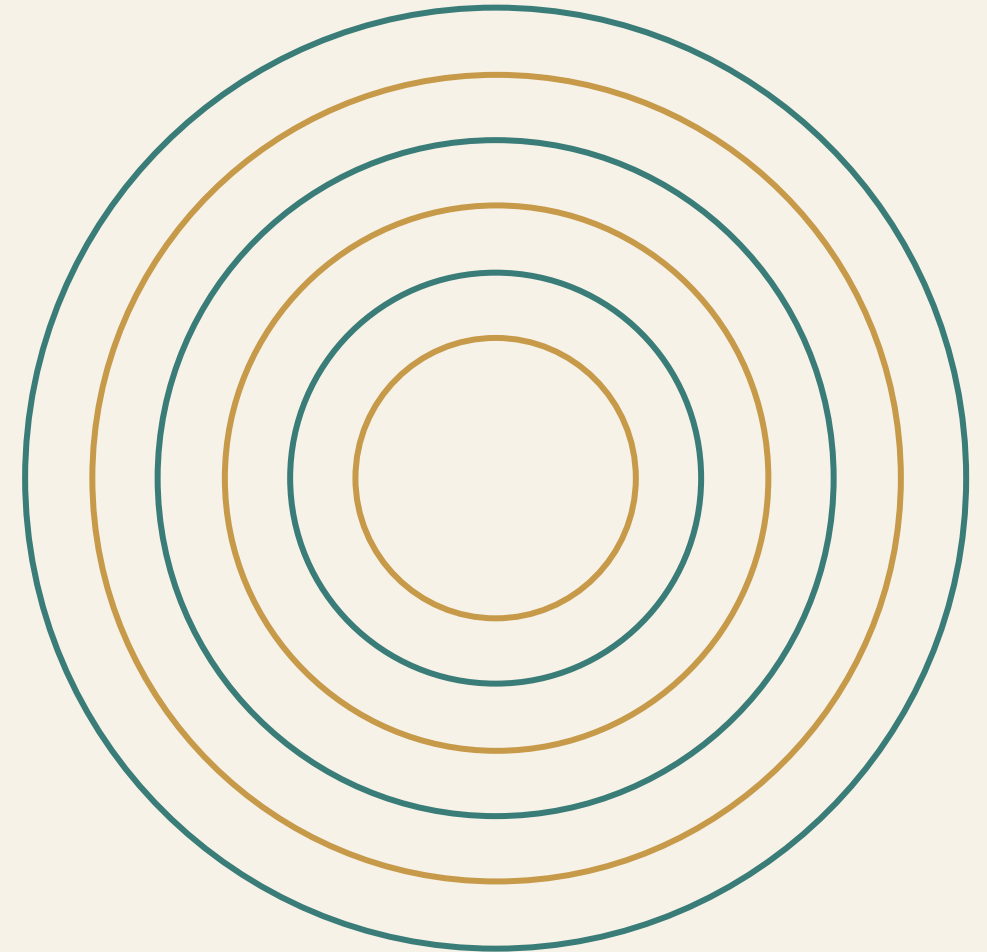


Energy: How the Body Creates Capacity

Cellular energy, metabolic access, oxygen delivery, and cardiovascular reserve



Golnosh Sharafsaleh, MD, MS, MBA, DipABLM, FAAFP, AGSF, CPE

Where Week 2 fits

Week 1

How aging changes
reserve and the 5Ms

Week 2

How energy is produced,
accessed, and delivered

Week 3

How energy becomes
disrupted—and how we
protect it

Today's learning goals

Define energy as biological capacity—not motivation or willpower

Explain how mitochondria convert fuel into ATP

Describe insulin resistance as impaired access to fuel

Connect oxygen delivery and cardiovascular reserve to stamina and recovery

“

Energy is not simply how awake you feel.

It is the capacity to perform biological work.

Produce. Access. Deliver.

Three linked systems determine whether energy reaches daily life

What requires energy?

Movement

Muscle contraction and balance

Thinking

Attention, memory, and decision-making

Maintenance

Cell repair and immune function

Adaptation

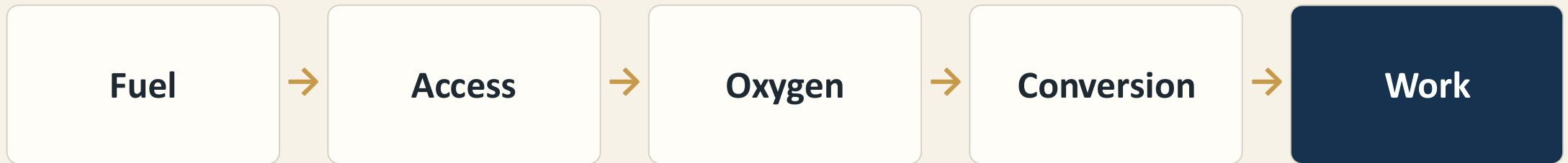
Responding to exertion, illness, and stress

“

Fatigue is not a character flaw.

It can be information about supply, access, delivery, or demand.

Energy as a supply chain



Energy is a balance

Supply

Fuel, oxygen,
mitochondrial capacity

Demand

Movement, cognition,
repair, immune work

Reserve

Capacity left when
demand suddenly rises

“

Reserve is energy capacity you are not using at rest.

It becomes visible when demand rises.

When does reserve matter?

A flight of stairs

Can delivery and use rise quickly?

An infection

Can the body power immunity and recovery?

Surgery

Can systems tolerate and repair after stress?

A hard week

Can sleep, mood, and function recover?

Low energy can have many contributors

Sleep or circadian disruption

Anemia, heart or lung disease, infection, pain, or endocrine disease

Medication effects and polypharmacy

Low muscle mass, deconditioning, undernutrition, or metabolic dysfunction

Depression, anxiety, grief, or chronic stress

Mitochondrial function

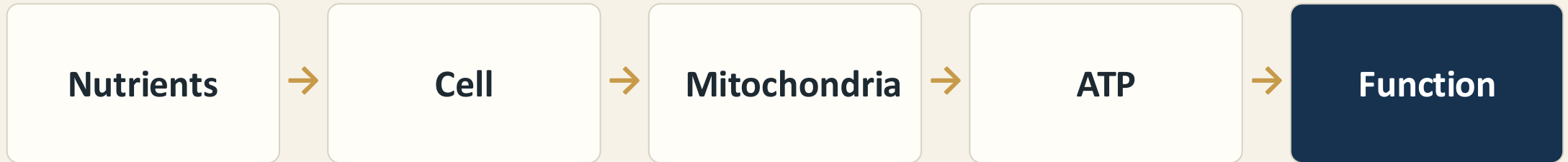
How cells convert potential fuel into usable energy

“

ATP is the cell's spendable energy.

Food contains potential energy. ATP powers the work.

From food to cellular work



ATP powers continuous work

Heart

Contraction without pause

Brain

Electrical signaling and information processing

Muscle

Force, posture, and movement

Cell repair

Maintenance, replacement, and quality control

“

Mitochondria are more than power plants.

They sense fuel, oxygen, hormones, movement, and stress.

High-demand tissues reveal problems early

Brain

Brain fog, slower processing, reduced resilience

Heart

Lower output and exercise tolerance

Muscle

Weakness, early fatigue, slower recovery

What changes with mitochondrial aging?

Efficiency

Less ATP may be produced from the same fuel

Byproducts

Oxidative and metabolic stress can rise

Quality control

Damaged components may accumulate

Flexibility

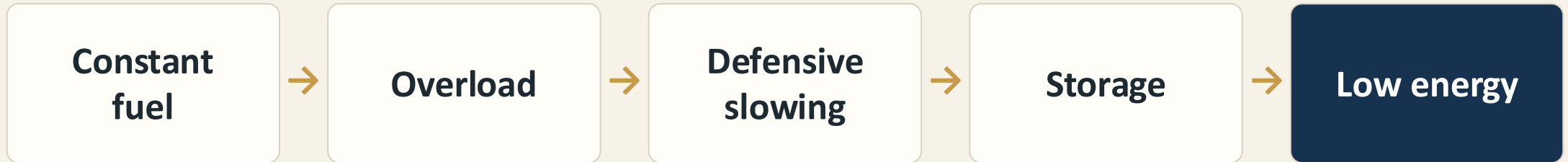
Scaling output to demand can become harder

“

A full fuel tank does not guarantee a working engine.

Calories are potential energy—not automatically usable energy.

The flooded-engine analogy



Signals govern energy use

Insulin

Signals fuel availability and glucose access

Thyroid hormone

Influences metabolic pace

Cortisol

Mobilizes energy during stress

Movement

Signals that greater capacity is needed

Metabolic flexibility

Flexible system

Shifts fuel use and output as demand changes

Rigid system

Remains stuck in storage, stress, or low-output patterns

“

Movement tells mitochondria they are needed.

Demand is one of the strongest signals for adaptation.

“

Inactivity sends the opposite message.

Mitochondrial capacity and conditioning can decline quickly during illness or bed rest.

Nutrition supports conversion—not just calories

Fuel quantity

Too little and too much
can both impair function

Fuel quality

Whole-food patterns
reduce metabolic overload

Cofactors

Iron, magnesium, B
vitamins, amino acids, and
others support pathways

“

Inflammation consumes and redirects energy.

Chronic immune activation can reduce the energy available for movement, cognition, and repair.

What cellular energy is not

Not willpower

Not a single laboratory number

Not automatically restored by eating more

Not fully repaired by one supplement

Not independent of sleep, movement, oxygen, and metabolic health

Mitochondria integrate the system

Inputs

Fuel, oxygen, micronutrients

Signals

Hormones, nervous system, circadian timing

Demand

Movement, cognition, immunity, repair

Output

ATP, heat, adaptation, and metabolic byproducts

“

What makes your energy rise—and what reliably drains it?

Notice patterns before searching for a single answer.

Pause and reset

Stand, hydrate, or step out as needed

Metabolic access

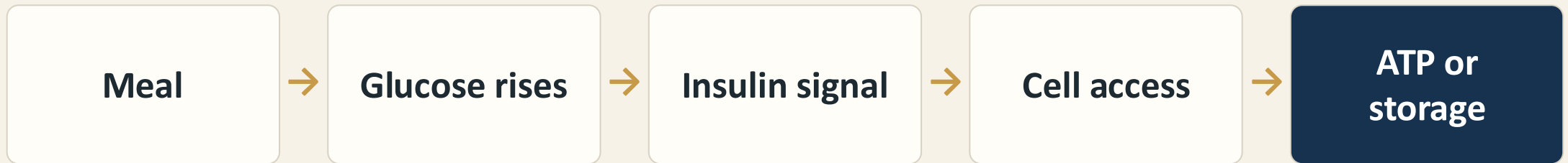
Fuel can be abundant and still fail to reach the cell

“

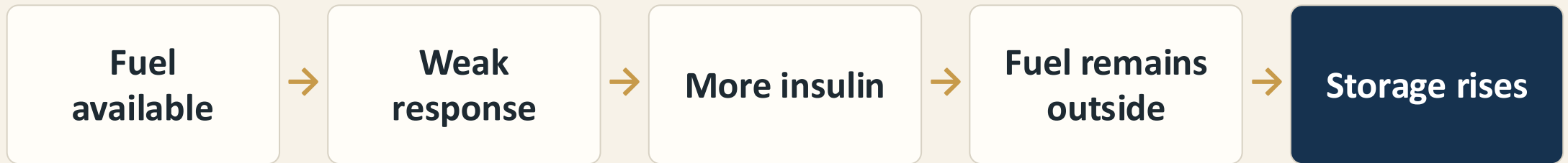
Insulin is a gatekeeper of energy access.

It signals cells—especially muscle—that glucose is available.

When insulin signaling works



When cells resist the signal



Early compensation can hide the problem

Insulin rises

The pancreas works harder to preserve glucose control

Glucose may look normal

Routine testing may not reveal early dysfunction

Symptoms may come first

Post-meal fatigue, brain fog, or reduced stamina

“

Insulin resistance begins as an access problem.

High blood sugar may appear later.

The over-nourished, under-energized paradox

Bloodstream

Fuel is abundant

Muscle cell

Access and use are
impaired

Fat tissue

More excess energy is
stored

“

The tank is full. The fuel line is restricted.

Adding more fuel does not repair access.

Muscle is an energy sink

It is not only for strength—it is a major destination for glucose

Why muscle protects metabolic health

Glucose disposal

Active muscle takes up and stores glucose

Insulin sensitivity

Contraction improves access to fuel

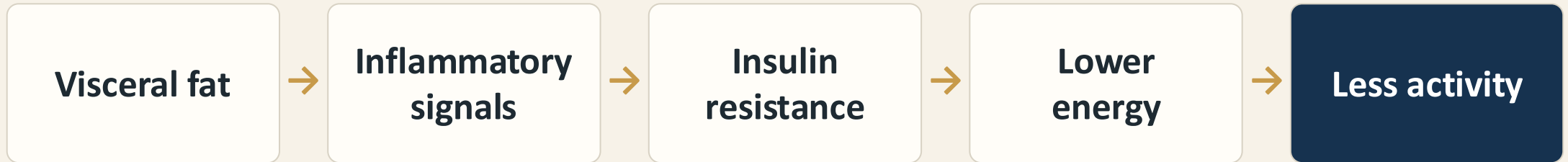
Reserve

More functional tissue supports higher demand

Aging

Loss of muscle reduces metabolic capacity

Visceral fat and inflammation



“

Type 2 diabetes is a systemic energy disorder.

Blood vessels, nerves, kidneys, eyes, brain, and muscle are all affected.

Early clues deserve attention

Body pattern

Increasing abdominal fat or declining muscle

After meals

Sleepiness or mental fog

Movement

Reduced tolerance or recovery

Laboratory pattern

Rising triglycerides, glucose, or A1c

“

Body weight does not tell the whole metabolic story.

A person can be thin and insulin resistant—or heavier and metabolically healthier.

What improves metabolic access?

Preserve and use skeletal muscle

Move after meals and reduce prolonged sitting

Support sleep and circadian regularity

Choose nutrient-dense foods and reduce chronic energy overload

Address stress, medications, and medical contributors

Oxygen delivery

Fuel cannot become efficient energy without oxygen

“

Fuel without oxygen cannot meet sustained demand.

Oxygen is the final gatekeeper of efficient ATP production.

The full energy supply chain



“

Cardiovascular reserve is the margin above rest.

It is the ability to increase delivery when demand rises.

The delivery infrastructure

Heart

Pump

Lungs

Gas exchange

Blood

Oxygen-carrying medium

Blood vessels

Distribution and responsiveness

Endothelial function matters

Healthy response

Vessels dilate and redirect flow as demand changes

Metabolic injury

Glucose, inflammation, and oxidative stress impair responsiveness

Microvascular effect

Brain and muscle may receive less efficient perfusion

“

Early decline often feels like reduced capacity—not chest pain.

Stairs feel harder. Recovery slows. Exertion costs more.

VO₂ max measures integrated reserve

Delivery

Heart, lungs, blood, and vessels move oxygen

Use

Muscle extracts and uses oxygen

Meaning

Higher capacity generally reflects greater resilience under load

“

Fatigue can be an early warning signal.

Persistent change deserves evaluation; it should not automatically be labeled “normal aging.”

What supports oxygen delivery?

Aerobic conditioning appropriate to ability and health

Muscle preservation and regular movement

Blood-pressure and metabolic risk management

Assessment of anemia, heart, lung, and sleep disorders when indicated

Avoidance of tobacco and protection of pulmonary health

A systems case

The story

A 72-year-old reports post-meal fatigue and avoids hills

Possible links

Low muscle mass, insulin resistance, sleep apnea, anemia, medication effects, cardiac or pulmonary limits

Better question

Where is production, access, delivery, or reserve being constrained?

Map your energy

Look for patterns—this is not a diagnosis

Your Week 2 reflection

Pattern

When during the day is your energy strongest and weakest?

Recovery

How long does it take to recover after activity, poor sleep, travel, or illness?

Fuel and movement

What happens after meals or long periods of sitting?

One question

What persistent change is worth discussing with your clinician?

What to carry forward

Energy is biological capacity—not motivation

Mitochondria convert potential fuel into usable ATP

Insulin resistance restricts access to fuel

Oxygen delivery determines whether output can rise with demand

Reserve—not resting numbers alone—shapes recovery and independence

“

Energy must be produced, accessed, and delivered.

Next week: allocation, timing, fatigue, medications, and disease.

E — Energy

Energy Is More Than Feeling Tired

Energy is one of the most overlooked aspects of healthy aging.

Many people assume fatigue is simply a normal part of getting older. While some physiologic changes do occur with aging, persistent low energy is often influenced by many interconnected factors:

- Sleep quality
- Stress
- Inflammation
- Muscle mass
- Blood sugar regulation
- Medications
- Nutrition
- Emotional health
- Chronic disease
- Lack of recovery

Reflection: Understanding My Energy

How would you describe your current energy level?

When during the day do you feel your best?

When do you feel most fatigued?

What situations most commonly drain your energy?

- ☐ Poor sleep
- ☐ Stress
- ☐ Caregiving responsibilities
- ☐ Chronic pain
- ☐ Busy schedule
- ☐ Poor nutrition
- ☐ Lack of movement
- ☐ Illness or medical conditions
- ☐ Emotional stress
- ☐ Medications
- ☐ Social isolation
- ☐ Other: _____

The Foundation of Energy: Sleep

As you reflected on your energy patterns, you may have noticed a common theme. Many of the factors that influence our energy throughout the day are closely connected to sleep.

Sleep is not simply a period of rest. It is one of the body's most important recovery processes. During sleep, the brain consolidates memories, hormones are regulated, tissues repair, inflammation is reduced, and energy stores are restored.

When sleep is disrupted, we often experience more than just fatigue. Poor sleep can affect concentration, mood, decision-making, appetite, blood sugar regulation, physical performance, and overall resilience. Over time, chronic sleep disturbances may contribute to increased health risks and reduced quality of life.

While nutrition, movement, stress management, social connection, and medical conditions all influence energy, sleep is often the foundation upon which these other areas depend.

Before exploring additional factors that influence energy, take a moment to reflect on your current sleep habits and consider how they may be affecting the way you feel each day.

Sleep & Recovery Reflection

Sleep is one of the body's most important recovery systems. During deep sleep, the brain and body perform essential restorative functions involving:

- Memory
- Hormone regulation
- Inflammation
- Metabolism
- Immune health
- Emotional processing

Poor sleep over time may affect energy, cognition, mood, blood sugar regulation, and overall healthspan.

The 10-3-2-1-0 Sleep Rule

- **10 hours before bed:** No more caffeine
- **3 hours before bed:** No more food or alcohol
- **2 hours before bed:** No more active work
- **1 hour before bed:** No more screens
- **0 snooze presses:** Maintain a consistent wake time

You will learn more about sleep, in the chapter dedicated to Longevity. You can also learn more about the 10-3-2-1 Rule by reviewing Appendix B. Adapted from the [GeriAcademy Sleep Protocol](#):

Energy Leaks

What currently drains your energy the most?

What activities, habits, or relationships restore your energy?

Small Changes That Support Energy

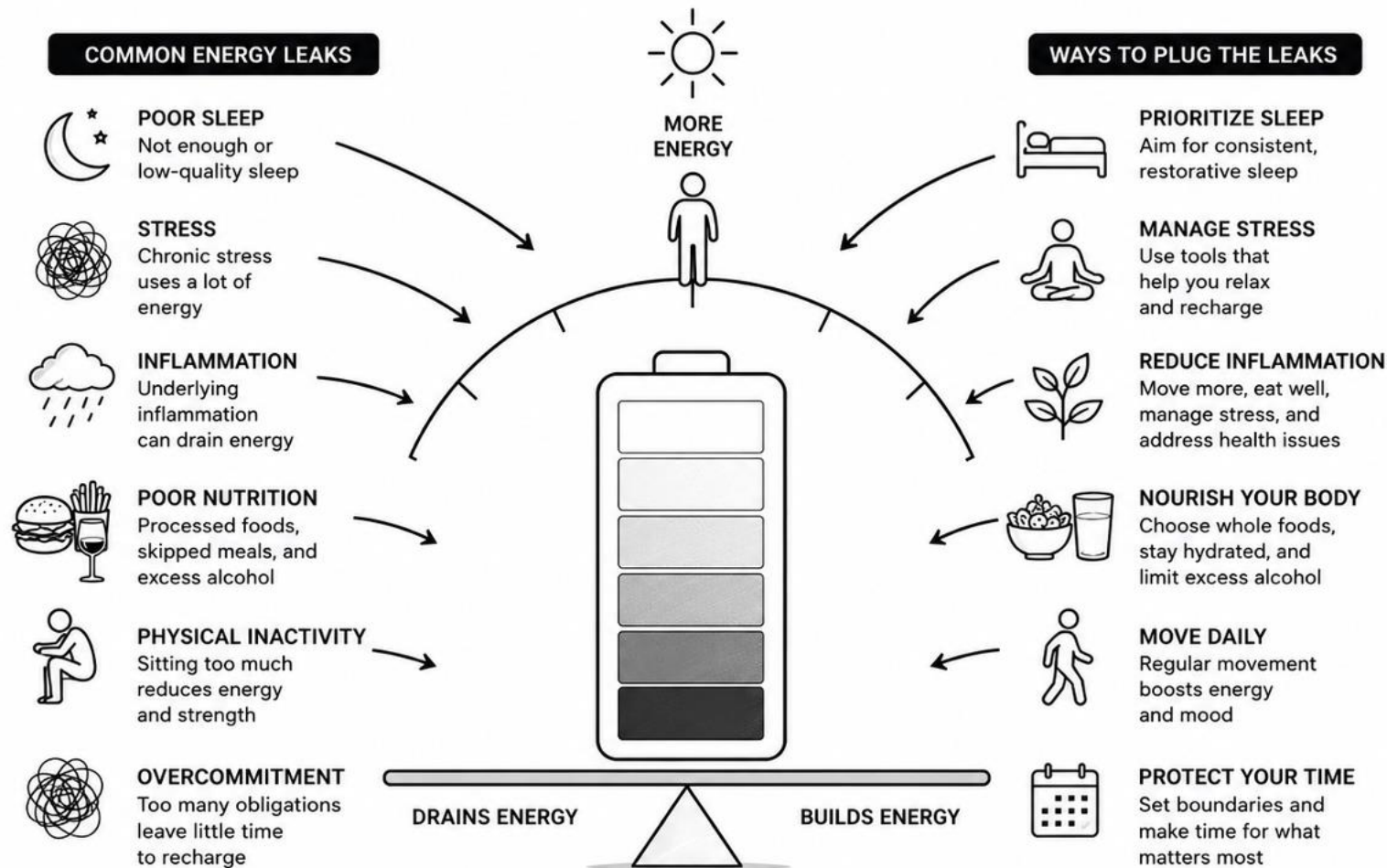
Healthy aging is rarely transformed through one dramatic intervention.

Often, energy improves through consistent small habits practiced repeatedly over time:

- Improving sleep routines
- Building muscle
- Reducing sedentary behavior
- Managing stress
- Improving nutrition
- Creating recovery time
- Reconnecting socially
- Addressing medical concerns early

RECOGNIZING ENERGY LEAKS

Many small drains can leave us feeling empty.
Awareness is the first step to more energy.



Small changes in many areas can lead to big improvements in your energy.
Focus on progress, not perfection.