Two processes, two comparisons

Bioaccumulation concerns a contaminant building up within an organism. Biomagnification concerns increasing concentration at successively higher feeding positions in a food web.

1. CHOOSE THE CORRECT SCALE

BIOACCUMULATION

Within one organism

A fish takes in a chemical from its food or environment faster than it removes it. Retained contaminant builds up over time.

BIOMAGNIFICATION

Across trophic levels

Compare the same chemical per unit of tissue in prey and predators. Increasing concentration up the chain is magnification.

Both processes can occur in the same food web. A larger animal containing more total pollutant does not, by itself, demonstrate biomagnification.

2. FOLLOW UPTAKE AND REMOVAL

Body burden is the total amount of contaminant retained in an organism. It increases when uptake exceeds elimination and breakdown of that chemical. Concentration is amount per unit tissue mass, so growth can change concentration even when body burden rises. The two measurements are not interchangeable.

3. NOT ALL CONTAMINANTS ARE STORED IN FAT

Persistent, fat-soluble chemicals such as DDT and PCBs often accumulate in fatty tissues. Methylmercury also accumulates and biomagnifies, but binds to proteins in fish muscle. Fat solubility is a common route to retention, not a universal requirement. Mercury cannot be removed from fish by ordinary cooking.

Definitions and common accumulating substances: College Board, STB-3.I and STB-3.J.
Methylmercury in muscle and food webs: Health Canada, Mercury in Fish Q&A.

Scope: College Board AP Environmental Science CED, Topic 8.8, p. 165.

Compare concentration, not body size

A predator consumes many prey over its lifetime. If it retains a contaminant efficiently and removes it slowly, its tissues can become more concentrated than those of its prey.

1. AN ILLUSTRATIVE AQUATIC FOOD CHAIN

Invented teaching values for one biomagnifying chemical. All concentrations use the same basis: milligrams per kilogram of wet tissue (mg/kg).

Phytoplankton	→	Zooplankton	→	Small fish	→	Large fish
0.02 mg/kg		0.10 mg/kg		0.50 mg/kg		2.50 mg/kg

Arrows point from food to consumer. Each step here is fivefold, but nature has no fixed multiplier. The example shows concentration increasing with trophic position, not new pollutant being created.

2. CALCULATE AND KEEP THE UNITS

Concentration = contaminant mass / tissue mass
Example: 0.8 mg / 2 kg = 0.4 mg/kg.

Predator-to-prey concentration ratio = 2.50 / 0.50 = 5.
Top-to-base ratio = 2.50 / 0.02 = 125.
The ratios have no units because the matching mg/kg units cancel.

3. DO NOT APPLY THE 10% ENERGY RULE

Energy transfer efficiency does not set a pollutant concentration multiplier. Some food is respired, excreted or used for growth, while certain absorbed contaminants remain. Food-web magnification depends on chemical retention, diet and organism biology; not every pollutant increases at every trophic level.

Concentration per unit tissue and trophic levels: College Board, STB-3.I.2.
Dietary methylmercury transfer: Health Canada, Mercury in Fish Q&A.

Scope: College Board AP Environmental Science CED, Topic 8.8, p. 165.

From tissue residues to biological harm

Consequences depend on the substance, dose and organism. Reproductive failure and developmental deformities can reduce populations even when exposed adults do not immediately die.

1. MATCH THE CONTAMINANT TO THE EFFECT

DDT / DDE	DDE, a breakdown product of DDT, can thin eggshells in susceptible birds. Eggs are more likely to fail, reducing reproductive success in fish-eating birds and other predators.
Methylmercury	Food-web transfer can expose people eating contaminated fish. The developing nervous system is particularly sensitive. Species, diet and exposure duration affect the risk.
PCBs	Studies show reproductive, developmental, immune and nervous-system effects. Human concerns also include circulatory effects such as elevated blood pressure. Not every chemical causes every outcome.

For DDE, eggshell thickness and hatching success are more informative endpoints than adult mortality alone.

2. BUILD A TESTABLE INVESTIGATION

Hypothesis: fish at higher trophic positions in the same lake have higher methylmercury concentrations. Measure the same tissue type on the same wet-mass basis; sample multiple individuals per group in the same season. Record age, size and diet because these can affect concentrations. A field association alone does not prove which factor caused the pattern.

3. INTERPRET RESULTS WITHOUT OVERCLAIMING

Report concentration, units, sample size and variation, not just a single predator value. A low water reading cannot rule out contaminated tissues. Monitoring can guide source reduction and consumption advice. Fish also provide nutritional benefits; use current official advice rather than assuming all fish have the same risk.

Eggshell thinning and evidence: US EPA, The Case of DDT.
Neurological sensitivity and fish exposure: Health Canada, Mercury in Fish Q&A.
Reproductive, immune and circulatory effects: US EPA, Health Effects of PCBs.

Scope: College Board AP Environmental Science CED, Topic 8.8, p. 165.