

The background features a green-tinted image of a runner in profile, wearing a head-mounted display and a backpack, running on a treadmill in a laboratory setting. The treadmill's rollers and belt are visible. The overall scene is dimly lit, emphasizing the runner's form and the scientific environment.

HYDRATION PRINCIPLES: INTAKE, ABSORPTION, DISTRIBUTION & RETENTION

The logo for the Gatorade Sports Science Institute (GSSI) is located in the upper right corner. It consists of a stylized white lightning bolt with grey and black accents, pointing downwards and to the right. Below the lightning bolt is a white rectangular box with rounded corners and a thin green border. Inside this box, the text "GATORADE SPORTS SCIENCE INSTITUTE" is written in a bold, black, sans-serif font, stacked in four lines.

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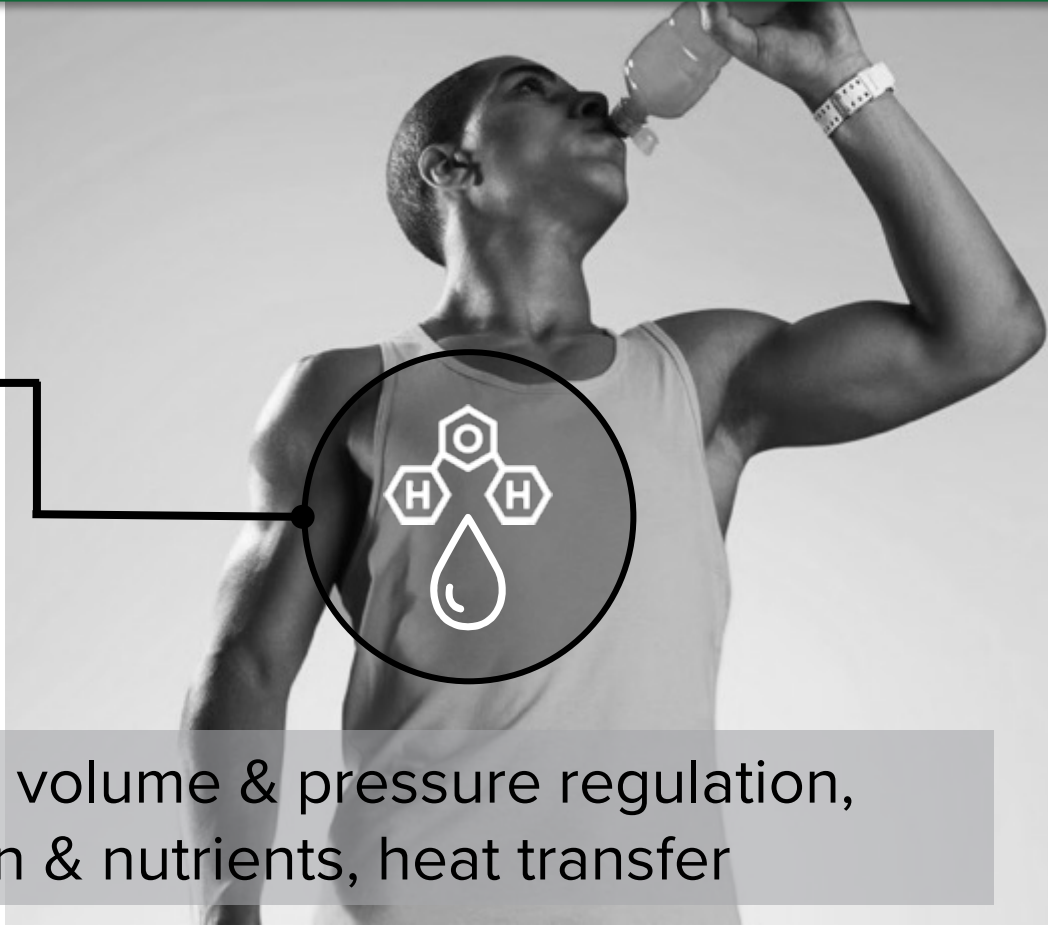
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OVERVIEW

- Physiological importance of hydration
- Effects of dehydration on performance
- Sweat rate estimation
- Fluid absorption and gastric emptying
- Hydration and rehydration recommendations

WATER

60%
WATER



Waste excretion, blood volume & pressure regulation,
transport of oxygen & nutrients, heat transfer



HYDRATE TO SUPPORT

- ✓ Cardiovascular function
- ✓ Body temperature regulation
- ✓ Performance



DEHYDRATION



Impairs the ability to remove heat

Leading to:

Cardiovascular strain

Increased glycogen use

Altered metabolic & CNS function

Decreased fluid absorption

Risk of heat illness



DEHYDRATION



Increases physiological strain



Can impair performance, especially in the heat



SWEATING

Cools the Body



FACTORS INFLUENCING SWEAT RATE



Temperature



Environment
& Equipment



Humidity



Training Status
& Intensity



SWEAT RATE

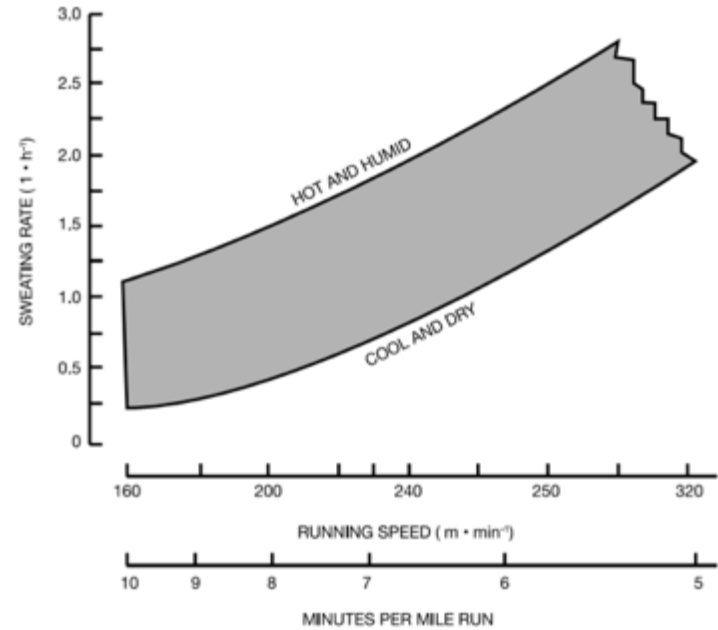
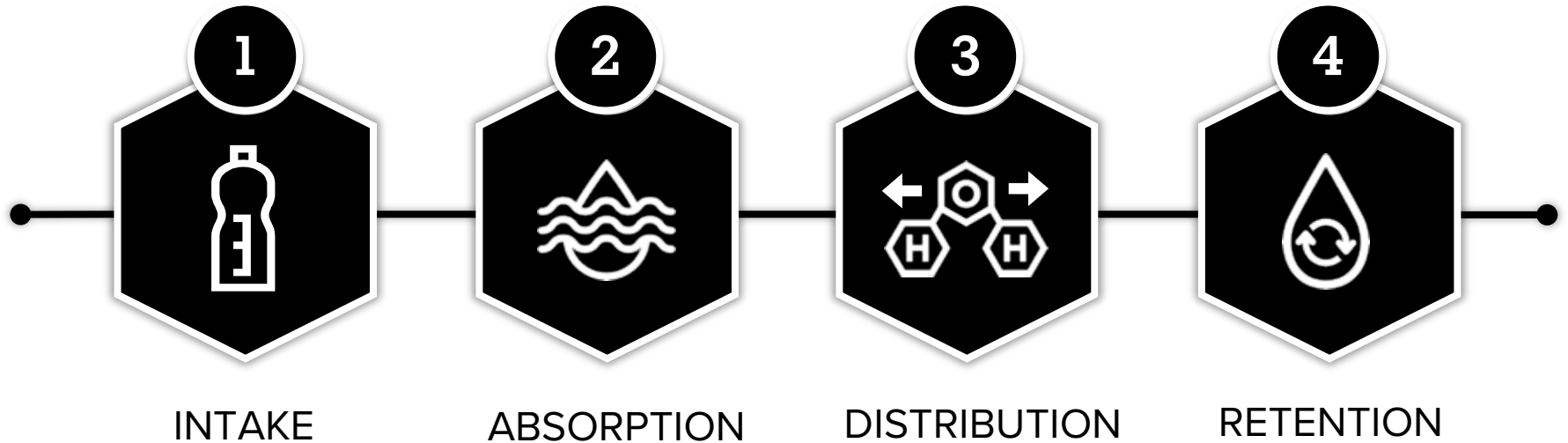


Figure 1: Approximation of hourly sweat rates for runners at different paces and heat stress conditions (Sawka, 1992).

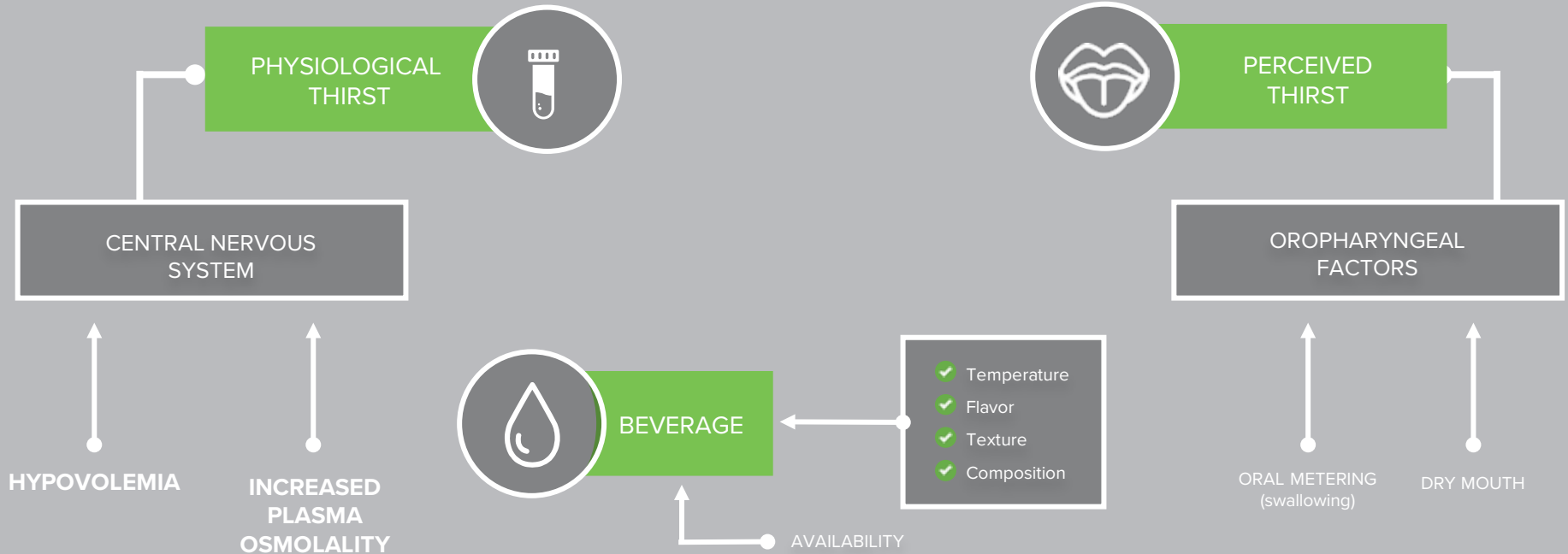
PHASES OF HYDRATION



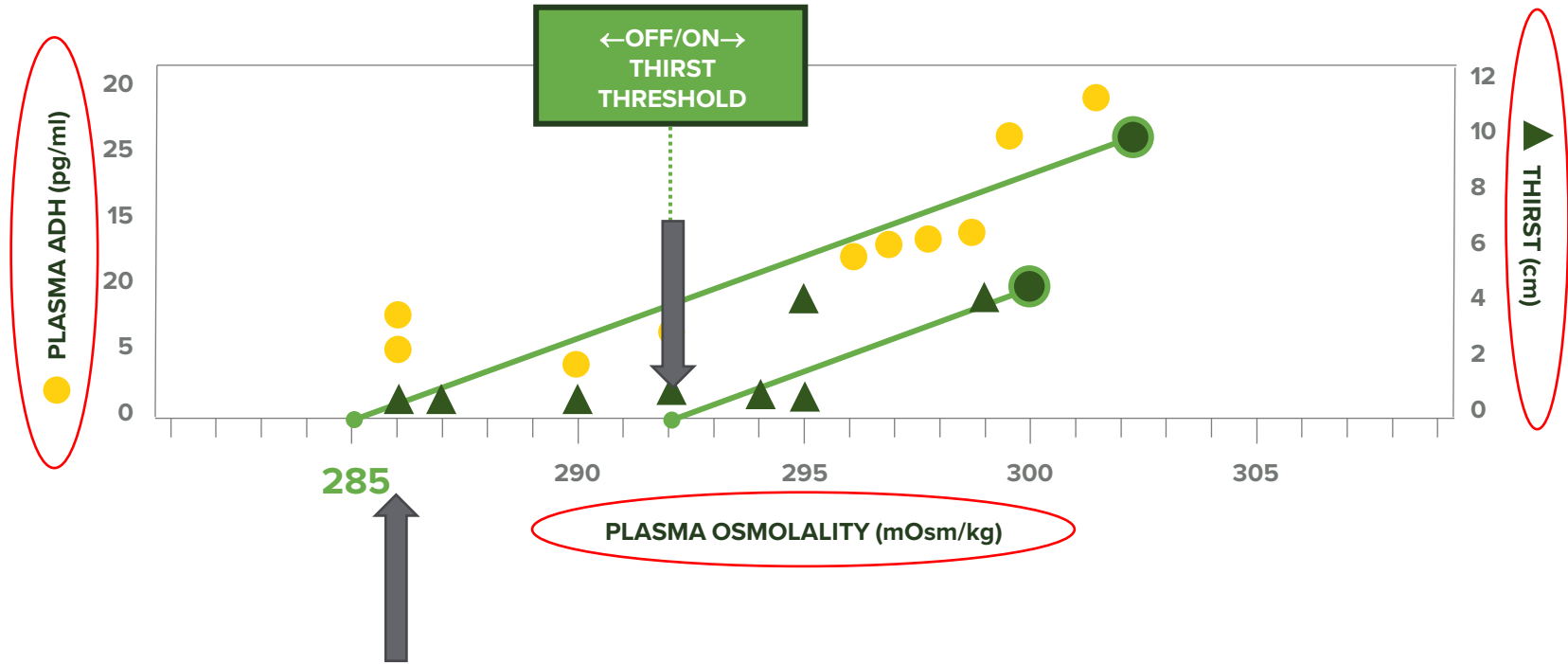


FLUID INTAKE

THIRST & FLUID FACTORS



THIRST, HYDRATION & ADH





PLANNED VS DRINKING TO THIRST



Planned Drinking

Longer duration activities > 90 min
Particularly in the heat
High intensity
High sweat rates
When performance is a concern
When carbohydrate intake of 1 g/min



Drink to Thirst

Short duration activities < 60 to 90 min
Cooler conditions
Lower intensity

SSE #182





VOLUNTARY DEHYDRATION

Despite having access to cool palatable fluid, athletes typically dehydrate during exercise.

DRINKING & DEHYDRATION

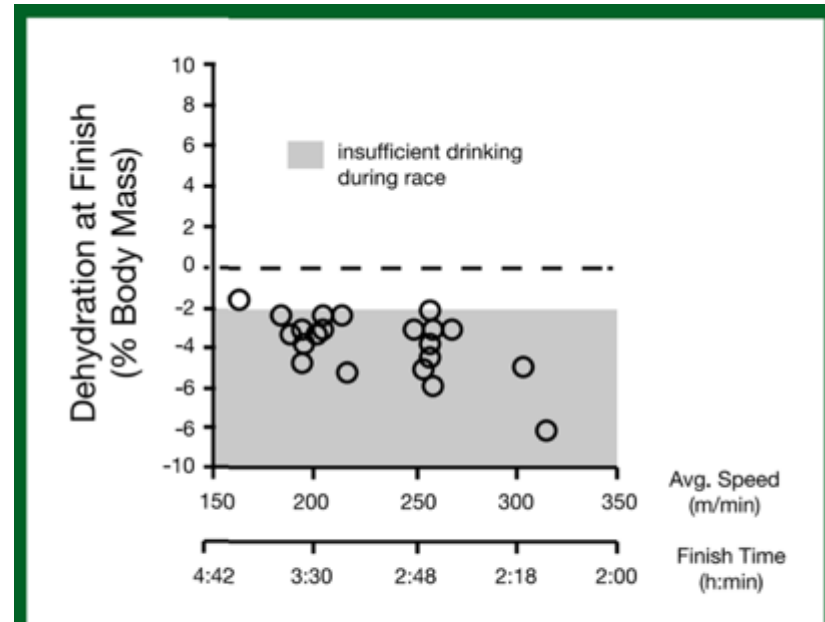


Figure 2: Plot of average running speed of finishing time for 42 km against the magnitude of post-race hypohydration when drinking ad libitum (Cheuvront et al., 2007).



DEHYDRATION

Effects of progressive dehydration

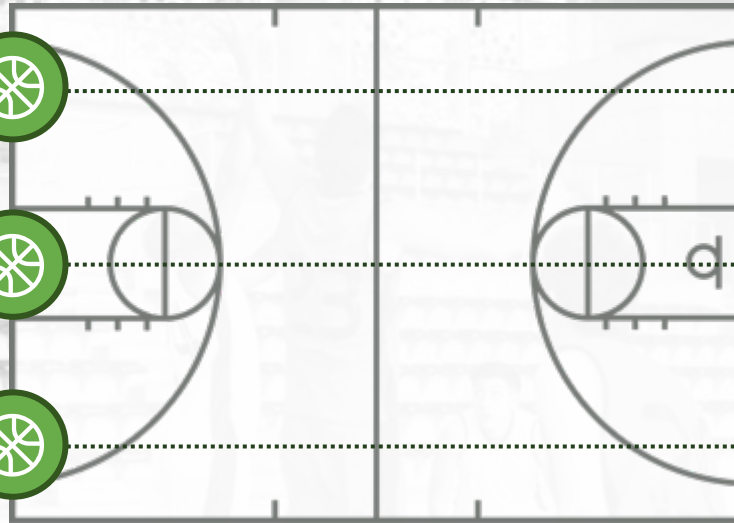
FULLY HYDRATED



2% DEHYDRATED

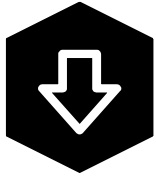


4% DEHYDRATED



SLOWER SPRINT SPEED AND FEWER SHOTS MADE AS LEVEL OF DEHYDRATION INCREASES

SWEAT RATE ESTIMATION



1 LB WEIGHT LOSS = 16 OZ OF SWEAT LOSS



$$\text{SWEAT RATE (L/H)} = \frac{\text{WEIGHT LOSS} + \text{FLUID INTAKE}}{\text{DURATION OF EXERCISE (HRS)}}$$



FLUID ABSORPTION



FACTORS IN GASTRIC EMPTYING

- ✔ Gastric volume
- ✔ Energy content
- ✔ Carbohydrate type
- ✔ Body position
- ✔ Dehydration
- ✔ Exercise intensity
- ✔ Beverage osmolality
- ✔ Beverage pH

IMPORTANCE OF ENERGY DENSITY



6% CARBS



WATER



8% CARBS

CARBOHYDRATE

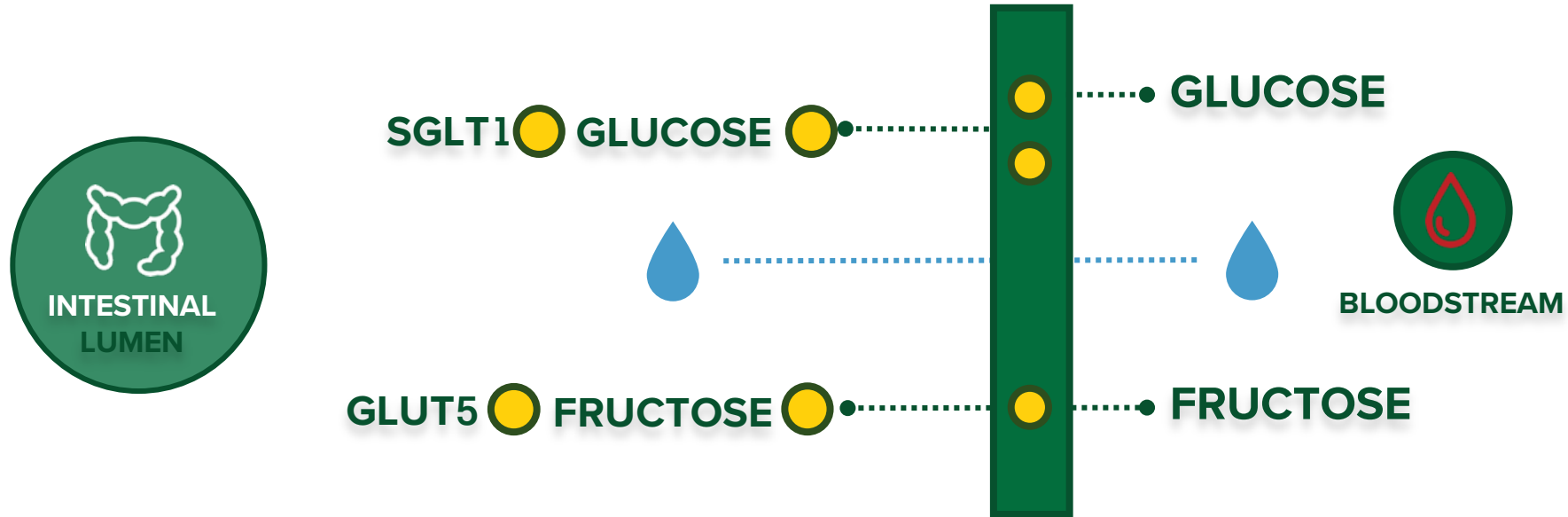
When to Add Carbohydrate

If an athlete is training or competing for 60 minutes or longer with a performance goal.

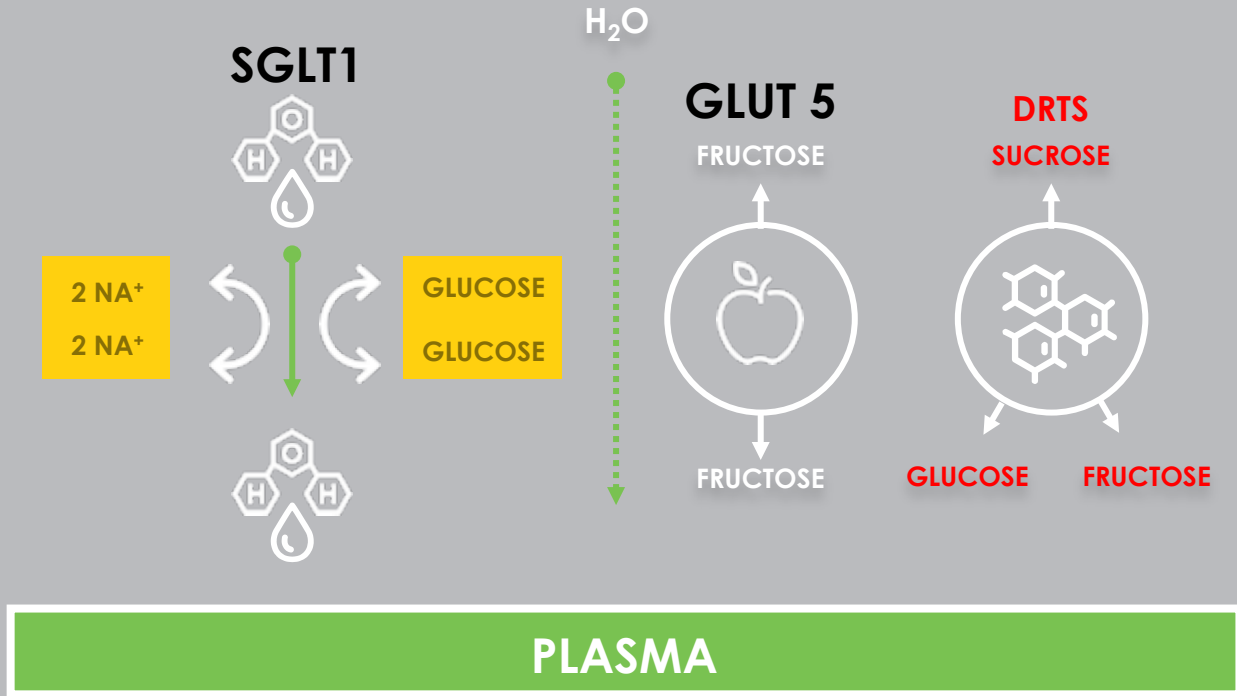
Add 30-60 g/h carbohydrate, resulting in no more than a 6% solution (6% = 14 g/8 oz).

Choose quickly oxidized carbohydrates to provide energy and minimize GI upset.

INTESTINAL WATER ABSORPTION



INTESTINAL WATER ABSORPTION





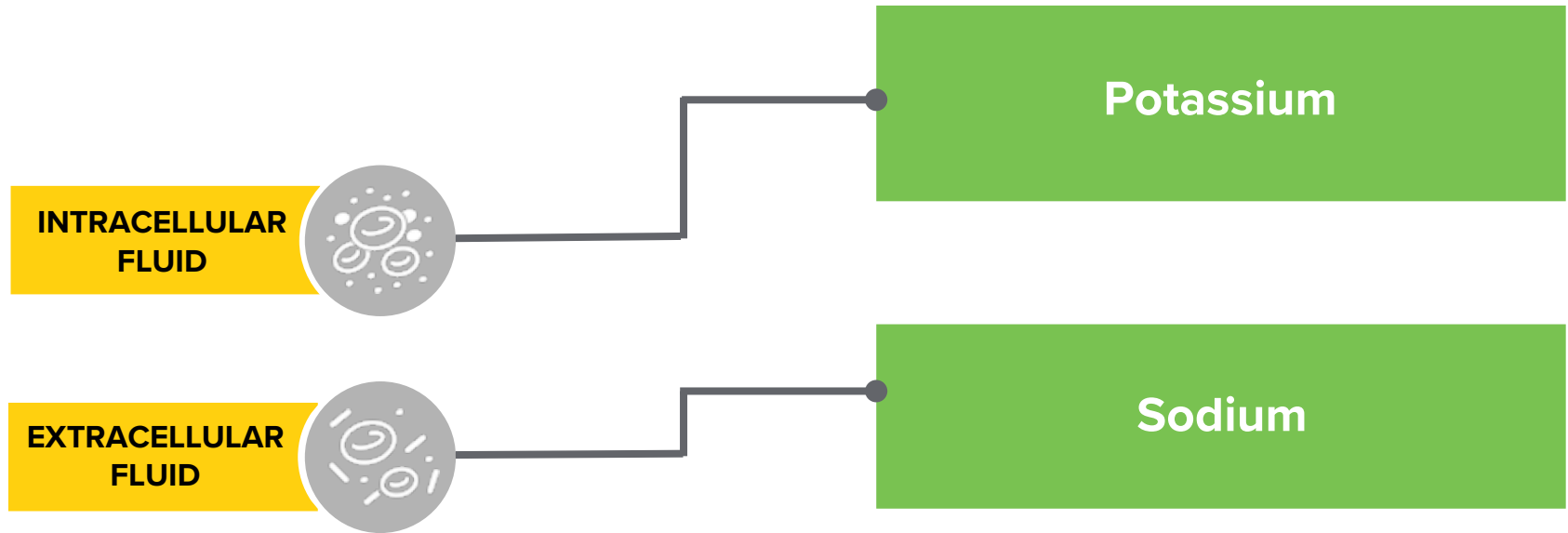
Importance of drinking pattern



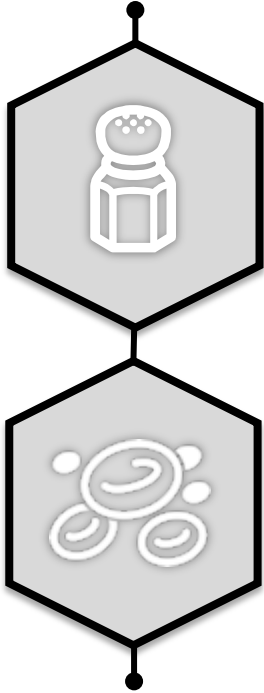
FLUID DISTRIBUTION & RETENTION



FLUID & ELECTROLYTE DISTRIBUTION



CONSUMING SODIUM PROVIDES:



Better maintenance
of blood sodium concentration

Better maintenance of plasma volume



SODIUM & FLUID RETENTION



BEVERAGE WITH SODIUM

- ↑ BLOOD OSMOLALITY
- ↑ BLOOD SODIUM
- ↑ REABSORPTION

WATER

- ↓ BLOOD OSMOLALITY
- ↓ BLOOD SODIUM
- ↓ REABSORPTION



FLUID VOLUME & REHYDRATION

- ✓ Replace up to 150% of fluid loss
- ✓ 20-24 oz / lb body weight
- ✓ Sodium critical for complete rehydration



REHYDRATION RECOMENDATIONS



DURING

~16 oz/lb **lost**



AFTER

~20-24 oz/lb **lost**

REHYDRATION IS IMPORTANT...



During
two-a-day
practices



Throughout
day-long
competitions



Tournament
play



After weigh-ins



REHYDRATION BEVERAGES

Phase of Rehydration

Beverage Component

Fluid Intake



Water

Fluid Absorption



Carbohydrate

Fluid Distribution



Sodium

Fluid Retention



Sodium

HYDRATION RECOMMENDATIONS

- ✓ Before: Drink ~5-7 mL/kg of fluids with sodium ~4 h prior and another 3-5 mL/kg ~2 h prior if athlete cannot urinate or the urine is dark
- ✓ During: Amount of fluid based on sweat rate
- ✓ After: 20-24 oz/lb lost

Exercise Associated Muscle Cramps



- The cause and treatment of exercise-associated muscle cramps (different from whole-body cramping) is not well understood
- Some cramps *may* be associated with disturbances of water and salt balance, but not all
- When water and salt losses are high, drinks containing electrolytes, especially sodium, should be used rather than plain water

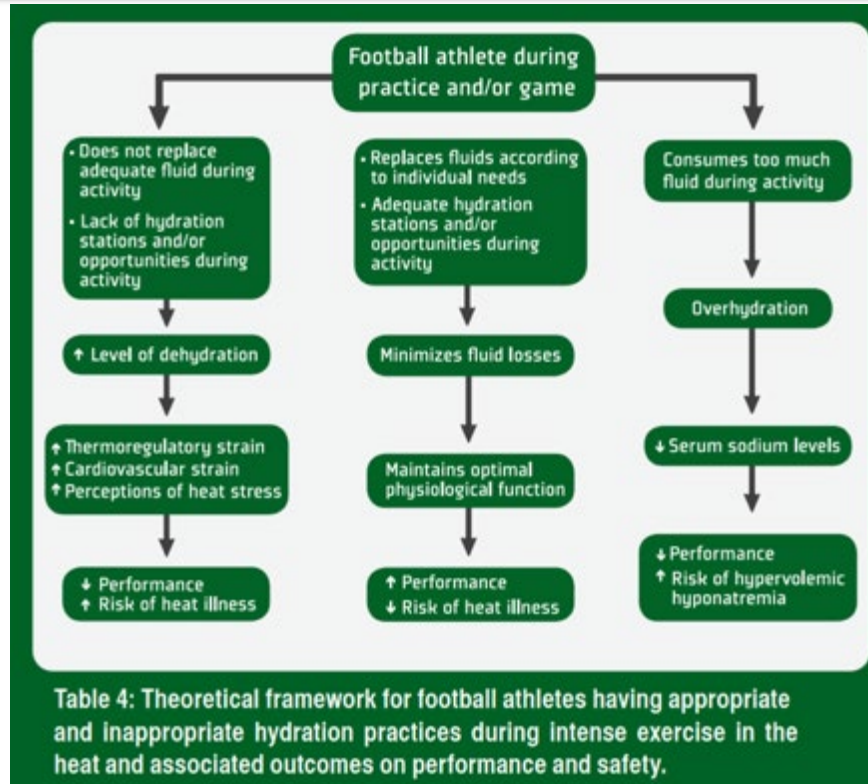
PUTTING IT TOGETHER

American Football Example

SSE#141



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KEY TAKEAWAYS

- ✓ Sweating cools the body, but dehydration impairs the ability to lose heat.
- ✓ Athletes should aim for no greater than 2% body weight loss during exercise.
- ✓ For exercise where performance is a goal, and in hot, humid environments, athletes should have a drinking plan based on their unique sweat profile.
- ✓ A small amount of carbohydrate (6%) does not delay gastric emptying of fluid and provides energy.
- ✓ Sodium helps retain fluid with proper distribution.



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