NUTRITION · STUDY GUIDE

Exam 4 Study Guide

This guide covers minerals and water, then energy balance. Chapter 7 is a numbers chapter: every mineral comes with a reference value, a group and a unit, and the trace minerals sit close to their upper limits. Chapter 8 asks how energy in and energy out talk to each other, how bodies are measured, and why the evidence points to behaviors rather than blame. Work one chapter at a time, run the arithmetic yourself, and finish each chapter with its ten self-test items.

WHAT THIS GUIDE COVERS

- Chapter 7 · major versus trace minerals; calcium, phosphorus, magnesium, sodium, potassium, chloride; iron, zinc, iodine, selenium, fluoride; bioavailability; heme and nonheme iron and hepcidin; stages of iron deficiency; water balance; electrolytes and blood pressure.
- Chapter 8 · the Atwater factors, energy balance and the EER, BMR, TEF and activity (including NEAT), BMI and waist measures, body composition methods, hunger and satiety hormones, the defense of body weight, and what the evidence says about weight management.

CHAPTER 7

Minerals and Water

Read it in full: **Chapter 7 in the textbook**. Practice it in the lab: **The Iron Absorption Mixer** and **The Daily Water Ledger**.

What to know

A mineral is a single inorganic element the body needs but cannot make. Heat cannot destroy it, but water can leach it, so boiling vegetables and pouring off the water loses potassium and magnesium. Minerals give 0 kcal. They build bone, carry charge across membranes, sit in enzymes and hold the osmotic pressure that decides where water goes.

A **major mineral** is needed at more than 100 mg a day (or is present at more than about 5 g in the body): calcium, phosphorus, magnesium, sodium, potassium, chloride, plus sulfur. A **trace mineral** is needed in mg or µg amounts. Trace is not minor: iodine is counted in micrograms and its lack causes goiter and harms fetal brain development.

Calcium is the most abundant mineral; about 99% is in bone and teeth as hydroxyapatite. The other 1% runs muscle contraction, nerves, hormone release and clotting. RDA 1,000 mg for ages 19 to 50; 1,200 mg for women 51+ and men 71+; 1,300 mg for ages 9 to 18. Adult pregnancy does not raise it, because absorption improves. UL 2,500 mg (19 to 50) and 2,000 mg (51+). Blood calcium stays normal even when intake is low, because bone pays the bill. **Phosphorus** (RDA 700 mg) is in bone, ATP, membranes and DNA, and deficiency is rare. **Magnesium** is a cofactor for over 300 enzymes, since ATP works as Mg-ATP. RDA 400 mg men 19 to 30, 420 mg men 31+, 310 and 320 mg for women. Its 350 mg UL covers supplements only.

Sodium and chloride rule the fluid outside cells, and **potassium** rules the fluid inside. All three have AIs: sodium 1,500 mg; chloride 2,300 mg (19 to 50); potassium 3,400 mg men and 2,600 mg women (2,900 mg in pregnancy). Sodium also has a Chronic Disease Risk Reduction Intake (CDRR) of 2,300 mg, which replaced its UL in 2019. US intake averages about 3,400 mg.

Trace minerals usually work inside one protein: iron in heme, zinc in zinc fingers, iodine in thyroid hormone, selenium as selenocysteine. Their safe window is narrow. **Zinc**: RDA 11 mg men, 8 mg women, UL 40 mg; deficiency slows growth, wound healing, immunity and taste, and high-dose zinc causes copper deficiency. **Iodine**: RDA 150 µg, 220 µg pregnancy, 290 µg lactation, UL 1,100 µg; the curve is U-shaped. **Selenium**: RDA 55 µg, UL 400 µg; Keshan disease in selenium-poor regions, selenosis in excess. **Fluoride**: AI 4 mg men, 3 mg women, UL 10 mg; it cuts caries, and too much while teeth form causes fluorosis.

Bioavailability is the share absorbed. Phytate in whole grains, legumes, nuts and seeds binds zinc, iron, calcium and magnesium. Oxalate in spinach binds calcium so tightly that spinach is a poor calcium source. Vitamin C raises nonheme iron absorption. Soaking, sprouting, fermenting and yeast leavening lower phytate. Big supplement doses of one mineral can crowd out another (zinc and copper, calcium and iron, iron and zinc).

Heme iron from meat, poultry and fish is absorbed at about 15 to 35% and is little affected by the meal. **Nonheme iron** from plants, eggs, dairy and fortified grains is absorbed at about 2 to 20% and is very sensitive to the meal. Vitamin C and the MFP factor in meat help. Phytates, tea and coffee polyphenols, large calcium doses and oxalates hurt. People who eat no meat, poultry or fish need about 1.8 times the standard RDA.

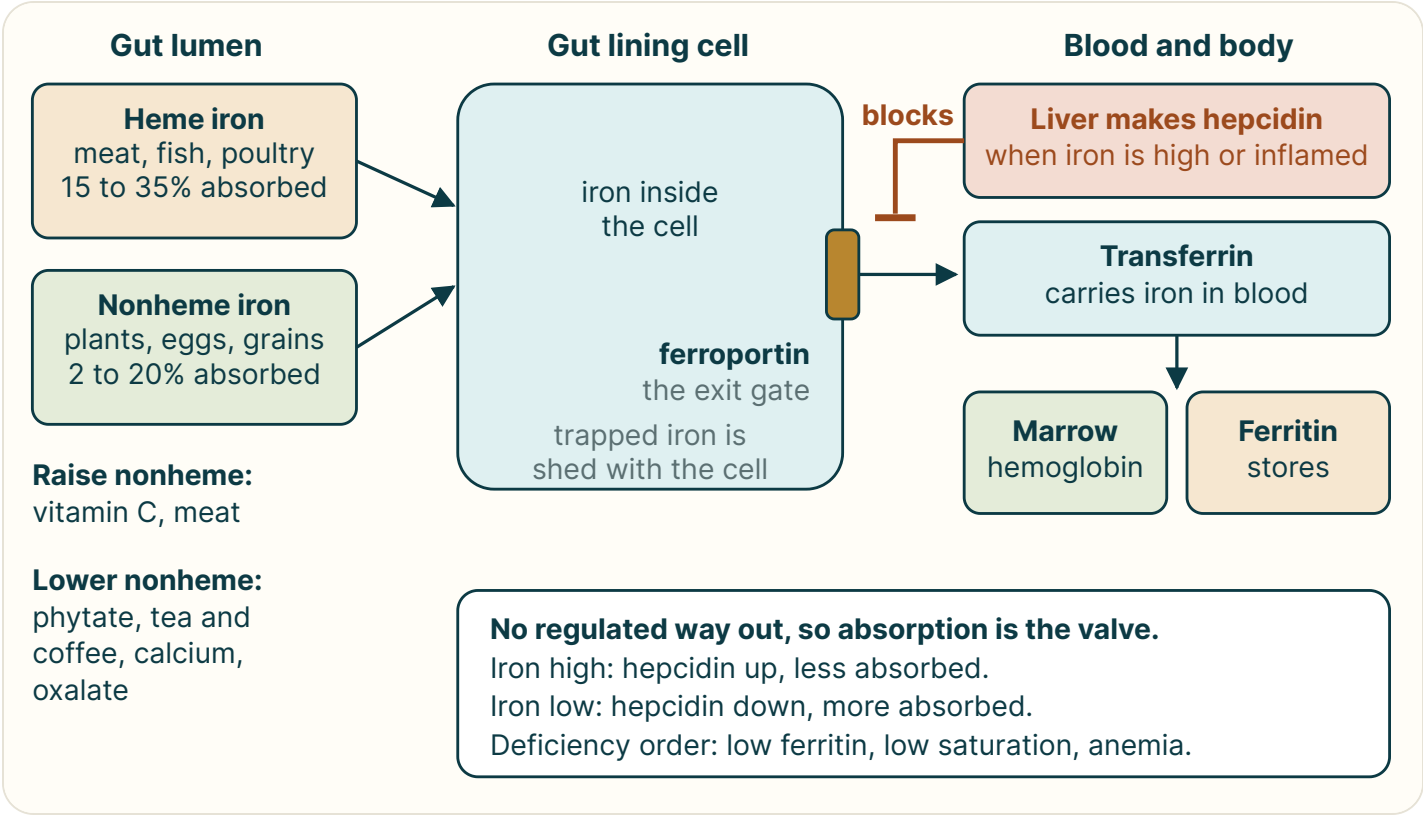
The body has no regulated way to excrete iron, so absorption is the control valve. The liver hormone **hepcidin** rises when iron is plentiful or inflammation is present. It degrades ferroportin, the export protein, so iron stays trapped in the gut cell and is shed. When iron is low, hepcidin falls. Transferrin carries iron in blood, and ferritin stores it. Deficiency comes in stages: depleted stores (ferritin falls, hemoglobin normal), early functional deficiency (transferrin saturation falls), then iron deficiency anemia (small, pale cells, MCV below about 80 fL). Iron RDA: 8 mg men, 18 mg women 19 to 50, 8 mg women 51+, 27 mg pregnancy; UL 45 mg.

Water is 50 to 70% of body weight, about two thirds inside cells and one third outside. It is solvent and reactant, transport, coolant, cushion and the base of blood volume. Water follows solute by osmosis. In: beverages (about 80% of intake, coffee and tea included), food and about 250 to 350 mL of metabolic water. Out: urine (at least about 500 mL), insensible loss through skin and lungs (about 700 to 1,000 mL), sweat and feces. Thirst and ADH defend concentration; aldosterone defends volume by holding sodium. The total water AI is 3.7 L men and 2.7 L women (3.0 L pregnancy, 3.8 L lactation), with about 3.0 L and 2.2 L from beverages. Thirst is blunted in older adults. Too much plain water during endurance events can cause hyponatremia.

The Na^+/K^+-ATPase pushes 3 sodium out and brings 2 potassium in per ATP. Lowering sodium lowers blood pressure, which is **strong** evidence, with bigger effects in salt-sensitive groups. Raising potassium lowers it too, which is **moderate** evidence, clearest in people with hypertension. Effects on heart attacks and strokes rest on fewer trials. About 70% of US sodium comes from packaged and restaurant foods. One teaspoon of salt holds about 2,300 mg of sodium, since salt is about 40% sodium. Potassium salt substitutes can be dangerous with kidney disease or some blood pressure medicines.

LOCK THESE IN

- Major minerals are over 100 mg a day. Trace minerals are less, and the margin to toxicity is narrow.
- Calcium RDA 1,000 mg (19 to 50); 1,200 mg (women 51+, men 71+); 1,300 mg (9 to 18).
- Sodium AI 1,500 mg and CDRR 2,300 mg. Potassium AI 3,400 mg men, 2,600 mg women.
- Heme iron 15 to 35% absorbed; nonheme 2 to 20%. Vegetarian iron need is about 1.8 times the RDA.
- Hepcidin up means less iron absorbed. There is no regulated iron excretion.
- Stages: low ferritin, then low transferrin saturation, then microcytic anemia.
- Water AI 3.7 L men, 2.7 L women, from food and all drinks.
- 1 tsp salt is about 2,300 mg sodium. About 70% of sodium is already in packaged and restaurant food.



Absorption is the valve. With no regulated way to excrete iron, hepcidin closes the ferroportin gate when iron is plentiful.

Key minerals: roles, sources and reference values (adults)

Mineral	Main role	Good sources	Reference intake	UL or limit
Calcium	Bone mineral; muscle, nerve, clotting	Dairy, fortified plant drinks, calcium-set tofu, kale, bok choy, canned fish with bones	RDA 1,000 mg (19 to 50); 1,200 mg (women 51+, men 71+)	2,500 mg (19 to 50); 2,000 mg (51+)
Phosphorus	Bone; ATP; DNA; membranes	Protein foods, dairy, legumes, whole grains	RDA 700 mg	Excess matters mainly in kidney disease
Magnesium	Cofactor for 300+ enzymes; Mg-ATP	Nuts, seeds, legumes, whole grains, greens	RDA 400/420 mg men; 310/320 mg women	350 mg from supplements only
Sodium	Outside-cell fluid volume; nerve impulses	Packaged and restaurant foods, breads, cured meats, cheese	AI 1,500 mg	CDRR 2,300 mg
Potassium	Inside-cell cation; heart rhythm	Potatoes, beans, lentils, bananas, oranges, tomatoes, yogurt	AI 3,400 mg men; 2,600 mg women	Risk of high levels in kidney disease
Chloride	Stomach acid; outside-cell anion	Table salt and salted foods	AI 2,300 mg (19 to 50)	Travels with sodium
Iron	Hemoglobin, myoglobin, electron transport	Meat, poultry, fish (heme); beans, fortified grains (nonheme)	RDA 8 mg men; 18 mg women 19 to 50; 27 mg pregnancy	45 mg
Zinc	300+ enzymes; zinc fingers; immunity	Meat, shellfish, legumes, whole grains	RDA 11 mg men; 8 mg women	40 mg
Iodine	Thyroid hormone	Iodized salt, seafood, dairy	RDA 150 µg; 220 pregnancy; 290 lactation	1,100 µg

Mineral	Main role	Good sources	Reference intake	UL or limit
Selenium	Glutathione peroxidase; thyroid activation	Brazil nuts (very variable), seafood, grains	RDA 55 µg	400 µg
Fluoride	Strengthens enamel	Fluoridated water, toothpaste	AI 4 mg men; 3 mg women	10 mg

Daily water balance (typical adult, mL)

Water in	Amount	Water out	Amount
Beverages	1,500 to 2,500	Urine (minimum about 500)	1,000 to 2,000
Food	700 to 1,000	Skin and lungs (insensible)	700 to 1,000
Metabolic water	250 to 350	Sweat at rest	100 to 500; heat or exertion can add over 1,000 per hour
Not applicable	Not applicable	Feces	100 to 200; much more in diarrhea

Worked examples

WORKED EXAMPLE 1 · IRON NEEDS ON A MEAT-FREE DIET

Aisha is 28 and eats no meat, poultry or fish. Her brother Omar, 30, follows the same pattern. Estimate each one's iron need.

STEP 1 · FIND THE STANDARD RDAS

Women 19 to 50: 18 mg. Men 19+: 8 mg.

STEP 2 · APPLY THE FACTOR

The DRI committee estimates about 1.8 times the RDA for people eating no meat, poultry or fish.

STEP 3 · AISHA

18 × 1.8 = **32.4 mg/day**.

STEP 4 · OMAR

8 × 1.8 = **14.4 mg/day**.

WHY

Nearly all of their iron is nonheme, absorbed at only about 2 to 20%. Pairing beans or fortified grains with vitamin C at the same meal raises what they absorb.

WORKED EXAMPLE 2 · HOW MUCH IRON IS ABSORBED FROM ONE MEAL?

A meal holds 2 mg of heme iron and 10 mg of nonheme iron. Assume 25% of the heme is absorbed. The nonheme is absorbed at 5% with tea, or 15% with a glass of orange juice instead. How much iron is absorbed each way?

STEP 1 · HEME PART

2 × 0.25 = 0.5 mg either way. Heme absorption barely changes with the meal.

STEP 2 · NONHEME WITH TEA

10 × 0.05 = 0.5 mg. Total 0.5 + 0.5 = **1.0 mg**.

STEP 3 · NONHEME WITH ORANGE JUICE

10 × 0.15 = 1.5 mg. Total 0.5 + 1.5 = **2.0 mg**.

THE LESSON

Switching the drink doubled the iron absorbed. The meal's 12 mg on paper is not 12 mg in the body.

WORKED EXAMPLE 3 · READING SODIUM ON A LABEL

A serving of canned soup lists 640 mg of sodium. What share of the 2,300 mg CDRR is that, and how much salt does it equal?

STEP 1 · SHARE

640 ÷ 2,300 = 0.278, about **28%** of the CDRR in one serving.

STEP 2 · SALT TO SODIUM

Salt is about 40% sodium, so 1 tsp (about 2,300 mg sodium) is about 5.75 g of salt.

STEP 3 · THIS SERVING AS SALT

640 ÷ 0.40 = 1,600 mg, or about **1.6 g of salt**.

WHY LABELS SAY SODIUM

Sodium is the part tied to blood pressure, and most of it arrives already in packaged and restaurant food rather than from the shaker.

WORKED EXAMPLE 4 · BALANCING A DAY OF WATER

One day: beverages 1,800 mL, food 800 mL, metabolic water 300 mL. Losses: urine 1,500 mL, skin and lungs 900 mL, sweat 300 mL, feces 150 mL. Is the person in balance?

STEP 1 · ADD INTAKE

1,800 + 800 + 300 = 2,900 mL.

STEP 2 · ADD OUTPUT

1,500 + 900 + 300 + 150 = 2,850 mL.

STEP 3 · COMPARE

2,900 − 2,850 = +50 mL, which is **essentially balanced**. The kidney trims urine output to close small gaps.

COMPARE WITH THE AI

Total water here is 2,900 − 300 = 2,600 mL from food and drinks, close to the 2,700 mL AI for women. The AI counts food and beverages, not metabolic water.

TRAPS PEOPLE FALL INTO

- **Thinking cooking destroys minerals.** Heat cannot destroy an element. Water can leach it away.
- **Reading trace as minor.** Trace refers to the amount needed. Iodine lack harms the brain.
- **Judging calcium intake from a blood test.** Blood calcium is defended by drawing on bone.
- **Treating spinach as a top calcium source.** Its oxalate binds calcium tightly.
- **Assuming normal hemoglobin rules out iron deficiency.** Stores can be empty first. Anemia is the last stage.
- **Calling every anemia an iron problem.** B12 and folate deficiency make large cells, not small ones.
- **Treating "eight glasses a day" as a DRI.** It is not one, and it ignores water from food.
- **Assuming salt substitutes are safe for everyone.** Potassium can build up with kidney disease or some medications.

Chapter 7 self-test · ten items

1. Which property separates a mineral from a vitamin?

A. It dissolves only in fat and is stored in the liver
B. It supplies energy at about 4 kcal per gram of intake
C. It is always needed in amounts over 100 mg a day
D. It is a single element and cannot be destroyed by heat

D. It is a single element and cannot be destroyed by heat Minerals are inorganic elements. Heat cannot break them down, though water can leach them.

2. Tomas is 16 and wants to know how much calcium he needs while he is still growing. What is his RDA?

A. 2,500 mg/day
B. 1,300 mg/day
C. 1,000 mg/day
D. 1,200 mg/day

B. 1,300 mg/day Ages 9 to 18 have the highest calcium RDA, 1,300 mg, while the skeleton is being built. 2,500 mg is an adult UL.

3. Why does the magnesium UL of 350 mg apply only to supplements?

A. It is set by the laxative effect of magnesium salts
B. Supplements contain a toxic form of the element
C. Food magnesium is never absorbed by the gut
D. Food magnesium is used only to build bone

A. It is set by the laxative effect of magnesium salts The UL reflects diarrhea from magnesium salts. Magnesium in food does not cause that problem.

4. Which value replaced the sodium UL in the 2019 review?

A. An AI of 3,400 mg/day
B. An EAR of 2,300 mg/day
C. A CDRR of 2,300 mg/day
D. An RDA of 1,500 mg/day

C. A CDRR of 2,300 mg/day The Chronic Disease Risk Reduction Intake marks the level above which cutting sodium is expected to lower chronic disease risk.

5. A person takes a large zinc supplement every day for a year. Which mineral are they most likely to run low on?

A. Fluoride
B. Sodium
C. Copper
D. Iodine

C. Copper Zinc induces a gut protein that traps copper, so long-term high zinc can lead to copper deficiency.

6. Which meal change would most raise nonheme iron absorption from a lentil dish?

A. Drinking black tea with the meal
B. Adding extra bran to the lentils
C. Taking a calcium supplement with it
D. Adding peppers or citrus to the meal

D. Adding peppers or citrus to the meal Vitamin C reduces iron to the absorbable ferrous form. Tea polyphenols, large calcium doses and bran phytate all lower absorption.

7. When body iron stores are high, what does hepcidin do?

A. Rises and blocks iron export from gut cells
B. Tells the kidney to excrete the extra iron
C. Turns stored ferritin into transferrin
D. Falls so that more iron enters the blood

A. Rises and blocks iron export from gut cells High hepcidin degrades ferroportin, so absorbed iron stays in the gut cell and is shed. There is no regulated excretion route.

8. Lab results show low ferritin and a normal hemoglobin. Which stage of iron deficiency fits best?

A. Iron deficiency anemia
B. Depleted stores
C. Megaloblastic anemia
D. Iron overload

B. Depleted stores Ferritin falls first while hemoglobin is still normal. Anemia, with small pale cells, is the last stage.

9. What is the total water AI for a woman aged 30 who is not pregnant?

A. 3.7 L/day from drinks alone
B. 1.9 L/day from drinks alone
C. 2.2 L/day from food alone
D. 2.7 L/day from food and drinks

D. 2.7 L/day from food and drinks The total water AI for women is 2.7 L, about 2.2 L of it from beverages. Eight 8 oz glasses is about 1.9 L and is not a DRI.

10. Which statement matches the chapter's grading of the evidence?

A. Lowering sodium lowers blood pressure: strong
B. Raising potassium cuts strokes for all: strong
C. Very low sodium is known to be harmful: settled
D. The Na to K ratio sets risk: proven by trials

A. Lowering sodium lowers blood pressure: strong Many randomized feeding trials show that lowering sodium lowers blood pressure. The other claims are moderate, preliminary or unresolved.

CHAPTER 8

Energy Balance and Weight

Read it in full: **Chapter 8 in the textbook**. Practice it in the lab: **Where Your Calories Go** and **BMI and What It Misses**.

What to know

Food energy comes from four sources only: carbohydrate 4, protein 4, fat 9 and alcohol 7 kcal/g, with fiber about 2. These Atwater factors already allow for what is not digested or absorbed. A label Calorie is a kcal, and 1 kcal = 4.184 kJ.

Energy balance compares intake with expenditure over time. Equilibrium keeps stores stable. Positive balance stores energy, and it is needed in growth, pregnancy, lactation and recovery. Negative balance draws on stores. The first law of thermodynamics holds, but the two sides are not independent. Eat less and resting metabolism, spontaneous movement and fullness signals all shift. That is why the old "3,500 kcal per pound" rule overpredicts long-term loss. Dynamic models, such as the NIH Body Weight Planner, match trials better.

There is no RDA for energy, because an allowance covering 97 to 98% of people would overfeed nearly everyone. The **EER** is the average intake that keeps a person of a given age, sex, size and activity in balance. Pregnancy adds about 340 kcal/day in the second trimester and 452 in the third. Lactation adds about 330 kcal/day in the first six months and 400 in the second six.

Total energy expenditure has three parts. **Basal or resting metabolism** is about 60 to 75% and is set mainly by fat-free mass. The liver, brain, heart and kidneys burn about 60 to 70% of resting energy while making up only 5 to 6% of body weight. Resting muscle burns only about 6 kcal per pound a day. RMR runs about 5 to 10% above BMR. Fever raises it about 13% per degree Celsius. A large pooled analysis found size-adjusted expenditure stable from about age 20 to 60, then falling about 0.7% a year.

The **thermic effect of food** is about 10% of intake: about 20 to 30% for protein, 5 to 10% for carbohydrate and 0 to 3% for fat. **Physical activity** is about 15 to 30% and the most variable part. It includes exercise and NEAT, all the other movement of the day. NEAT can differ by hundreds of kcal between similar people and falls during restriction. To estimate TEE, multiply RMR by a physical activity level: about 1.0 to 1.39 sedentary, 1.4 to 1.59 low active, 1.6 to 1.89 active, 1.9 to 2.5 very active. Treat the result as a starting estimate.

Doubly labeled water is the gold standard for free-living expenditure. Indirect calorimetry measures oxygen and carbon dioxide. Prediction equations such as Mifflin-St Jeor are often off by 10% or more for one person, and wearables are often well off for calories.

BMI = kg ÷ m^2, or (lb ÷ in^2) × 703. Adult WHO ranges: under 18.5, 18.5 to 24.9, 25.0 to 29.9, and 30 and above, with lower cut points for many Asian populations (healthy 18.5 to 22.9, 23.0 to 27.4, 27.5 and above). Children 2 to 19 use BMI-for-age percentiles: below the 5th, 5th to below 85th, 85th to below 95th, and 95th and above. BMI measures mass for height, not fat or where fat sits. It misleads in muscular athletes, older adults, pregnancy and across ancestry groups, and it was built for populations.

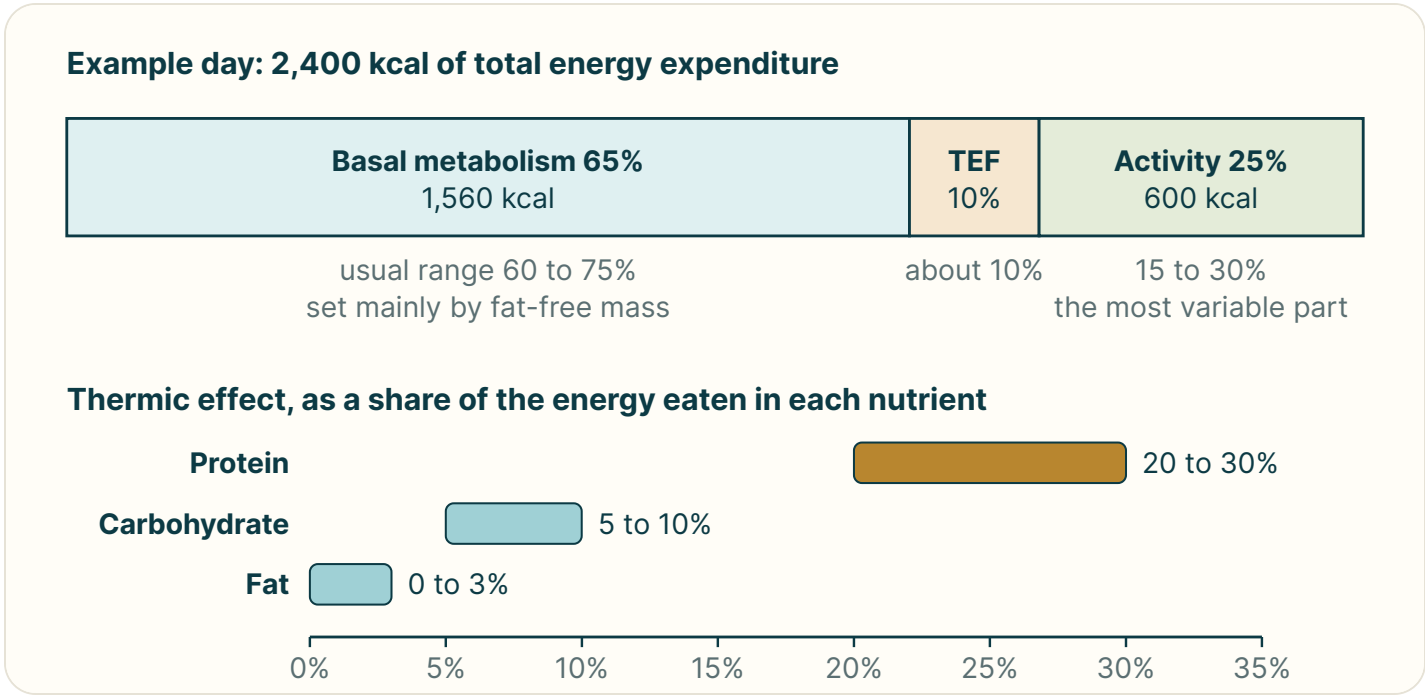
Fat distribution matters. Visceral fat around the organs is tied to insulin resistance, blood lipid changes, hypertension and heart disease more than fat on the hips and thighs. Waist circumference is measured at the top of the iliac crest. Common thresholds are above 102 cm (40 in) for men and 88 cm (35 in) for women of European descent, and lower (about 90 and 80 cm) for South Asian, Chinese and several other groups. A waist-to-height ratio under 0.5 is a simple guide. Essential fat is about 3 to 5% in men and 8 to 12% in women. DXA is a common reference for fat, lean and bone, and BIA is sensitive to hydration.

Hunger is the body's drive to eat. Appetite is the psychological desire. Satiation ends a meal, and satiety delays the next one. **Ghrelin** from the stomach raises hunger before meals. CCK, GLP-1, PYY, insulin and **leptin** restrain eating. Leptin from fat cells reports long-term stores. Common obesity involves high leptin and leptin resistance, not leptin deficiency, so leptin treatment does not help it. The hypothalamus integrates these signals through the melanocortin pathway and MC4R.

The body defends weight loss more strongly than weight gain. After loss, leptin falls, ghrelin and hunger rise, and expenditure drops more than size alone predicts (adaptive thermogenesis), for a year or more. BMI heritability is about 40 to 70%. In a small but rigorous inpatient trial, people ate about 500 kcal a day more on an ultra-processed menu. Health behaviors improve health whether or not weight changes. When weight change is appropriate, 5 to 10% improves markers, and the Diabetes Prevention Program cut progression to type 2 diabetes by 58%. Head-to-head diet trials find little difference at 1 to 2 years, so adherence is the active ingredient. Fad diets fail because early loss is glycogen water, restriction is hard to keep up, biology pushes back and there is no maintenance plan, not because of personal weakness.

LOCK THESE IN

- 4 4 9 7, fiber about 2; 1 kcal = 4.184 kJ.
- Energy has an EER, not an RDA.
- TEE = basal (60 to 75%) + TEF (about 10%) + activity (15 to 30%). Activity is the most variable.
- Fat-free mass drives BMR. TEF is highest for protein (20 to 30%).
- BMI = kg ÷ m^2 = (lb ÷ in^2) × 703. Children use percentiles.
- Waist risk above 102 cm (men) and 88 cm (women) in European-descent adults; waist-to-height under 0.5.
- Ghrelin raises hunger. Leptin reports fat stores; common obesity is leptin resistance.
- Adherence, not macronutrient ratio, predicts results. The DPP cut diabetes progression 58%.



Three parts of energy out. Basal metabolism is the largest share, activity the most variable, and protein has the highest thermic effect.

Energy expenditure and assessment numbers

Item	Value	Note
Basal or resting metabolism	About 60 to 75% of TEE	Driven by fat-free mass
Thermic effect of food	About 10% of intake	Protein 20 to 30%; carbohydrate 5 to 10%; fat 0 to 3%
Physical activity	About 15 to 30% (50%+ in athletes)	Exercise plus NEAT
PAL factors	Sedentary 1.0 to 1.39; low active 1.4 to 1.59; active 1.6 to 1.89; very active 1.9 to 2.5	TEE = RMR × PAL
Fever	About 13% per °C (about 7% per °F)	Raises BMR
Resting muscle	About 6 kcal per pound per day	About 13 kcal per kg
Pregnancy EER add-on	About 340 kcal (2nd trimester); 452 kcal (3rd)	Above pre-pregnancy needs
Lactation EER add-on	About 330 kcal (0 to 6 mo); 400 kcal (7 to 12 mo)	Above pre-pregnancy needs
BMI, adults	Under 18.5; 18.5 to 24.9; 25.0 to 29.9; 30+	Asian cut points 23.0 and 27.5
BMI, ages 2 to 19	Under 5th; 5th to under 85th; 85th to under 95th; 95th+ percentile	Never adult categories
Waist	Over 102 cm (40 in) men; over 88 cm (35 in) women	Lower for several populations
Essential fat	3 to 5% men; 8 to 12% women	Not optional

Worked examples

WORKED EXAMPLE 1 · BMI TWO WAYS

Find the BMI of a 1.75 m, 70 kg adult. Then find the BMI of a 66 inch, 160 lb adult.

STEP 1 · SQUARE THE HEIGHT

$1.75 \times 1.75 = 3.0625\ m^2$.

STEP 2 · DIVIDE

$70 \div 3.0625 =$ **$22.9\ kg/m^2$**, inside 18.5 to 24.9.

STEP 3 · USE THE POUND FORMULA

$66 \times 66 = 4{,}356\ in^2$. Then $160 \div 4{,}356 = 0.03673$, and $0.03673 \times 703 =$ **25.8**.

READ IT CAREFULLY

25.8 falls in the 25.0 to 29.9 band, which is a screening category, not a diagnosis. If this person is a muscular athlete, BMI may misclassify them. A waist measurement adds what BMI cannot see.

WORKED EXAMPLE 2 · FROM RMR TO TOTAL EXPENDITURE

Pooja's measured RMR is 1,400 kcal/day and her activity puts her at a PAL of 1.75. Estimate her TEE, and then the share of it that is TEF.

STEP 1 · MULTIPLY

$1{,}400 \times 1.75 =$ **2,450 kcal/day**.

STEP 2 · TEF

TEF is about 10% of intake. If she eats about 2,450 kcal to stay in balance, TEF is about 245 kcal.

STEP 3 · RMR SHARE

$1{,}400 \div 2{,}450 = 57\%$, a little under the usual 60 to 75%, which fits an active person.

TREAT IT AS A HYPOTHESIS

Prediction steps are often off by 10% or more for one person. Real weight trends over weeks are the check.

WORKED EXAMPLE 3 · THERMIC EFFECT OF ONE MEAL

A meal supplies 100 kcal from protein, 400 kcal from carbohydrate and 300 kcal from fat. Use the middle of each TEF range (25%, 7.5% and 1.5%) to estimate the meal's TEF.

STEP 1 · PROTEIN

$100 \times 0.25 = 25$ kcal.

STEP 2 · CARBOHYDRATE

$400 \times 0.075 = 30$ kcal.

STEP 3 · FAT

$300 \times 0.015 = 4.5$ kcal.

STEP 4 · ADD

$25 + 30 + 4.5 =$ **59.5 kcal**, which is $59.5 \div 800 = 7.4\%$ of the meal.

THE LESSON

Protein is the most costly to process, but the totals are small. TEF is real, not a free pass.

WORKED EXAMPLE 4 · WAIST-TO-HEIGHT RATIO

Two adults have the same BMI of 22. Nadia is 168 cm with a 90 cm waist. Kofi is 180 cm with an 85 cm waist. Find each waist-to-height ratio.

STEP 1 · NADIA

90 ÷ 168 = **0.54**, above the 0.5 guide. Her waist is also above the 88 cm threshold often used for women of European descent.

STEP 2 · KOFI

85 ÷ 180 = **0.47**, under 0.5.

STEP 3 · COMPARE

Same BMI, different fat distribution. Central fat carries risk information that BMI does not show.

USE IT WELL

A measurement is information about a body, not a judgment of a person. It is one input among labs, history and function.

TRAPS PEOPLE FALL INTO

- **Treating 3,500 kcal per pound as a long-term law.** Expenditure adapts, so the static rule overpredicts loss over months.
- **Thinking muscle burns hundreds of extra kcal.** Resting muscle is about 6 kcal per pound per day.
- **Ranking TEF as the biggest part of expenditure.** Basal metabolism is largest. Activity is the most variable.
- **Using adult BMI bands for a child.** Ages 2 to 19 use BMI-for-age percentiles.
- **Saying BMI measures body fat.** It measures mass relative to height only.
- **Thinking common obesity is a leptin shortage.** Leptin is usually high; the brain responds poorly to it.
- **Crediting a fad diet's first week.** Most of that early loss is glycogen and its water.
- **Calling regain a lack of willpower.** Hunger rises and expenditure falls after loss, for a year or more.

Chapter 8 self-test · ten items

1. Why is there an EER for energy but no RDA?

A. Energy needs never change with activity
B. Energy is not a nutrient in the DRIs at all
C. There are not enough data on energy needs
D. An RDA would overfeed nearly everyone

D. An RDA would overfeed nearly everyone An RDA covers 97 to 98% of people, which for energy would overshoot most people's needs.

2. Which component of total energy expenditure is usually the largest?

A. Basal or resting metabolism
B. Adaptive thermogenesis
C. The thermic effect of food
D. Planned exercise sessions

A. Basal or resting metabolism Basal metabolism is about 60 to 75% of TEE in most adults.

3. Which macronutrient has the highest thermic effect per kcal eaten?

A. Fat, at about 10 to 15%
B. Protein, at about 20 to 30%
C. Alcohol, at about 30 to 40%
D. Carbohydrate, at about 20 to 30%

B. Protein, at about 20 to 30% Protein costs the most to process. Carbohydrate is about 5 to 10% and fat about 0 to 3%.

4. A person's RMR is 1,500 kcal and their PAL is 1.5. What is their estimated TEE?

A. 3,000 kcal/day
B. 1,650 kcal/day
C. 2,250 kcal/day
D. 2,000 kcal/day

C. 2,250 kcal/day TEE = RMR × PAL = 1,500 × 1.5 = 2,250 kcal.

5. What is the BMI of an adult who weighs 58 kg and is 1.62 m tall?

A. About 35.8
B. About 19.4
C. About 24.6
D. About 22.1

D. About 22.1 1.62 × 1.62 = 2.6244, and 58 ÷ 2.6244 = 22.1. Dividing by height without squaring gives 35.8.

6. For a 10-year-old, which tool classifies weight status?

A. The adult WHO BMI cut points of 25 and 30
B. A waist above 88 cm for every child
C. BMI-for-age percentiles on a growth chart
D. The adult waist-to-height ratio of 0.5 alone

C. BMI-for-age percentiles on a growth chart Ages 2 to 19 use percentiles: the 5th, 85th and 95th mark the bands.

7. Which hormone rises before meals and increases hunger?

A. Ghrelin, from the stomach
B. GLP-1, from intestinal L cells
C. PYY, from the ileum and colon
D. Leptin, from fat tissue

A. Ghrelin, from the stomach Ghrelin rises before meals and falls after. Leptin, PYY and GLP-1 restrain eating.

8. Why does giving leptin not help most people with common obesity?

A. Leptin is broken down in the stomach before use
B. Their leptin is already high; the brain responds poorly
C. Their fat cells make no leptin at all, so it is lost
D. Extra leptin raises ghrelin and makes hunger worse

B. Their leptin is already high; the brain responds poorly Common obesity involves leptin resistance. Only rare congenital leptin deficiency responds to replacement.

9. In head-to-head trials of low-fat and low-carbohydrate diets, what best predicted weight change at 1 to 2 years?

A. How much water was lost in week one
B. How well people stuck to the plan
C. Which macronutrient was cut most
D. Whether meals were eaten before 6 pm

B. How well people stuck to the plan Average differences between diets were trivial. Adherence was the active ingredient.

10. After weight loss, which change helps explain why regain is common?

A. Leptin rises sharply and appetite falls for good
B. Resting metabolism climbs well above its baseline
C. Fat cells stop storing triglyceride permanently
D. Hunger rises and expenditure falls beyond prediction

D. Hunger rises and expenditure falls beyond prediction Leptin falls, ghrelin rises and expenditure drops more than body size predicts, and these persist for a year or more.

ONE PAGE

Cram sheet

Everything from chapters 7 and 8 in one place. Cover the right column and see if you can rebuild each row.

Mineral and water numbers (adults)

Item	Value	Note
Calcium	RDA 1,000 mg; 1,200 mg women 51+ and men 71+; 1,300 mg ages 9 to 18	UL 2,500 mg (19 to 50), 2,000 mg (51+)
Phosphorus	RDA 700 mg	1,250 mg ages 9 to 18
Magnesium	400/420 mg men; 310/320 mg women	UL 350 mg supplements only
Sodium	AI 1,500 mg; CDRR 2,300 mg	1 tsp salt about 2,300 mg; US average about 3,400 mg
Potassium	AI 3,400 mg men; 2,600 mg women	2,900 mg pregnancy
Iron	8 mg men; 18 mg women 19 to 50; 8 mg 51+; 27 mg pregnancy	UL 45 mg; about 1.8 times for meat-free diets
Zinc	11 mg men; 8 mg women	UL 40 mg
Iodine	150 µg; 220 pregnancy; 290 lactation	UL 1,100 µg
Selenium	55 µg	UL 400 µg
Fluoride	AI 4 mg men; 3 mg women	UL 10 mg
Water	AI 3.7 L men; 2.7 L women; 3.0 L pregnancy; 3.8 L lactation	About 3.0 L and 2.2 L from drinks
Plasma ranges	Sodium 135 to 145 mEq/L; potassium 3.5 to 5.0 mEq/L	Potassium window is narrow

Energy equations and numbers

Name	Equation or value	Note
Food energy	4(carb) + 4(protein) + 9(fat) + 7(alcohol)	kcal
kJ	kcal × 4.184	1 kcal = 4.184 kJ
TEE	RMR × PAL	A starting estimate
BMI	kg ÷ m^2, or (lb ÷ in^2) × 703	kg/m^2
Waist-to-height	waist ÷ height	Under 0.5 is the simple guide
TEE parts	Basal 60 to 75%; TEF about 10%; activity 15 to 30%	Activity varies most
DPP	About 7% loss plus 150 min/week activity	58% less progression (drug arm 31%)
Activity guideline	150 to 300 min/week moderate plus 2 days resistance	Best predictor of maintenance

Rules that are not equations

Topic	The rule
Iron control	No regulated excretion; hepcidin sets absorption through ferroportin.
Iron stages	Low ferritin; then low transferrin saturation; then microcytic, hypochromic anemia.
Absorption	Vitamin C and MFP help nonheme iron; phytate, tea, large calcium doses and oxalate hurt.
Fluid hormones	Thirst and ADH defend concentration; aldosterone holds sodium to defend volume.
Evidence	Sodium and blood pressure strong; potassium moderate; events weaker.
Appetite	Ghrelin up; CCK, GLP-1, PYY, insulin, leptin down.
Weight defense	Asymmetric: loss is resisted more than gain.

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