used as a building material for the growth and repair of tissues of the body
- Broken down to amino acids to provide energy during prolonged endurance events e.g. long distance swimming or cycling
- Protein should provide around 10 to 15% of total energy

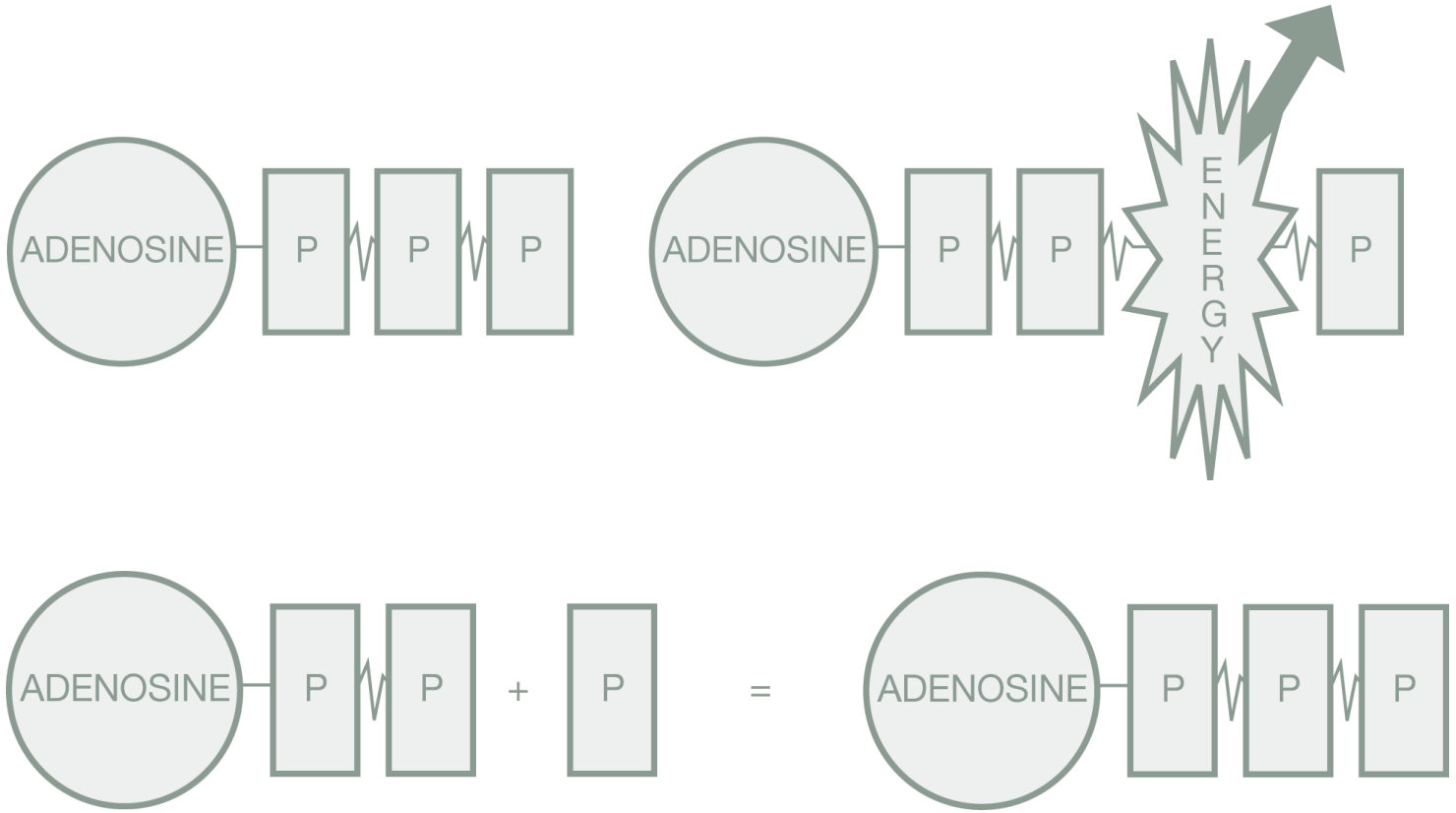
Energy

Energy is released in the body by the breakdown of carbohydrates, fat and protein to produce

Adenosine Triphosphate (ATP)

The body's energy 'currency'

ATP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Energy systems

Phosphocreatine system

- Used for high intensity/short duration activities lasting up to 15 seconds
- No harmful waste products
- Anaerobic
- Energy supplied by creatine phosphate

Energy systems

Lactic acid system

- Used for moderate to high intensity/short duration activities lasting 30 – 40 seconds
- Lactic acid waste product
- Anaerobic
- Energy supplied by glycogen

Energy systems

Aerobic system

- Used for low to moderate intensity / longer duration activities lasting 90 seconds or more
- CO2 and water waste products
- Aerobic
- Energy supplied by glycogen and fat

Energy systems

The main factors affecting choice/use of fuel include:

- Intensity
- Duration of activity
- Fitness level

Energy systems

When exercising, energy will be derived from all three systems

The emphasis will change according to the intensity of the activity relative to the person's fitness level

Sports that involve short, sharp, intense bursts of activity e.g. jumping, sprinting, throwing, are predominantly anaerobic

Energy systems

Sports that involve sustained rhythmical movements for long periods e.g. cycling, rowing are predominantly aerobic

However, most sports are a mixture of anaerobic and aerobic e.g. netball, football, which entail short bursts of high-intensity activity interspersed with longer periods of low to moderate intensity activity

Energy systems

The relative proportions of CP, fat, carbohydrate or protein used to fuel the body during exercise depends on the duration and intensity of the exercise but also on the training status of the individual

Carbohydrate and fat are rarely utilised alone
High intensity, anaerobic exercise of fairly short duration will predominantly rely on carbohydrate, as fat cannot be used in the absence of oxygen

Energy systems

Aerobic exercise will use different mixtures of fat and carbohydrate depending on the intensity

As a rule, the higher the intensity, the lower the fat consumption, even if the exercise remains aerobic

This has significant implications for fat loss programmes

Energy systems

No matter how intense or aerobic the exercise, the human body cannot efficiently burn fat alone

Fat can only be utilised efficiently for energy alongside carbohydrates

Energy systems

Fat is utilised for energy in the absence of carbohydrates

e.g. fasting, starvation, low-carbohydrate diet or poorly controlled diabetes mellitus

During this process, ketone bodies are produced and can produce a very unfavourable and acidic environment (ketosis)

Energy systems

For most people, even under steady state aerobic conditions, the ratio of fat to carbohydrate used will probably be about 50:50

This does improve with training, so fitter people will use proportionally more fat at any particular work rate compared to unfit people