NUTRITION · STUDY GUIDE

Exam 1 Study Guide

This guide covers the first two chapters. You will learn what a nutrient is, how food energy is counted, and how the reference standards work. Then you will follow a meal down the gut and out into the blood and lymph. Work one chapter at a time. Read the "what to know" paragraphs, copy the tables out by hand, then try each worked example with the steps covered. Finish each chapter with its ten self-test items. The cram sheet at the end puts every number in one place.

WHAT THIS GUIDE COVERS

- Chapter 1 · food versus nutrient, essential nutrients, the six classes, 4 4 9 and 7, kcal and kJ, the DRIs (EAR, RDA, AI, UL), AMDRs, guidelines and nutrient density.
- Chapter 2 · the GI tract organ by organ, mechanical and chemical digestion, enzymes and secretions, villi and the brush border, blood versus lymph, the liver and the gut microbiota.

CHAPTER 1

Nutrition Basics

Read it in full: **Chapter 1 in the textbook**. Practice it in the lab: **Count the Calories** and **The Requirement Curve**.

What to know

Nutrition is the science of how the body takes in, breaks down, absorbs, moves, uses and gets rid of what is in food. Food is what you eat. A nutrient is one chemical inside that food that the body needs. An orange is a food. The vitamin C inside it is a nutrient.

The two words are worth keeping apart. A food never holds just one nutrient. A chickpea brings protein, starch, fiber, folate, iron, magnesium and water all at once, held in a physical structure that changes how fast it is digested. That is why a whole food often acts differently from the same nutrient taken alone in a pill.

A nutrient is **essential** when the body cannot make it, or cannot make enough. The test is simple. Take it out of the diet and a deficiency appears. Put it back and the deficiency goes away. There are about forty essential nutrients: nine amino acids, two fatty acids (linoleic acid and alpha-linolenic acid), thirteen vitamins, a set of minerals, and water. There is no essential carbohydrate, because the body can build the glucose it needs from other material.

Every nutrient falls into one of six classes: carbohydrate, lipid, protein, vitamin, mineral and water. Macronutrients are needed in grams: carbohydrate, lipid, protein and, by convention, water. Micronutrients are needed in milligrams or micrograms: vitamins and minerals. Macro and micro describe the amount, not the importance. Adults need about 150 µg of iodine a day, a tiny amount, yet too little in pregnancy harms the baby's brain.

Only three classes give energy: carbohydrate, lipid and protein. Vitamins, minerals and water give none. Some B vitamins are coenzymes that help release energy from food, but a coenzyme is a tool, not fuel. Four classes are organic, meaning they contain carbon: carbohydrate, lipid, protein and vitamins. Minerals and water are inorganic. Minerals are single elements.

A food label Calorie is a kilocalorie (kcal). One kcal raises one kilogram of water by one degree Celsius. In SI units, 1 kcal = 4.184 kJ. The Atwater factors turn grams into energy: carbohydrate 4, protein 4, fat 9 and alcohol 7 kcal per gram. Fiber gives about 2 kcal/g from fermentation in the colon. Alcohol gives energy but is not a nutrient, because no body function needs it.

Energy out has three parts. Basal metabolic rate (BMR) keeps a resting body alive and is the largest share, about 60 to 70% in a sedentary adult. Physical activity is the most variable share. The thermic effect of food, the cost of digesting a meal, is about 10% of intake.

The **Dietary Reference Intakes** (DRIs) are a family of values for healthy people, set by life stage and sex. The EAR meets the need of half the group, so it is a population tool and the base for the RDA. The RDA covers 97 to 98% of the group and is the individual goal. It is the EAR plus two standard deviations. The AI stands in when the evidence is too thin for an EAR. The UL is a safety ceiling, never a target. No UL means not enough data, not proof of safety.

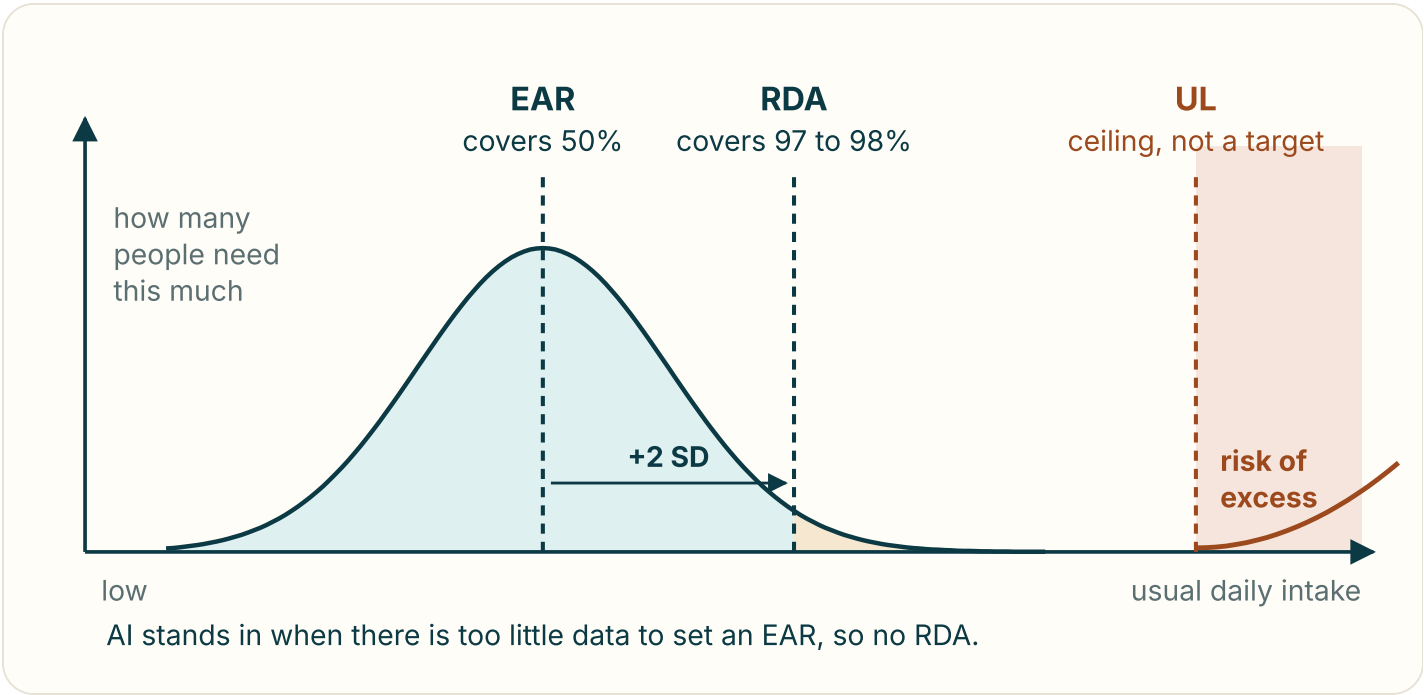
The AMDRs give healthy ranges as a share of calories for adults: carbohydrate 45 to 65%, fat 20 to 35% and protein 10 to 35%. Energy has an EER, not an RDA, because an RDA for energy

would overshoot most people. Dietary guidelines turn all of this into foods. Common adult targets are under 10% of calories from added sugars, under 10% from saturated fat, and under 2,300 mg of sodium a day. MyPlate shows about half the plate as vegetables and fruit, a quarter grains (at least half whole), a quarter protein foods, plus dairy or a fortified alternative.

Nutrient density is nutrients per calorie. Energy density is calories per gram. They vary on their own. Nuts are high in both. A soft drink is low in both, at about 0.4 kcal per gram, because it is mostly water. "Empty calories" is loose shorthand for energy with few nutrients alongside it. Naming the part (added sugars, saturated fat, alcohol) is more precise. The evidence on chronic disease is about the whole pattern over months and years, not any single food.

LOCK THESE IN

- Six classes: carbohydrate, lipid, protein, vitamin, mineral, water. Only the first three yield energy.
- 4 4 9 and 7: carbohydrate, protein, fat, alcohol, in kcal per gram. Fiber is about 2.
- A label Calorie is a kcal, and 1 kcal = 4.184 kJ.
- EAR covers 50%, RDA covers 97 to 98%, AI replaces the RDA when evidence is thin, UL is a ceiling.
- AMDRs for adults: carbohydrate 45 to 65%, fat 20 to 35%, protein 10 to 35% of calories.
- Every DRI needs its group and units. Iron is 8 mg for men, 18 mg for women 19 to 50, 27 mg in pregnancy.
- Nutrient density is nutrients per kcal. Energy density is kcal per gram. They are separate measures.
- There is no essential carbohydrate, and no RDA for energy.



Where the DRIs sit. Needs spread across a group. The EAR covers half, the RDA two standard deviations higher covers 97 to 98%, and the UL is a ceiling, not a goal.

Energy factors and DRI terms

Item	Value or meaning	Use it for
Carbohydrate	4 kcal/g (about 17 kJ/g)	Sugars and starches
Protein	4 kcal/g (about 17 kJ/g)	Nitrogen leaves as urea, so about 4 is usable
Fat	9 kcal/g (about 37 kJ/g)	The densest fuel
Alcohol	7 kcal/g (about 29 kJ/g)	Energy, but not a nutrient
Fiber	About 2 kcal/g	Recovered by colon fermentation
kcal to kJ	1 kcal = 4.184 kJ	Multiply kcal by 4.184
EAR	Meets the need of 50% of a group	Judging groups; deriving the RDA
RDA	Meets the need of 97 to 98% of a group	An individual goal
AI	Best estimate when there is no EAR	An individual goal, with lower confidence
UL	Highest usual intake with no likely risk	A ceiling for supplements and fortified foods
AMDR	Carb 45 to 65%, fat 20 to 35%, protein 10 to 35%	Share of total calories for adults

Reference values from the chapter (healthy adults, per day)

Nutrient	Value	Group and shifts
Protein	RDA 0.8 g/kg body weight	Adults 19+; higher in pregnancy and lactation
Vitamin C	RDA 90 mg men, 75 mg women	Add 35 mg for people who smoke
Iron	RDA 8 mg men, 18 mg women 19 to 50	8 mg for women 51+; 27 mg in pregnancy; UL 45 mg
Calcium	RDA 1,000 mg, ages 19 to 50	1,200 mg for women 51+ and everyone 71+; UL 2,500 mg
Vitamin D	RDA 600 IU (15 µg), ages 1 to 70	800 IU (20 µg) at 71+; UL 4,000 IU (100 µg)
Folate	RDA 400 µg DFE	600 µg DFE in pregnancy; UL 1,000 µg of folic acid only
Fiber	AI 38 g men, 25 g women 19 to 50	About 14 g per 1,000 kcal
Total water	AI 3.7 L men, 2.7 L women	Includes water from food and all drinks
Added sugars, saturated fat	Each under 10% of calories	Dietary guideline targets
Sodium	Under 2,300 mg	Dietary guideline target for adults

Worked examples

WORKED EXAMPLE 1 · ENERGY AND PERCENT OF CALORIES FROM A LABEL

A serving holds 45 g carbohydrate, 12 g protein and 14 g fat. Find the kcal, the share of calories from each macronutrient, and the energy in kJ.

STEP 1 · MULTIPLY BY THE FACTORS

Carbohydrate: 45 × 4 = 180 kcal. Protein: 12 × 4 = 48 kcal. Fat: 14 × 9 = 126 kcal.

STEP 2 · ADD THEM

180 + 48 + 126 = **354 kcal**.

STEP 3 · FIND EACH SHARE

Carbohydrate: 180 ÷ 354 = 50.8%. Protein: 48 ÷ 354 = 13.6%. Fat: 126 ÷ 354 = 35.6%.

STEP 4 · CONVERT TO KJ

354 × 4.184 = 1,481 kJ.

CHECK IT A SECOND WAY

The three shares add to 50.8 + 13.6 + 35.6 = 100.0%. Fat is only 14 of 71 grams, about 20% of the weight, yet it carries about 36% of the energy. That gap is the 9 at work.

WORKED EXAMPLE 2 · CHECKING A DAY AGAINST THE AMDRS

One day of eating supplies 250 g carbohydrate, 90 g protein and 70 g fat. Does each macronutrient fall inside its adult AMDR?

STEP 1 · FIND THE KCAL FROM EACH

Carbohydrate: 250 × 4 = 1,000. Protein: 90 × 4 = 360. Fat: 70 × 9 = 630.

STEP 2 · ADD THEM

1,000 + 360 + 630 = 1,990 kcal.

STEP 3 · FIND EACH SHARE

Carbohydrate: 1,000 ÷ 1,990 = 50.3%. Protein: 360 ÷ 1,990 = 18.1%. Fat: 630 ÷ 1,990 = 31.7%.

STEP 4 · COMPARE

Carbohydrate 50.3% sits inside 45 to 65%. Protein 18.1% sits inside 10 to 35%. Fat 31.7% sits inside 20 to 35%. **All three are inside their ranges.**

WHY PERCENT, NOT GRAMS

AMDRs are shares of energy. The same 70 g of fat would be a much bigger share of a 1,400 kcal day, so you always divide by the day's total.

WORKED EXAMPLE 3 · TURNING A GUIDELINE PERCENT INTO GRAMS

For a 2,000 kcal day, what is the most added sugar and the most saturated fat that stays under the 10% targets?

STEP 1 · FIND 10% OF THE CALORIES

2,000 × 0.10 = 200 kcal for each one.

STEP 2 · ADDED SUGARS ARE CARBOHYDRATE

200 kcal ÷ 4 kcal/g = **50 g** of added sugars.

STEP 3 · SATURATED FAT IS FAT

200 kcal ÷ 9 kcal/g = 22.2 g, so about **22 g** of saturated fat.

CHECK IT A SECOND WAY

Run it back. 50 × 4 = 200 and 22.2 × 9 = 200. Same calorie cap, but fewer grams of fat, because each gram of fat carries more energy.

WORKED EXAMPLE 4 · READING AN INTAKE AGAINST THE DRIS

Dana is 30, not pregnant, and averages 12 mg of iron and 1,800 kcal a day. Her fiber intake is 14 g. How should you read these numbers?

STEP 1 · FIND THE RIGHT GROUP

A woman aged 19 to 50 has an iron RDA of 18 mg and a fiber AI of 25 g.

STEP 2 · COMPARE IRON

12 mg is below the RDA of 18 mg. Because the RDA covers 97 to 98% of the group, many women need less. Her chance of inadequacy is higher, but this is **not a diagnosis**. Deficiency needs clinical and lab findings.

STEP 3 · SCALE THE FIBER AI

At 14 g per 1,000 kcal, 1,800 kcal × 14 ÷ 1,000 = 25.2 g. Her 14 g is a little over half of that.

STEP 4 · CHECK THE CEILING

The adult iron UL is 45 mg. A 65 mg supplement on top of food would put her over the ceiling, so more is not better here.

TRAPS PEOPLE FALL INTO

- **Thinking vitamins give energy.** B vitamins help release energy from food. They supply none themselves.
- **Using the EAR as a personal goal.** Half the group needs more than the EAR. The RDA or AI is the individual goal.
- **Treating the UL as a target.** It is a ceiling. And no UL means missing data, not a safe free-for-all.
- **Calling an intake below the RDA a deficiency.** The RDA is generous on purpose. Deficiency needs clinical and lab evidence.
- **Quoting a DRI with no group.** "Iron is 18 mg" is only true for women 19 to 50.
- **Mixing up the two densities.** Nutrients per kcal is nutrient density. Kcal per gram is energy density.
- **Reading micro as minor.** Micro is about the amount needed, not how much it matters.
- **Counting alcohol as a nutrient.** It gives 7 kcal/g, but no body function needs it.

Chapter 1 self-test · ten items

1. Which of these is a nutrient rather than a food?

A. A ripe banana eaten whole
B. A cup of plain cooked brown rice
C. The calcium in a glass of milk
D. A handful of roasted peanuts

C. The calcium in a glass of milk A food is the whole edible thing. A nutrient is one chemical inside it that the body needs, such as the calcium in milk.

2. What experiment shows that a nutrient is essential?

A. Double it, and blood levels rise above the normal range
B. Remove it, a deficiency appears; restore it, it resolves
C. Remove it, and body weight drops within a few days
D. Add it, and energy expenditure rises over a week

B. Remove it, a deficiency appears; restore it, it resolves The test is depletion and repletion. A characteristic deficiency must appear without it and clear up when it returns.

3. Which nutrient class is inorganic AND needed in milligram or microgram amounts?

A. Minerals
B. Vitamins
C. Proteins
D. Water

A. Minerals Minerals are single elements with no carbon, and they are micronutrients. Vitamins are organic. Water is inorganic but needed in large amounts.

4. A bowl of oatmeal with milk gives 30 g carbohydrate, 8 g protein and 6 g fat. What is its energy?

A. 176 kcal
B. 251 kcal
C. 230 kcal
D. 206 kcal

D. 206 kcal (30 × 4) + (8 × 4) + (6 × 9) = 120 + 32 + 54 = 206 kcal. Using 4 for the fat by mistake gives 176.

5. A drink has 14 g alcohol and 10 g carbohydrate. About what share of its energy comes from alcohol?

A. About 78%
B. About 58%
C. About 71%
D. About 64%

C. About 71% Alcohol: 14 × 7 = 98 kcal. Carbohydrate: 10 × 4 = 40 kcal. Total 138 kcal, and 98 ÷ 138 = 71%.

6. A food label lists 250 Calories. What is that in kilojoules?

A. About 1,046 kJ
B. About 598 kJ
C. About 1,250 kJ
D. About 2,500 kJ

A. About 1,046 kJ A label Calorie is a kcal. 250 × 4.184 = 1,046 kJ.

7. Which DRI is the right tool for judging whether a whole population's intake is adequate?

A. The UL
B. The EAR
C. The AI
D. The RDA

B. The EAR The EAR sits at the middle of the requirement curve, so it is used to judge groups and to derive the RDA.

8. Fiber has an AI rather than an RDA. What does that tell you?

A. Fiber needs are the same for everyone
B. Fiber is not needed by most adults
C. Fiber has no upper limit of any kind
D. The evidence was too thin to set an EAR

D. The evidence was too thin to set an EAR An AI is used when the data cannot support an EAR, so no RDA can be calculated. It is used like an RDA, with less certainty.

9. On a 2,000 kcal day, 90 g of fat supplies what share of calories, and is it inside the AMDR?

A. 40.5%, which is above the 20 to 35% range
B. 18.0%, which is below the 20 to 35% range
C. 31.5%, which is inside the 20 to 35% range
D. 45.0%, which is inside the 20 to 45% range

A. 40.5%, which is above the 20 to 35% range 90 × 9 = 810 kcal, and 810 ÷ 2,000 = 40.5%. The adult fat AMDR is 20 to 35%.

10. A soft drink and a handful of almonds are compared. Which statement fits the chapter?

A. Both foods are equal in nutrient density per calorie
B. The drink is higher in both energy and nutrient density
C. Almonds are lower in energy density than the drink
D. Almonds are higher in both energy and nutrient density

D. Almonds are higher in both energy and nutrient density Nuts are high in both measures. A soft drink is mostly water, so it is low in energy density (about 0.4 kcal/g) and also low in nutrients per calorie.

CHAPTER 2

Digestion, Absorption and Transport

Read it in full: **Chapter 2 in the textbook**. Practice it in the lab: **Follow One Meal** and **Blood or Lymph?**.

What to know

The GI tract is one long muscular tube from mouth to anus, about five meters in a living person. The older nine meter figure comes from cadavers, where the muscle has lost its tone. The inside of the tube is really outside the body. Food counts as nutrition only once it crosses the single layer of cells lining the intestine. That crossing is called absorption.

The accessory organs are the salivary glands, liver, gallbladder and pancreas. Food never passes through them. They make secretions and send them into the tube through ducts.

Follow the stations in order. The mouth chews and mixes food with saliva into a bolus. The esophagus moves it down by peristalsis. The stomach churns food with acid into chyme and lets it out through the pyloric sphincter in small squirts over about 2 to 4 hours. The small intestine has three parts: the duodenum, where bile and pancreatic juice arrive; the jejunum, where most absorption happens; and the ileum, which takes up vitamin B12 and recycles bile salts. The colon absorbs water and electrolytes and hosts the gut microbes.

Mechanical digestion makes pieces smaller without changing the chemistry: chewing, churning, segmentation and bile breaking fat into droplets. It buys surface area for enzymes. **Chemical digestion** breaks bonds, nearly always by hydrolysis, which adds water across a bond. Every digestive enzyme is a hydrolase.

Each macronutrient has an end point. Starch starts with salivary amylase, is finished by pancreatic amylase, and the brush border enzymes make the last cut: lactase, sucrase and maltase. Only monosaccharides are absorbed. Protein is unfolded by stomach acid and cut by pepsin, then by trypsin, chymotrypsin and carboxypeptidase, then by brush border peptidases. It is absorbed as amino acids plus di and tripeptides. Fat is emulsified by bile, split by pancreatic lipase with colipase into monoglycerides and free fatty acids, then carried in micelles. Fiber is not broken down by human enzymes and reaches the colon intact.

Protein enzymes are made as inactive zymogens so they do not digest the organs that make them. Pepsinogen becomes pepsin in stomach acid. Trypsinogen becomes trypsin when it meets enteropeptidase on the duodenal lining. The stomach's parietal cells make hydrochloric acid (about pH 1.5 to 3.5) and intrinsic factor, which B12 needs. The pancreas sends about 1.5 L of juice a day, full of enzymes and bicarbonate. Bile, about 500 to 600 mL a day, has no enzymes at all. It is a detergent. Hormones run the timing: gastrin raises acid, secretin calls for bicarbonate, and CCK squeezes the gallbladder and releases pancreatic enzymes.

The small intestine folds its surface three ways: plicae circulares, villi and microvilli (the brush border). Careful measurement puts the multipliers near 1.6, 6.5 and 13, or about 130 fold, and the total surface near 30 m^2, not the old "tennis court." Nutrients cross by passive diffusion, facilitated diffusion (fructose through GLUT5) or active transport (glucose and galactose through SGLT1 with sodium). Iron and calcium are absorbed mainly in the duodenum, most nutrients in the jejunum, and B12 and bile salts in the terminal ileum.

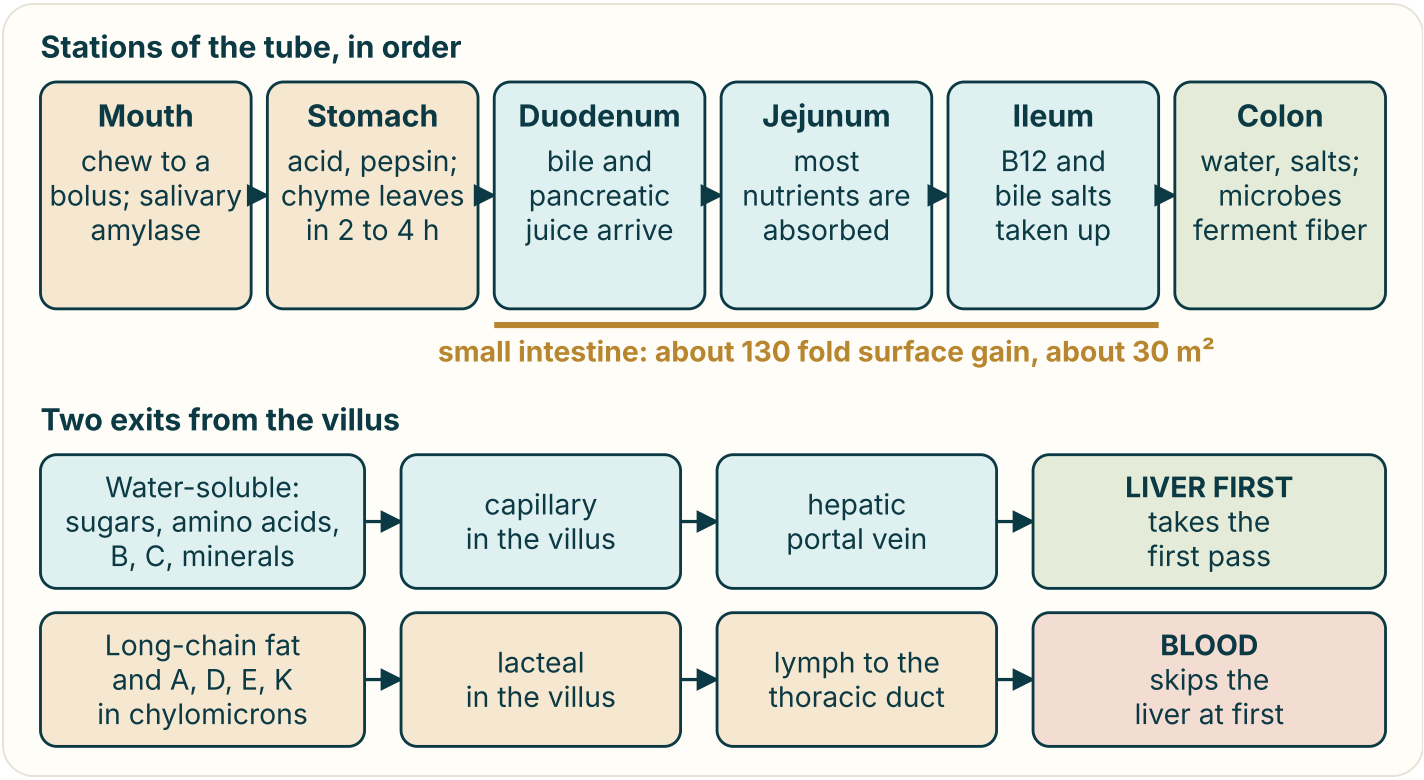
There are two exits. Water soluble nutrients enter the capillary in each villus and ride the hepatic portal vein to the liver, which gets the first pass. Fat is rebuilt into triglycerides inside the cell and packed into chylomicrons. These are too big for capillaries, so they enter the lacteal and travel through the lymph to the thoracic duct, skipping the liver at first. The liver stores glycogen, turns

extra amino acid nitrogen into urea, builds lipoproteins, stores vitamins A, D and B12 and iron, and makes bile.

The colon holds about 3.8×10^{13} bacteria, about the same order as the body's own cells. They ferment fiber into short chain fatty acids (acetate, propionate and butyrate), make some vitamin K and B vitamins, and crowd out pathogens. The benefits of fiber are well supported. Most claims linking specific microbes to mood, weight or disease are still preliminary. Bioavailability is the share of a nutrient you actually absorb. Vitamin C raises non-heme iron absorption, and fat-soluble vitamins need fat and bile.

LOCK THESE IN

- Accessory organs add secretions through ducts. Food never passes through them.
- Hydrolysis is the reaction of chemical digestion. Every digestive enzyme is a hydrolase.
- Absorbable end points: monosaccharides; amino acids plus di and tripeptides; monoglycerides plus fatty acids.
- Bile has no enzymes. It emulsifies fat and builds micelles, and it is recycled in the ileum.
- Pancreatic bicarbonate raises the pH so pancreatic enzymes can work.
- B12 needs intrinsic factor from the stomach and is absorbed only in the terminal ileum.
- Blood route goes to the liver first. Chylomicrons take the lymph and skip it.
- About 130 fold surface gain and about 30 m^2, not a tennis court.



Six stations and two exits. Water-soluble nutrients go to the liver first by the portal vein. Long-chain fat rides chylomicrons into the lymph and skips the liver at first.

Who makes what, and what it does

Secretion or enzyme	Made by	Acts on	Result
Salivary amylase	Salivary glands	Starch	Shorter chains, maltose
Hydrochloric acid	Parietal cells, stomach	Protein, microbes, bound minerals	Denatures protein; activates pepsin; frees iron and B12
Intrinsic factor	Parietal cells, stomach	Vitamin B12	Needed for B12 uptake in the ileum
Pepsin (from pepsinogen)	Chief cells, stomach	Protein	Large polypeptides
Pancreatic amylase	Pancreas	Starch	Disaccharides, short chains
Pancreatic lipase with colipase	Pancreas	Triglycerides	Monoglycerides and free fatty acids
Trypsin, chymotrypsin, carboxypeptidase	Pancreas, as zymogens	Polypeptides	Short peptides, amino acids
Bicarbonate	Pancreatic duct cells	Acidic chyme	Raises pH for pancreatic enzymes
Bile salts	Liver; stored in gallbladder	Fat droplets	Emulsifies fat; builds micelles (not an enzyme)
Lactase, sucrase, maltase	Brush border	Disaccharides	Monosaccharides
Gastrin, secretin, CCK	Stomach and duodenum	Control signals	Acid; bicarbonate; gallbladder and enzymes

Worked examples

WORKED EXAMPLE 1 · FOLLOW ONE MEAL

Trace a turkey sandwich: the bread starch, the turkey protein and the mayonnaise fat. Name where each starts, what finishes it, and what gets absorbed.

STEP 1 · STARCH

Salivary amylase starts on it in the mouth and stops in stomach acid. Pancreatic amylase cuts it to maltose and short chains in the duodenum. Maltase on the brush border makes glucose, which is absorbed.

STEP 2 · PROTEIN

Stomach acid unfolds the protein and turns pepsinogen into pepsin. Trypsin, chymotrypsin and carboxypeptidase keep cutting in the duodenum. Brush border peptidases finish, leaving amino acids and di and tripeptides.

STEP 3 · FAT

Bile breaks the fat into small droplets. Pancreatic lipase with colipase splits each triglyceride into a monoglyceride and two free fatty acids. Micelles carry them to the cell surface.

STEP 4 · THE EXITS

Glucose and amino acids go into villus capillaries and on to the liver. The fat is rebuilt inside the cell, packed into chylomicrons and sent out through the lacteal into the lymph.

WORKED EXAMPLE 2 · HOW MUCH SURFACE DO THE FOLDS ADD?

Older books used multipliers of 3, 10 and 20 for the plicae, villi and microvilli. Newer measurements give about 1.6, 6.5 and 13. Find the total gain each way.

STEP 1 · MULTIPLY THE OLD NUMBERS

$3 \times 10 \times 20 = 600$ fold.

STEP 2 · MULTIPLY THE NEW NUMBERS

$1.6 \times 6.5 = 10.4$, and $10.4 \times 13 = 135.2$, so about **130 fold**.

STEP 3 · COMPARE

The newer total is about $600 \div 135 = 4.4$ times smaller. That is why the surface comes out near 30 m^2 instead of 250 to 300 m^2.

THE LESSON

The levels multiply, not add. A number repeated for decades can still be revised by better measurement.

WORKED EXAMPLE 3 · PREDICT THE DEFICIENCY FROM THE MISSING SEGMENT

Rafael has had his terminal ileum removed. Mei has had surgery that bypasses her duodenum. What does each one now absorb poorly?

STEP 1 · LIST WHAT THE ILEUM DOES

The terminal ileum is the only site for vitamin B12 with intrinsic factor, and it reclaims bile salts.

STEP 2 · APPLY IT TO RAFAEL

He will absorb **B12** poorly. Fewer bile salts return to the liver, so the pool shrinks, fat is absorbed less well, and the fat-soluble vitamins A, D, E and K can fall too.

STEP 3 · LIST WHAT THE DUODENUM DOES

The duodenum is the main site for iron and calcium, and some magnesium.

STEP 4 · APPLY IT TO MEI

She is most at risk of low **iron and calcium**.

WHY IT WORKS

Absorption is mapped to places. Losing one segment gives a predictable pattern, not general malnutrition.

TRAPS PEOPLE FALL INTO

- **Calling bile an enzyme.** Bile is a detergent. Lipase is the enzyme that splits fat.
- **Saying food in the stomach is "in" the body.** It is still in the lumen. Nothing counts until it crosses the intestinal lining.
- **Sending chylomicrons to the liver first.** They go into the lacteal and the lymph and skip the first pass.
- **Placing B12 absorption in the stomach.** The stomach makes intrinsic factor. Uptake happens in the terminal ileum.
- **Forgetting why bicarbonate matters.** Pancreatic enzymes work near neutral pH and are destroyed in acid.
- **Adding the fold multipliers.** They multiply. 1.6 × 6.5 × 13 is about 130.
- **Treating lactase loss as a disease.** Lactase non-persistence is the human norm. Tolerance varies from person to person.
- **Trusting every microbiome claim.** Fiber benefits are strong. Most microbe and disease links are early or come from mice.

Chapter 2 self-test · ten items

1. Which of these adds a secretion to the GI tract through a duct, with no food ever passing through it?

A. The colon
B. The jejunum
C. The liver
D. The stomach

C. The liver The liver makes bile, which reaches the duodenum through ducts. It is an accessory organ. Food moves only through the tube itself.

2. Which change is mechanical digestion rather than chemical digestion?

A. Lactase splitting lactose in two
B. Bile breaking fat into small droplets
C. Lipase splitting a triglyceride apart
D. Pepsin cutting a long protein chain

B. Bile breaking fat into small droplets Emulsifying makes droplets smaller without breaking any bonds. The other three are hydrolysis by enzymes.

3. Which enzyme is made in an inactive form and switched on by enteropeptidase?

A. Amylase
B. Lactase
C. Pepsin
D. Trypsin

D. Trypsin Trypsinogen from the pancreas is activated by enteropeptidase on the duodenal lining. Pepsinogen is activated by stomach acid.

4. A person has lost the cells that make intrinsic factor. Which nutrient will they absorb poorly?

A. Vitamin B12
B. Vitamin C
C. Vitamin B6
D. Vitamin D

A. Vitamin B12 Intrinsic factor from the parietal cells is needed for B12 uptake in the terminal ileum.

5. What is the main job of pancreatic bicarbonate?

A. Activate pepsinogen in the stomach lumen
B. Kill swallowed microbes in the duodenum
C. Neutralize acid so pancreatic enzymes can work
D. Emulsify large fat droplets into micelles

C. Neutralize acid so pancreatic enzymes can work Pancreatic enzymes work near neutral pH, so the acid in chyme must be neutralized first.

6. Which hormone triggers the gallbladder to contract when fat arrives?

A. Secretin, from the duodenum
B. Gastrin, from the stomach
C. Ghrelin, from the stomach
D. CCK, from the duodenum

D. CCK, from the duodenum Fat and protein in the duodenum release CCK, which squeezes the gallbladder and releases pancreatic enzymes.

7. How does fructose cross into the intestinal cell?

A. Facilitated diffusion through GLUT5
B. Simple diffusion through the membrane
C. Packaging into micelles with bile
D. Active transport through SGLT1

A. Facilitated diffusion through GLUT5 Fructose uses a carrier but no energy. Glucose and galactose use the sodium-linked SGLT1.

8. Where do chylomicrons go first after leaving the intestinal cell?

A. Back into the intestinal lumen
B. Into the lacteal and the lymph
C. Into the hepatic portal vein
D. Straight into the gallbladder

B. Into the lacteal and the lymph Chylomicrons are too large for capillary pores, so they enter the lacteal, travel through the lymph and skip the liver at first.

9. Which of these is absorbed mainly in the duodenum?

A. B12 and bile salts
B. Most of the water
C. Vitamin K and biotin
D. Iron and calcium

D. Iron and calcium Iron and calcium are taken up mainly in the duodenum. B12 and bile salts belong to the terminal ileum, and the colon reclaims much of the water.

10. Which statement about the gut microbiota is best supported by evidence?

A. Their makeup has been shown to cause obesity
B. Home stool tests can set a personal diet plan
C. They ferment fiber into short chain fatty acids
D. They outnumber human cells by ten to one or more

C. They ferment fiber into short chain fatty acids Fermenting fiber into acetate, propionate and butyrate is well shown. The ten to one ratio was revised, and most disease links are preliminary.

ONE PAGE

Cram sheet

Everything from chapters 1 and 2 in one place. Cover the right column and see if you can rebuild each row.

Numbers to know

Item	Value	Note
Energy factors	Carb 4, protein 4, fat 9, alcohol 7 kcal/g	Fiber about 2; vitamins, minerals, water 0
kcal and kJ	1 kcal = 4.184 kJ	A label Calorie is a kcal
Energy out	BMR 60 to 70%; thermic effect about 10%	Activity is the most variable part
AMDRs	Carb 45 to 65%, fat 20 to 35%, protein 10 to 35%	Share of total kcal, adults
Guideline limits	Added sugars under 10%, saturated fat under 10%	Sodium under 2,300 mg/day
Iron RDA	8 mg men; 18 mg women 19 to 50; 27 mg pregnancy	UL 45 mg
Calcium RDA	1,000 mg ages 19 to 50	1,200 mg women 51+ and all 71+
Vitamin D RDA	600 IU (15 µg); 800 IU (20 µg) at 71+	UL 4,000 IU
Fiber AI	38 g men, 25 g women (19 to 50)	14 g per 1,000 kcal
Water AI	3.7 L men, 2.7 L women	From food and all drinks
GI volumes	Pancreatic juice about 1.5 L/day; bile 500 to 600 mL/day	Stomach pH about 1.5 to 3.5
Transit	Stomach 2 to 4 h; small intestine 3 to 5 h	Whole gut about 24 to 72 h
Surface	About 130 fold, about 30 m^2	1.6 × 6.5 × 13

Equations

Name	Equation	Units
Food energy	kcal = 4(carb g) + 4(protein g) + 9(fat g) + 7(alcohol g)	kcal
Percent of calories	% = (kcal from the nutrient ÷ total kcal) × 100	percent
Grams from a percent cap	g = (total kcal × fraction) ÷ kcal per g	g
kcal to kJ	kJ = kcal × 4.184	kJ
Fiber AI	g = 14 × kcal ÷ 1,000	g/day
Protein RDA	g = 0.8 × body weight in kg	g/day

Rules that are not equations

Topic	The rule
Essential	Remove it, deficiency appears; restore it, it resolves.
DRI use	RDA or AI for one person; EAR for groups; UL as a ceiling.
End products	Monosaccharides; amino acids and small peptides; monoglycerides and fatty acids.
Zymogens	Pepsinogen by acid; trypsinogen by enteropeptidase.
Absorption sites	Iron and calcium in the duodenum; most nutrients in the jejunum; B12 and bile salts in the terminal ileum.
Two exits	Water soluble to the portal vein and liver; chylomicrons to the lacteal and lymph.
Densities	Nutrient density is nutrients per kcal; energy density is kcal per gram.

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