NUTRITION · STUDY GUIDE

Exam 5 Study Guide

This guide covers nutrition for physical activity and nutrition across the lifespan. Both chapters are about matching intake to a changing demand: an hour of hard work, a growth spurt, a pregnancy, or an older body that needs fewer calories but the same nutrients. Most of the numbers here are per kilogram or per life stage, so always write the group and the unit. Work one chapter at a time and finish each with its ten self-test items.

WHAT THIS GUIDE COVERS

- Chapter 9 · the three energy systems, fuel stores, glycogen and hitting the wall, carbohydrate by training load and timing, loading, protein for active people, the anabolic window, sweat, dehydration versus hyponatremia, ergogenic aids and low energy availability.
- Chapter 10 · pregnancy energy and weight gain by BMI, folate and iron, what to avoid and why, lactation and human milk, formula safety, complementary foods and allergens, toddler appetite and the division of responsibility, adolescent bone and iron, and older adults.

CHAPTER 9

Nutrition and Physical Activity

Read it in full: **Chapter 9 in the textbook**. Practice it in the lab: **Which Fuel, When** and **Losing Fluid, and Putting It Back**.

What to know

Muscles run on ATP, and a fiber holds only enough for about one to two seconds of all-out work, so ATP is made continuously. The **phosphagen** system uses phosphocreatine and covers about 0 to 10 seconds of maximal effort, with no oxygen. **Anaerobic glycolysis** breaks glucose or glycogen to pyruvate without oxygen, making lactate when it outruns the mitochondria, and covers about 10 seconds to 2 minutes. The **oxidative** system burns carbohydrate and fat with oxygen and covers anything longer. All three are always on to some degree.

Intensity is the switch between fuels. At rest and easy effort, fat supplies most of the energy. As intensity rises, carbohydrate takes over (the crossover). Fat oxidation has more steps and cannot make ATP fast enough for hard work, and carbohydrate is the only fuel usable without oxygen. Protein supplies only about 5% of energy during most exercise, a bit more when glycogen is low.

Fuel stores differ hugely. Blood glucose is about 4 to 5 g (about 20 kcal). Liver glycogen is about 80 to 110 g (320 to 440 kcal) and keeps blood glucose steady. Muscle glycogen is about 300 to 500 g (1,200 to 2,000 kcal) and is the limiting fuel for long hard efforts. Fat holds tens of thousands of kcal and is never the limit. Glycogen holds about 3 g of water per gram, which is why the body keeps only a modest supply.

Muscle glycogen serves only the muscle that stores it. When it runs low, usually past about 90 minutes of demanding effort, power drops sharply: "hitting the wall." This is one of the best-replicated findings in sports nutrition. Daily carbohydrate scales with training: about 3 to 5 g/kg for light activity, 5 to 7 g/kg for about an hour a day, 6 to 10 g/kg for 1 to 3 hours, and 8 to 12 g/kg for more than about 4 to 5 hours.

Carbohydrate loading means a training taper plus about 10 to 12 g/kg/day for the 36 to 48 hours before an event. It only helps events of about 90 minutes or longer and adds 1 to 2 kg of water weight. Before exercise, eat about 1 to 4 g/kg one to four hours ahead. During exercise: nothing needed under about 45 minutes; small amounts or a mouth rinse at 45 to 75 minutes; 30 to 60 g/hour for 1 to 2.5 hours; up to about 90 g/hour beyond 2.5 to 3 hours, using glucose plus fructose, because SGLT1 saturates near 60 g/hour and fructose uses GLUT5. For a second hard session within about 8 hours, refuel at 1.0 to 1.2 g/kg/hour for four hours. Practice race fueling in training.

The protein RDA is 0.8 g/kg/day for adults 19+, 0.85 for ages 14 to 18, and 1.1 in pregnancy and lactation. Position statements guide active people to about 1.2 to 2.0 g/kg/day: about 1.2 to 1.6 for endurance and 1.6 to 2.0 for resistance training or muscle gain, with little benefit above 2.0. About 0.25 to 0.3 g/kg (roughly 20 to 40 g) per meal, with about 2 to 3 g of leucine, maximizes muscle protein synthesis. Spreading protein over 3 or 4 meals works a bit better. The 30 minute "anabolic window" is not supported; total daily protein matters most, and protein cannot build muscle without enough total energy.

Total water AI: 3.7 L for men and 2.7 L for women, about 20% from food. Sweat rates run about 0.5 to 2.0 L/hour, and sweat sodium varies from about 20 to 80 mmol/L. Performance and thinking fall once fluid loss passes about 2% of body mass. Weigh before and after to estimate loss. To fully rehydrate, drink about 1.25 to 1.5 L per kg lost, with sodium.

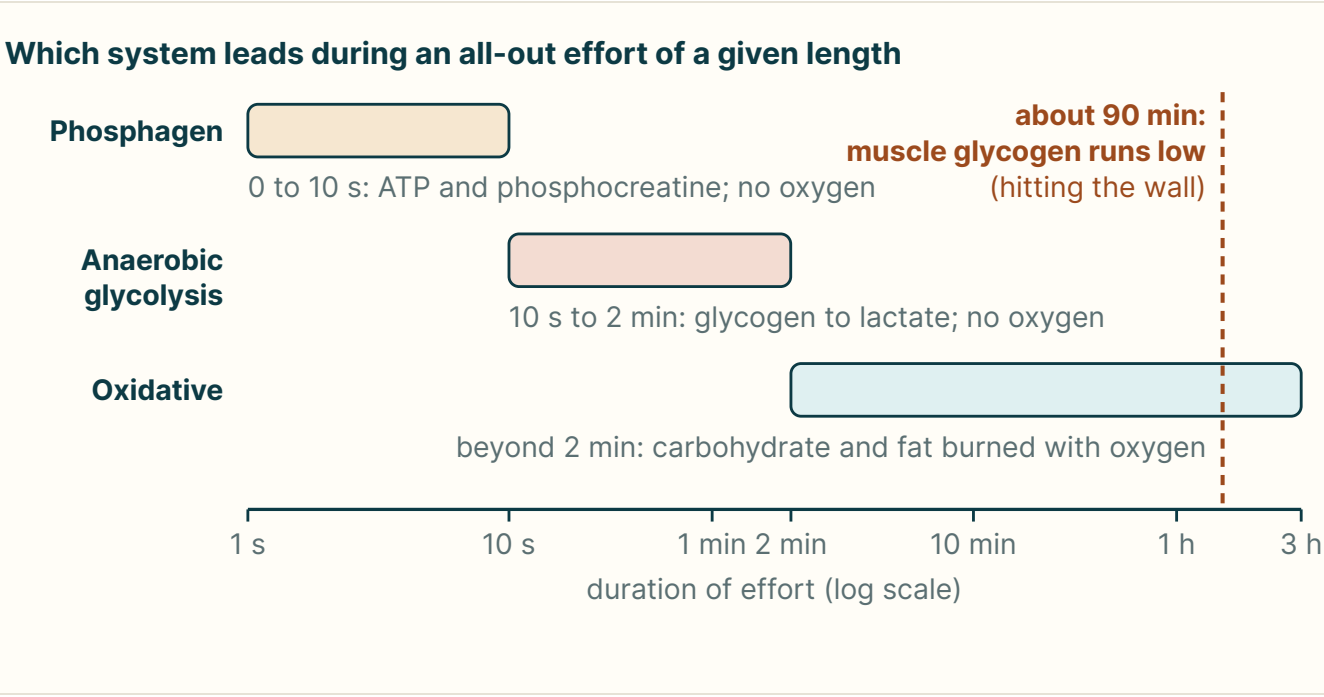
Exercise-associated hyponatremia (EAH) is blood sodium below 135 mmol/L from drinking more dilute fluid than you lose, often with ADH still active. Body mass stays the same or rises. Symptoms look like dehydration, but drinking more makes it worse, and severe cases are emergencies. Current consensus is to drink to thirst and treat weight gain during a long event as a warning. Sports drinks help replace sodium but do not prevent EAH.

Only a short list of ergogenic aids has strong evidence: **creatine** monohydrate (repeated high-intensity efforts, strength and lean mass with training; some non-responders; 1 to 2 kg early water gain), **caffeine** (endurance and some high intensity; studied around 3 to 6 mg/kg an hour before), **beta-alanine** (efforts of about 30 seconds to 10 minutes; skin tingling), **sodium bicarbonate** (about 1 to 7 minutes; stomach upset) and **dietary nitrate** (economy; smaller effect in trained athletes). Iron and vitamin D help only when a deficiency is documented. HMB, ketone esters, tart cherry and probiotics are preliminary. BCAAs, glutamine, "testosterone boosters" and most fat burners lack credible evidence.

US supplements are regulated more like foods than drugs, are not approved for effect before sale, and have been found with undeclared stimulants and anabolic agents. Third-party lot testing reduces the risk. **Low energy availability** means intake does not cover training plus basic body functions. It suppresses bone turnover, reproductive hormones, immunity, thyroid activity and mood, and the wider syndrome is RED-S. It occurs in every body size and every sex, and it is a medical issue, not a discipline issue.

LOCK THESE IN

- Phosphagen 0 to 10 s; anaerobic glycolysis 10 s to 2 min; oxidative beyond that.
- Fat dominates at rest and easy effort; carbohydrate takes over as intensity rises.
- Muscle glycogen limits hard efforts past about 90 minutes. Fat never runs out first.
- Daily carbohydrate 3 to 12 g/kg by training load. Loading 10 to 12 g/kg for 36 to 48 h.
- During exercise: 30 to 60 g/h for 1 to 2.5 h; up to 90 g/h beyond, as glucose plus fructose.
- Protein RDA 0.8 g/kg; active people 1.2 to 2.0 g/kg; about 20 to 40 g per meal.
- Over 2% body mass lost hurts performance. EAH is sodium below 135 mmol/L from overdrinking.
- Strong ergogenic aids: creatine, caffeine, beta-alanine, sodium bicarbonate, nitrate.



Duration picks the system. All three systems run at once; the bars show which leads. Note the log scale on the time axis.

Sports nutrition numbers

Item	Value	Note
Carbohydrate, light	3 to 5 g/kg/day	Low-intensity training
Carbohydrate, moderate	5 to 7 g/kg/day	About 1 h a day
Carbohydrate, endurance	6 to 10 g/kg/day	1 to 3 h a day
Carbohydrate, very high	8 to 12 g/kg/day	More than about 4 to 5 h a day
Loading	10 to 12 g/kg/day for 36 to 48 h plus taper	Events of 90 min or more; adds 1 to 2 kg
Pre-exercise meal	1 to 4 g/kg, 1 to 4 h before	Tops off liver glycogen
During exercise	30 to 60 g/h (1 to 2.5 h); up to 90 g/h beyond	Glucose plus fructose above about 60 g/h
Rapid refueling	1.0 to 1.2 g/kg/h for 4 h	Only if the next session is within about 8 h
Protein	RDA 0.8 g/kg; active 1.2 to 2.0 g/kg	Endurance 1.2 to 1.6; strength 1.6 to 2.0
Protein per meal	0.25 to 0.3 g/kg (about 20 to 40 g)	About 2 to 3 g leucine
Sweat	0.5 to 2.0 L/h; sodium 20 to 80 mmol/L	Varies widely between people
Rehydration	1.25 to 1.5 L per kg lost	With sodium
EAH	Blood sodium below 135 mmol/L	Weight stable or up; drinking more makes it worse

The energy systems and fuel stores

System or store	Fuel or amount	Dominates or lasts
Phosphagen	ATP and phosphocreatine	0 to 10 s all-out
Anaerobic glycolysis	Glycogen, blood glucose	About 10 s to 2 min
Oxidative	Carbohydrate and fat with oxygen	Minutes to hours
Liver glycogen	80 to 110 g (320 to 440 kcal)	Keeps blood glucose steady
Muscle glycogen	300 to 500 g (1,200 to 2,000 kcal)	The limit for long hard efforts
Fat	Several kg	Tens of thousands of kcal

Worked examples

WORKED EXAMPLE 1 · DAILY CARBOHYDRATE FOR A TRAINING LOAD

Jae is a 60 kg runner who trains about an hour a day, and in race season about two hours a day. Find his daily carbohydrate range for each phase.

STEP 1 · ABOUT 1 H A DAY

5 to 7 g/kg: 60 × 5 = 300 g and 60 × 7 = 420 g, so **300 to 420 g/day**.

STEP 2 · 1 TO 3 H A DAY

6 to 10 g/kg: 60 × 6 = 360 g and 60 × 10 = 600 g, so **360 to 600 g/day**.

STEP 3 · LOADING BEFORE A MARATHON

10 to 12 g/kg for 36 to 48 h: 600 to 720 g/day, with a taper.

WHY PER KILOGRAM

Ranges written per kg scale to the person. Someone training an hour a day does not need the intake of someone training five.

WORKED EXAMPLE 2 · FUEL DURING A LONG EVENT

Lena's cycling event lasts about 4 hours. How much carbohydrate could she aim for in total, and why does the type of carbohydrate matter?

STEP 1 · PICK THE BAND

Beyond about 2.5 to 3 hours, intakes up to about 90 g/hour have been shown to help.

STEP 2 · MULTIPLY

90 g/h × 4 h = **360 g** at the top of the range.

STEP 3 · CHOOSE THE MIX

SGLT1 saturates near 60 g/hour of glucose. Fructose enters through GLUT5, so a glucose plus fructose blend lets total absorption rise toward 90 g/hour.

PRACTICE FIRST

The gut must be trained to absorb that much. A new fueling plan should never debut on race day.

WORKED EXAMPLE 3 · SWEAT LOSS AND REHYDRATION

Ravi weighs 70.0 kg before a 90 minute run in the heat and 68.4 kg after. He drank 0.5 L during the run. Find his percent loss, his sweat rate, and how much to drink to rehydrate fully.

STEP 1 · MASS LOST

70.0 − 68.4 = 1.6 kg, about 1.6 L of net fluid.

STEP 2 · PERCENT

1.6 ÷ 70.0 = 0.0229, so **2.3%** of body mass, past the 2% line where performance falls.

STEP 3 · SWEAT RATE

Sweat = net loss + what he drank = 1.6 + 0.5 = 2.1 L over 1.5 h, so 2.1 ÷ 1.5 = **1.4 L/hour**.

STEP 4 · REHYDRATE

1.25 to 1.5 L per kg lost: 1.6 × 1.25 = 2.0 L and 1.6 × 1.5 = 2.4 L, so **2.0 to 2.4 L**, with sodium.

IF HE HAD GAINED WEIGHT

A gain during a long event signals overdrinking and possible hyponatremia, not good hydration.

WORKED EXAMPLE 4 · PROTEIN FOR STRENGTH TRAINING

Tariq weighs 80 kg and is lifting to gain muscle. Find his RDA, his position-statement range, and a per-meal target.

STEP 1 · RDA

0.8 × 80 = 64 g/day, the floor for adequacy.

STEP 2 · TRAINING RANGE

1.6 to 2.0 g/kg for resistance training: 80 × 1.6 = 128 g and 80 × 2.0 = 160 g, so **128 to 160 g/day**.

STEP 3 · PER MEAL

0.25 to 0.3 g/kg: 80 × 0.25 = 20 g and 80 × 0.3 = 24 g per meal for the maximal synthesis response.

DISTRIBUTION

Four meals of 32 to 40 g reach the daily range and each clears the per-meal threshold. Timing within a few hours of training is fine; total intake does most of the work.

TRAPS PEOPLE FALL INTO

- **Saying fat runs out during a marathon.** Fat stores are huge. Muscle glycogen is what runs low.
- **Thinking muscle glycogen can feed the blood.** Muscle lacks the enzyme to release free glucose.
- **Loading for a short event.** Loading only helps efforts of about 90 minutes or longer.
- **Believing in a 30 minute protein window.** The window is hours wide. Total daily protein matters most.
- **Assuming more protein always means more muscle.** The benefit flattens above about 2.0 g/kg; training is the limiter.
- **Drinking more for every collapsed runner.** If it is hyponatremia, more water makes it worse.
- **Expecting sports drinks to prevent EAH.** They are still dilute compared with plasma.
- **Treating underfueling as discipline.** Low energy availability harms bone, hormones and immunity in every body.

Chapter 9 self-test · ten items

1. A single maximal jump is powered mainly by which system?

A. Oxidative fat metabolism
B. Oxidative carbohydrate use
C. The phosphagen system
D. Anaerobic glycolysis

C. The phosphagen system Phosphocreatine regenerates ATP almost instantly for about 0 to 10 seconds of all-out work.

2. A cyclist moves from an easy spin to a hard climb. How does the share of each fuel change?

A. Fat's share rises and carbohydrate's falls
B. The mix stays the same at every intensity
C. Protein becomes the main fuel source
D. Carbohydrate's share rises and fat's falls

D. Carbohydrate's share rises and fat's falls This is the crossover. Fat cannot supply ATP fast enough for hard work.

3. Why does a marathon runner "hit the wall" with plenty of body fat left?

A. Muscle glycogen ran low; fat is too slow for the pace
B. Blood ketones rose high and blocked the muscles
C. Liver glycogen was converted into body fat
D. Fat stores were used up in the first 90 minutes

A. Muscle glycogen ran low; fat is too slow for the pace Fat oxidation is too slow to sustain a demanding pace once muscle glycogen is low.

4. What is the daily carbohydrate range for a 70 kg person training about an hour a day?

A. 210 to 350 g/day
B. 350 to 490 g/day
C. 560 to 840 g/day
D. 420 to 700 g/day

B. 350 to 490 g/day About 5 to 7 g/kg: $70 \times 5 = 350$ and $70 \times 7 = 490$.

5. Why are glucose plus fructose blends used for intakes near 90 g/hour?

A. Glucose alone causes hyponatremia in races
B. Fructose is burned faster than glucose by muscle
C. Fructose raises insulin more than glucose does
D. Fructose uses GLUT5, so total absorption rises

D. Fructose uses GLUT5, so total absorption rises SGLT1 saturates near 60 g/hour. Fructose crosses through a separate transporter, GLUT5.

6. A 75 kg endurance athlete wants a protein range from position statements. Which fits best?

A. 90 to 120 g/day
B. 60 to 75 g/day
C. 45 to 60 g/day
D. 150 to 180 g/day

A. 90 to 120 g/day Endurance training is about 1.2 to 1.6 g/kg: 75 × 1.2 = 90 and 75 × 1.6 = 120.

7. A runner weighs 1.5 kg more after a 5 hour race and is confused and nauseated. What is the most likely problem?

A. Low blood potassium from fructose
B. Simple dehydration from heavy sweat
C. Exercise-associated hyponatremia
D. Glycogen depletion in the liver only

C. Exercise-associated hyponatremia Weight gain during a long event points to overdrinking and diluted blood sodium. Drinking more would make it worse.

8. A 64 kg athlete lost 1.0 kg during training. About how much fluid should be drunk to rehydrate fully?

A. 2.5 to 3.0 L
B. 1.25 to 1.5 L
C. 0.5 to 0.75 L
D. 3.7 L, the full AI

B. 1.25 to 1.5 L Drink about 1.25 to 1.5 L per kg lost, because urine losses continue while rehydrating.

9. Which ergogenic aid works by raising muscle phosphocreatine?

A. Sodium bicarbonate
B. Beta-alanine powder
C. Creatine monohydrate
D. Beetroot juice nitrate

C. Creatine monohydrate Creatine enlarges the phosphagen tank. Beta-alanine raises carnosine, bicarbonate buffers outside the cell, and nitrate improves economy.

10. An athlete has steady performance but missed periods and a stress fracture. What should be suspected?

A. Too much dietary protein
B. Low energy availability
C. Caffeine taken before training
D. Excess vitamin D from food

B. Low energy availability Underfueling suppresses reproductive hormones and bone turnover, and it can occur even when performance looks fine.

Nutrition Through the Lifespan

Read it in full: **Chapter 10 in the textbook**. Practice it in the lab: **How Far Each Need Rises in Pregnancy** and **The First Year: An Infant Feeding Timeline**.

What to know

Pregnancy adds less energy than most people expect: about 0 kcal in the first trimester, +340 kcal/day in the second and +452 kcal/day in the third. Nutrient needs rise much faster than energy needs, so nutrient density matters more than volume. Weight gain is mostly placenta, amniotic fluid, uterus and breast tissue, blood volume, extra fluid and fat stores for lactation, not just the fetus. Recommended gain is indexed to pre-pregnancy BMI: under 18.5, 28 to 40 lb; 18.5 to 24.9, 25 to 35 lb; 25.0 to 29.9, 15 to 25 lb; 30 and above, 11 to 20 lb. These are outcome-based ranges, not a scorecard. Protein rises to 1.1 g/kg/day, about 25 g more.

Folate is needed for cell division. The neural tube closes by about 28 days after conception, often before a pregnancy is known, which is why anyone who could become pregnant is advised to get 400 µg/day of folic acid from fortified food or a supplement, on top of food folate. The evidence is strong. Folate RDA: 400 µg DFE (not pregnant), 600 in pregnancy, 500 in lactation. The 1,000 µg UL applies to synthetic folic acid only.

Iron rises from 18 mg to 27 mg/day in pregnancy. Plasma volume expands about 50% while red cell mass rises less, so hemoglobin falls by dilution, which is expected. True iron deficiency anemia is also common, so prenatal vitamins carry iron. Iodine rises to 220 µg and choline to 450 mg. Calcium stays at 1,000 mg for adults because absorption roughly doubles, but pregnant teens stay at 1,300 mg.

Avoid or limit for three reasons. **Teratogens**: alcohol (no safe threshold) and high-dose preformed vitamin A. **Pathogens**: Listeria from unpasteurized milk, raw-milk soft cheese, deli meats, smoked seafood and raw sprouts; Salmonella, Toxoplasma and Campylobacter from raw or undercooked eggs, meat and shellfish. **Toxicants**: methylmercury in shark, swordfish, king mackerel, tilefish and bigeye tuna. Caffeine above about 200 mg/day is limited as a precaution. Most fish are encouraged: about 8 to 12 oz a week of low-mercury seafood such as salmon, sardines, cod and canned light tuna.

Lactation costs about as much as late pregnancy: about +330 kcal/day for the first six months (about 500 kcal exported in milk minus about 170 from stored fat) and +400 kcal/day after. Vitamin A peaks at 1,300 µg RAE and iodine at 290 µg, while iron drops to 9 mg because menstruation is usually paused. Human milk has about 65 to 70 kcal per 100 mL: about 7 g lactose, 3.5 to 4.5 g fat and 1 g protein. Fat supplies about half the energy. Colostrum is rich in protein and secretory IgA. Human milk oligosaccharides feed the infant's Bifidobacterium, not the infant. Exclusive breastfeeding for about six months is recommended, with vitamin K at birth and vitamin D 400 IU/day for breastfed infants.

Iron-fortified cow-milk-based formula is the safe default for infants not exclusively breastfed. Specialty formulas are for medical needs. Formula must be mixed exactly as labeled. Diluting it causes water intoxication and low sodium, and homemade formula is unsafe. If cost is the barrier, the answer is food assistance, not a thinner bottle.

Infants double birth weight by about 4 to 6 months and triple it by 12 months. Energy needs start near 100 kcal/kg/day and ease to about 80 by age one, against about 30 to 35 for adults. Iron stores last about 4 to 6 months, so iron-rich complementary foods start around six months, when the infant shows readiness: sitting with support, head control, fading tongue thrust and interest in food. No honey before 12 months (botulism), no cow's milk as the main drink before 12 months, no juice in the first year, and care with choking hazards. After the LEAP trial, common allergens such as peanut are introduced in the first year rather than delayed, with medical guidance first for severe eczema or existing allergy.

After age one, growth and appetite both slow: a toddler gains about 2 to 3 kg a year. Intake swings from meal to meal but is steady across a week. Track the child's own growth curve (WHO charts to age 2, CDC charts 2 to 20). Too much cow's milk displaces iron-rich foods and is a leading cause of toddler iron deficiency. Food neophobia peaks around ages 2 to 6 and fades with 8 to 15 or more neutral exposures. Pressure and food-as-reward reduce liking. In the **division of responsibility**, caregivers decide what, when and where; the child decides whether and how much.

Adolescents add 15 to 20% of adult height and about half of adult skeletal mass. About 90% of peak bone mass is in place by about age 18 to 20, so calcium is 1,300 mg/day for ages 9 to 18, the

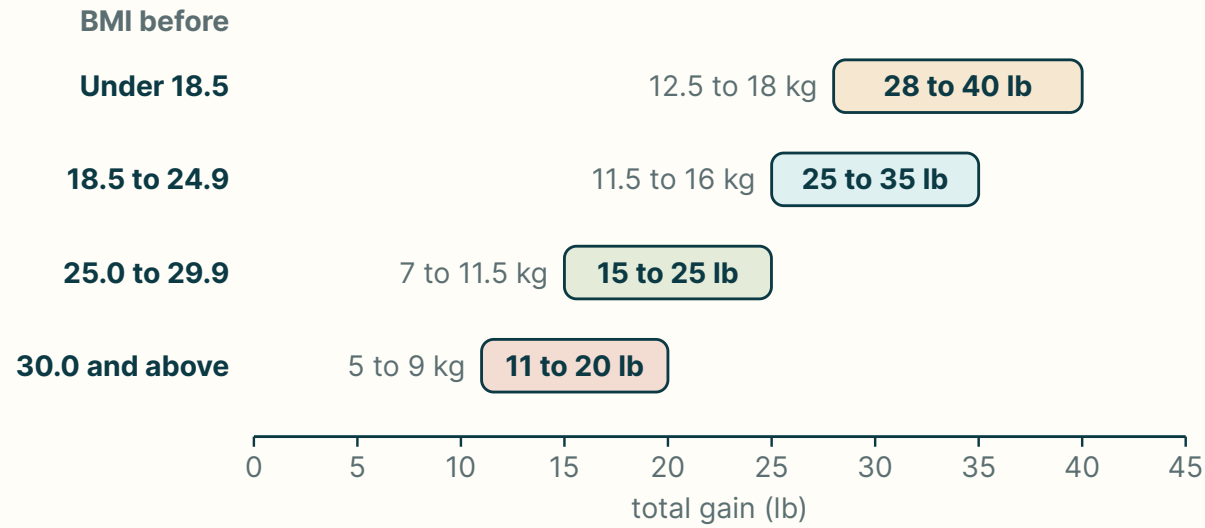
highest of any life stage, with 600 IU of vitamin D. Iron at 14 to 18 is 11 mg for males (growth and blood volume) and 15 mg for females (menstrual loss). Zinc is 11 and 9 mg. Weight-focused talk and weight teasing predict disordered eating; behavior-focused, weight-neutral language is better supported. Underfueling in active teens harms bone and cycles.

Older adults need fewer calories but the same or more of most nutrients, so nutrient density rules. Vitamin D rises to 800 IU over 70. Calcium is 1,200 mg for women 51+ and everyone 71+. B6 rises after 50. B12 stays at 2.4 µg but should come mostly from fortified food or supplements, because 10 to 30% of older adults have atrophic gastritis. Sarcopenia drives falls; experts suggest 1.0 to 1.2 g/kg protein with resistance exercise (consensus, not a DRI). Appetite falls for many reasons, including living alone and food insecurity. Thirst is blunted, so offer fluids on a schedule. Unintentional weight loss in an older adult is a warning sign.

LOCK THESE IN

- Pregnancy energy: 0, +340, +452 kcal/day by trimester. Lactation: +330 then +400.
- Weight gain by pre-pregnancy BMI: 28 to 40, 25 to 35, 15 to 25, 11 to 20 lb.
- Folate 600 µg DFE in pregnancy, plus 400 µg folic acid before conception. Neural tube closes by day 28.
- Iron 27 mg in pregnancy, 9 mg in lactation. Calcium unchanged for pregnant adults.
- Infants: vitamin K at birth, vitamin D 400 IU if breastfed, solids about 6 months, no honey before 12 months.
- Introduce common allergens in the first year (LEAP).
- Calcium 1,300 mg at ages 9 to 18, the highest of any life stage. Iron 11 mg boys, 15 mg girls (14 to 18).
- Over 70: vitamin D 800 IU, calcium 1,200 mg; B12 from fortified foods after 50.

Recommended total gain, single baby, by BMI before pregnancy



Energy added: 0, then +340, then +452 kcal a day by trimester.

Gain is indexed to BMI. The higher the BMI before pregnancy, the lower the recommended range. These are outcome-based ranges, not a scorecard.

Reference values that shift across the lifespan

Nutrient	Value and group	Why
Folate	400 µg DFE adults; 600 pregnancy; 500 lactation	Cell division; neural tube
Iron	18 mg women 19 to 50; 27 pregnancy; 9 lactation	Red cell mass, placenta; no menses in lactation
Iron, children	7 mg (1 to 3); 10 mg (4 to 8); 8 mg (9 to 13)	Toddlers are peak-risk
Iron, teens	11 mg boys; 15 mg girls (14 to 18)	Growth; menstrual loss
Iodine	150 µg; 220 pregnancy; 290 lactation	Fetal thyroid and brain
Choline (AI)	425 mg; 450 pregnancy; 550 lactation	Membranes, neurodevelopment
Vitamin A	700 µg RAE women; 1,300 lactation	Peaks in lactation
Calcium	700 mg (1 to 3); 1,000 (4 to 8); 1,300 (9 to 18); 1,000 adults; 1,200 women 51+, all 71+	Bone accrual and loss
Vitamin D	400 IU infants (AI); 600 IU ages 1 to 70; 800 IU over 70	Less skin synthesis with age
Protein	1.05 g/kg (1 to 3); 0.95 (4 to 13); 0.85 (14 to 18); 0.8 adults; 1.1 pregnancy	Growth per kg
B12	2.4 µg adults; from fortified food or supplement after 50	Atrophic gastritis
Fiber (AI)	19 g (1 to 3); 25 g (4 to 8); 30 g men and 21 g women 51+	About 14 g per 1,000 kcal

Gestational weight gain by pre-pregnancy BMI (singleton)

Pre-pregnancy BMI	Total gain	Weekly, 2nd and 3rd trimester
Under 18.5	28 to 40 lb (12.5 to 18 kg)	About 1 lb (0.51 kg)
18.5 to 24.9	25 to 35 lb (11.5 to 16 kg)	About 1 lb (0.42 kg)
25.0 to 29.9	15 to 25 lb (7 to 11.5 kg)	About 0.6 lb (0.28 kg)
30.0 and above	11 to 20 lb (5 to 9 kg)	About 0.5 lb (0.22 kg)

Worked examples

WORKED EXAMPLE 1 · GESTATIONAL WEIGHT GAIN RANGE

Before pregnancy, Carmen weighed 72 kg at 1.65 m. Find her pre-pregnancy BMI and her recommended total gain.

STEP 1 · SQUARE THE HEIGHT

$1.65 \times 1.65 = 2.7225$ m^2.

STEP 2 · BMI

$72 \div 2.7225 =$ **26.4**.

STEP 3 · READ THE TABLE

26.4 falls in 25.0 to 29.9, so the range is **15 to 25 lb (7 to 11.5 kg)**, about 0.6 lb a week in the second and third trimesters.

HOW TO FRAME IT

These ranges come from outcome data and are for a clinician to individualize. Both too little and too much gain carry risk.

WORKED EXAMPLE 2 · WHAT HUMAN MILK IS MADE OF

Use 7 g lactose, 4 g fat and 1 g protein per 100 mL of milk. Find the energy per 100 mL, the share from fat, and the daily energy in 780 mL.

STEP 1 · CARBOHYDRATE

$7 \times 4 = 28$ kcal.

STEP 2 · FAT

4 × 9 = 36 kcal.

STEP 3 · PROTEIN

1 × 4 = 4 kcal.

STEP 4 · TOTAL AND FAT SHARE

28 + 36 + 4 = **68 kcal per 100 mL**, inside the 65 to 70 range. Fat: 36 ÷ 68 = **53%**.

STEP 5 · A DAY OF MILK

780 mL × 0.68 kcal/mL = 530 kcal, which fits the roughly 500 kcal a day exported as milk.

WORKED EXAMPLE 3 · PREGNANCY NEEDS IN NUMBERS

Greta weighs 60 kg. Compare her non-pregnant and pregnant protein RDAs, then list the change in iron, folate and calcium.

STEP 1 · PROTEIN

0.8 × 60 = 48 g; 1.1 × 60 = 66 g. The rise is **18 g/day**.

STEP 2 · IRON

18 mg to **27 mg**, which few eating patterns meet without a supplement.

STEP 3 · FOLATE

400 to **600 µg DFE**, and the 400 µg of folic acid should start before conception.

STEP 4 · CALCIUM

Unchanged at 1,000 mg, because absorption roughly doubles.

ENERGY FOR COMPARISON

Energy rises only 0, 340 and 452 kcal by trimester. Nutrient needs climb proportionally much more.

WORKED EXAMPLE 4 · INFANT ENERGY NEEDS

An infant weighs 7 kg at 4 months and 10 kg at 12 months. Estimate daily energy at each age.

STEP 1 · 4 MONTHS

About 100 kcal/kg: 7 × 100 = **700 kcal/day**.

STEP 2 · 12 MONTHS

About 80 kcal/kg: 10 × 80 = **800 kcal/day**.

STEP 3 · COMPARE WITH AN ADULT

An adult needs about 30 to 35 kcal/kg, so per kg an infant needs about three times as much.

WHY SOLIDS START NEAR 6 MONTHS

Milk alone stops covering needs around then, and the first nutrient to run short is iron, since birth stores last about 4 to 6 months.

TRAPS PEOPLE FALL INTO

- **Saying "eating for two."** Pregnancy adds 340 to 452 kcal at most. Nutrients rise far more than energy.
- **Starting folic acid at a positive test.** The neural tube closes by day 28, often before a pregnancy is known.
- **Raising calcium in adult pregnancy.** It stays at 1,000 mg because absorption increases.
- **Telling pregnant people to avoid all fish.** Low-mercury fish are encouraged, about 8 to 12 oz a week.
- **Diluting formula to stretch it.** It can cause dangerously low sodium within days.
- **Delaying peanut to prevent allergy.** LEAP showed early introduction lowers peanut allergy in high-risk infants.
- **Treating a toddler's smaller appetite as illness.** Growth slows sharply after age one, and appetite follows.
- **Changing the B12 amount for older adults.** The amount stays 2.4 µg. The source changes to fortified foods or supplements.

Chapter 10 self-test · ten items

1. About how much extra energy is estimated for the third trimester of pregnancy?

A. About 340 kcal/day
B. About 0 kcal/day
C. About 1,000 kcal/day
D. About 452 kcal/day

D. About 452 kcal/day The added need is about 0, 340 and 452 kcal/day across the three trimesters.

2. A woman with a pre-pregnancy BMI of 22 asks about weight gain. Which range applies?

A. 25 to 35 lb
B. 11 to 20 lb
C. 28 to 40 lb
D. 15 to 25 lb

A. 25 to 35 lb A BMI of 18.5 to 24.9 maps to 25 to 35 lb for a singleton pregnancy.

3. Why is folic acid advised for everyone who could become pregnant, not just those who are?

A. Food folate becomes unsafe in early pregnancy
B. Body folate stores take a full year to fill up
C. Neural tube closure precedes many positive tests
D. Folic acid can only be absorbed before conception

C. Neural tube closure precedes many positive tests Closure happens by about day 28, often before a positive test, and many pregnancies are unplanned.

4. Why does hemoglobin concentration normally fall in pregnancy?

A. The placenta destroys maternal red cells
B. Plasma volume expands more than red cell mass
C. Folate needs block hemoglobin production
D. Iron is pulled out of the blood into bone

B. Plasma volume expands more than red cell mass Plasma rises about 50% while red cells rise less, so the blood is diluted. True iron deficiency can also occur.

5. Which nutrient need goes DOWN during lactation compared with a non-pregnant adult woman?

A. Iron needs
B. Choline needs
C. Zinc needs
D. Iodine needs

A. Iron needs Iron falls to 9 mg/day because menstruation is usually paused. Iodine, vitamin A and choline all rise.

6. Which statement about human milk oligosaccharides is correct?

A. They carry most of the milk's iron to the infant
B. They are added to milk only after six months
C. They feed the infant's gut bacteria, not the infant
D. They are the main energy source in human milk

C. They feed the infant's gut bacteria, not the infant Infants cannot digest HMOs. They feed Bifidobacterium in the infant gut.

7. A grandparent wants to sweeten a 7-month-old's oatmeal with honey. What is the concern?

A. It raises the risk of a peanut allergy
B. Botulism spores can grow in the immature gut
C. It dilutes blood sodium like extra water
D. Its sugar blocks iron absorption in infants

B. Botulism spores can grow in the immature gut Clostridium botulinum spores can germinate in an infant's gut and cause infant botulism.

8. A toddler drinks large amounts of cow's milk and eats little else. What is the main concern?

A. Too much vitamin D
B. Excess dietary fiber
C. Too little calcium
D. Iron deficiency anemia

D. Iron deficiency anemia Milk displaces iron-rich foods, has almost no iron and can cause small blood losses from the gut.

9. A parent sets dinner at 6 pm with three dishes on the table. Under the division of responsibility, what is left to the child?

A. When and where meals happen
B. Whether to eat and how much
C. Which foods are offered
D. Which foods earn dessert

B. Whether to eat and how much Caregivers decide what, when and where. The child keeps control of whether and how much, which protects hunger and fullness signals.

10. Why is B12 from fortified foods or supplements advised for adults over 50?

A. Their B12 RDA doubles once they reach 50
B. Fortified B12 is absorbed in the stomach instead
C. Many have too little stomach acid to free food B12
D. Animal foods lose their B12 in long storage

C. Many have too little stomach acid to free food B12 Atrophic gastritis affects 10 to 30% of older adults. Crystalline B12 is not protein-bound, so it is absorbed normally.

Cram sheet

Everything from chapters 9 and 10 in one place. Cover the right column and see if you can rebuild each row.

Activity numbers

Item	Value	Note
Energy systems	Phosphagen 0 to 10 s; glycolysis 10 s to 2 min; oxidative longer	Intensity decides the mix
Carbohydrate per day	3 to 5, 5 to 7, 6 to 10, 8 to 12 g/kg	Light, moderate, endurance, very high
Loading	10 to 12 g/kg/day for 36 to 48 h	Events 90 min or more
During exercise	30 to 60 g/h (1 to 2.5 h); up to 90 g/h beyond	SGLT1 saturates near 60 g/h
Protein	0.8 g/kg RDA; 1.2 to 2.0 g/kg active	20 to 40 g per meal
Fluid	Loss over 2% hurts; replace 1.25 to 1.5 L per kg lost	Water AI 3.7 L men, 2.7 L women
EAH	Sodium below 135 mmol/L	Weight stable or up
Strong aids	Creatine, caffeine, beta-alanine, bicarbonate, nitrate	Iron and D only if deficient

Lifespan numbers

Stage	Key values	Note
Pregnancy energy	0, +340, +452 kcal/day	By trimester
Pregnancy nutrients	Folate 600 µg DFE; iron 27 mg; iodine 220 µg; protein 1.1 g/kg	Calcium unchanged for adults
Weight gain	28 to 40; 25 to 35; 15 to 25; 11 to 20 lb	By BMI band
Lactation	+330 then +400 kcal; iron 9 mg; vitamin A 1,300 µg; iodine 290 µg	Milk about 750 to 800 mL/day
Human milk	65 to 70 kcal/100 mL; fat about half the energy	HMOs feed gut bacteria
Infancy	100 kcal/kg falling to 80; vitamin D 400 IU; vitamin K at birth	Solids about 6 months; no honey before 12 months
Teens	Calcium 1,300 mg; iron 11 mg boys, 15 mg girls	About 90% of peak bone by 18 to 20
Older adults	Vitamin D 800 IU over 70; calcium 1,200 mg; B12 from fortified sources	Protein 1.0 to 1.2 g/kg suggested

Rules that are not equations

Topic	The rule
Avoid in pregnancy	Teratogens (alcohol, high-dose retinol); pathogens (Listeria and others); toxicants (high-mercury fish).
Formula	Mix exactly to the label. Never dilute, never homemade.
Allergens	Introduce in the first year; medical guidance first for severe eczema or known allergy.
Feeding children	Division of responsibility; repeated neutral exposure; no pressure or food rewards.
Body talk	Behavior-focused and weight-neutral language is better supported.
Older adults	Nutrient density; scheduled fluids; unintentional weight loss is a warning sign.

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