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Trace Elements and Essential Micronutrients: Less Than a Gram, Yet Essential

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Practice: 8 MCQs

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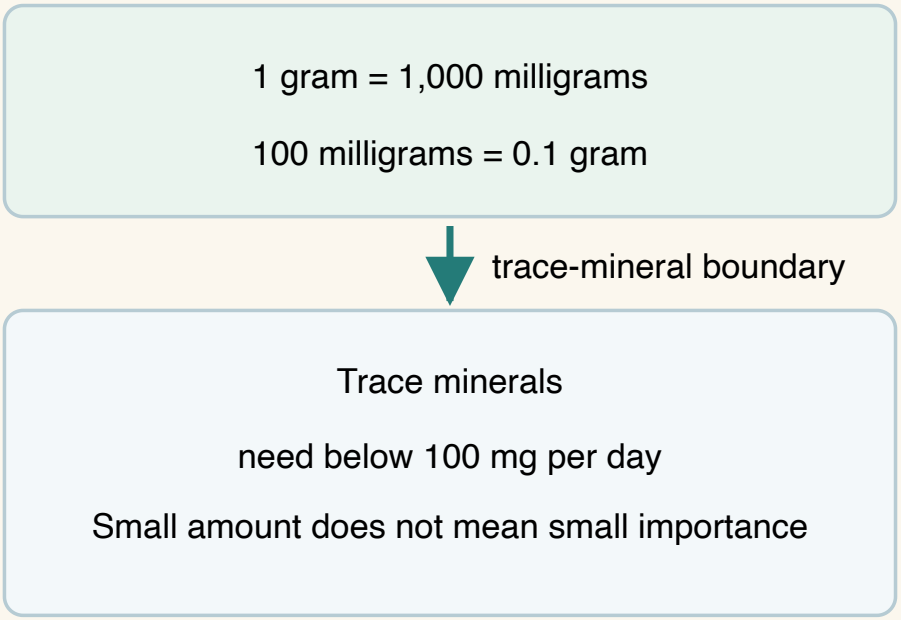
Small quantities and essential functions

1. What does “trace” mean?

- **Trace element:** a mineral nutrient needed in very small amounts.
- **Micronutrient:** a vitamin or mineral needed in small quantities.
- Vitamins are not chemical elements. Trace elements belong to the mineral part of micronutrition.
- In a common nutrition classification, trace minerals are required below **100 milligrams per day**. The threshold groups nutrients by

quantity, not by importance.

- The daily requirement is not the total amount stored in the body. It is also not a safe supplement dose for every mineral.



Grouped by quantity, not importance. Original explanatory diagram.

The trace-mineral classification threshold is a safe supplement dose for every mineral. True or False?

Sources:

- Mineral classification
- Nutrition and diet

2. How small is a milligram?

- **1 gram = 1,000 milligrams.** Therefore, 100 milligrams equals 0.1 gram.

- This conversion explains “less than a gram.” It does not mean every essential element has the same requirement.
- A nutrient measured in milligrams can still support an indispensable process. Quantity and function answer different questions.

Sources:
- Mineral quantities
- Iron requirements

The elements and their roles

3. Why does the familiar nine-element list need care?

- The familiar **nine-element list** names iron, zinc, copper, manganese, iodine, selenium, chromium, fluorine and molybdenum.
- However, all nine names should not receive an identical essentiality label. Chromium’s essential role in human nutrition is not established.
- Not every chromium compound is harmless. Hexavalent chromium can harm health.
- Fluoride helps protect teeth against decay. That benefit is distinct from proving an indispensable physiological requirement.
- Fluorine names the element. **Fluoride** names the ionic form discussed in dental nutrition.
- The following functions explain the list more accurately than memorising nine names alone.

Sources:
- Chromium evidence
- Hexavalent chromium health effects
- Chromium assessment
- Fluoride assessment

- Dental effects

4. Iron: carrying oxygen

- **Iron** is part of haemoglobin, the oxygen-carrying protein in red blood cells. Haemoglobin carries oxygen from the lungs to body tissues.
- Iron also supports cellular energy production and immune function. Iron deficiency can cause iron-deficiency anaemia.
- For example, inadequate iron can limit haemoglobin production. However, anaemia has causes other than iron deficiency.

Sources:

- Iron
- Trace-mineral functions
- Iron functions

5. Iodine: making thyroid hormones

- **Iodine** is needed to produce thyroid hormones. These hormones help regulate metabolism, growth and development.
- Iodine deficiency can cause an enlarged thyroid, called **goitre**. Other conditions can also enlarge the thyroid.
- The hormone example shows why minerals are not merely enzyme helpers. A mineral can be part of a hormone's chemical structure.

Iodine is needed for thyroid-hormone production. True or False?

Sources:

- Iodine
- Thyroid hormone reasoning

6. Copper and zinc: helping cellular work

- **Copper** supports enzymes involved in energy production and iron metabolism. Some copper-containing enzymes also contribute to

antioxidant protection.

- **Zinc** supports enzyme activity, protein production, wound healing and immune function. Copper and zinc have different functions despite appearing together in some enzymes.
- For example, extra zinc cannot replace iodine in thyroid hormones. Sharing the label “mineral” does not make nutrients interchangeable.

Sources:

- Copper
- Zinc
- Copper chapter
- Zinc chapter
- Zinc, MedlinePlus
- Iodine

7. Selenium and molybdenum: parts of enzyme systems

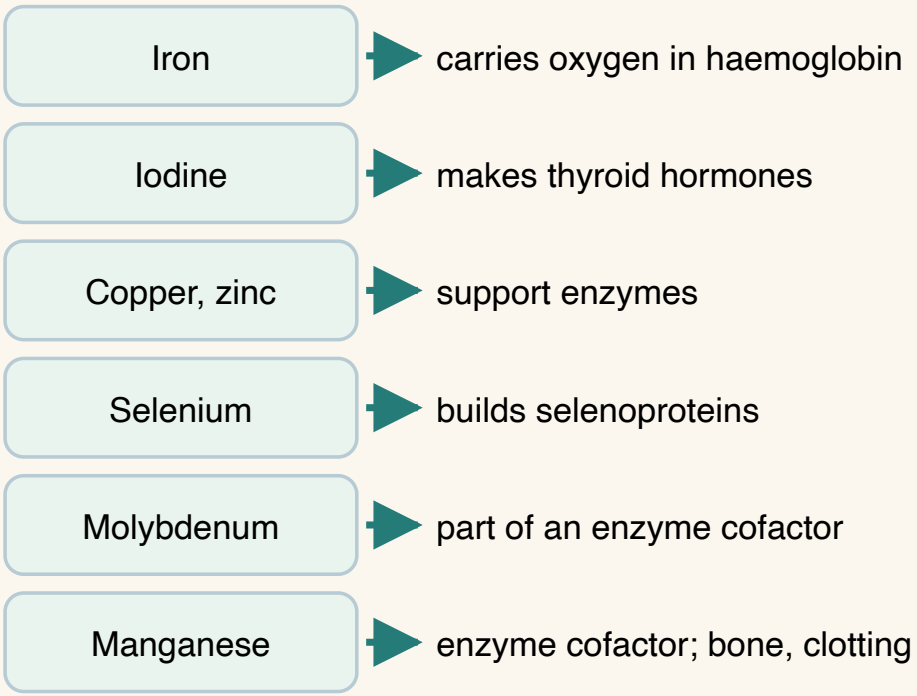
- **Selenium** is incorporated into proteins called selenoproteins. Several selenoproteins help protect cells from oxidative damage.
- **Molybdenum** forms part of a cofactor required by several human enzymes. These enzymes help process particular compounds during metabolism.
- Both elements support enzyme systems. However, their chemical roles are not identical to a freely bound metal ion.

Sources:

- Selenium
- Molybdenum
- Molybdenum requirements
- Mineral roles

8. Manganese: metabolism, bones and clotting

- **Manganese** is a cofactor for several enzymes. Manganese-dependent enzymes contribute to carbohydrate, amino-acid and cholesterol metabolism.
- These functions connect manganese with processing carbohydrates, proteins and fats. Manganese also contributes to bone formation and blood clotting.
- Manganese is not the only nutrient involved in those processes. Blood clotting, for example, also depends on vitamin K.



One main role each. Original explanatory diagram.

Sources:

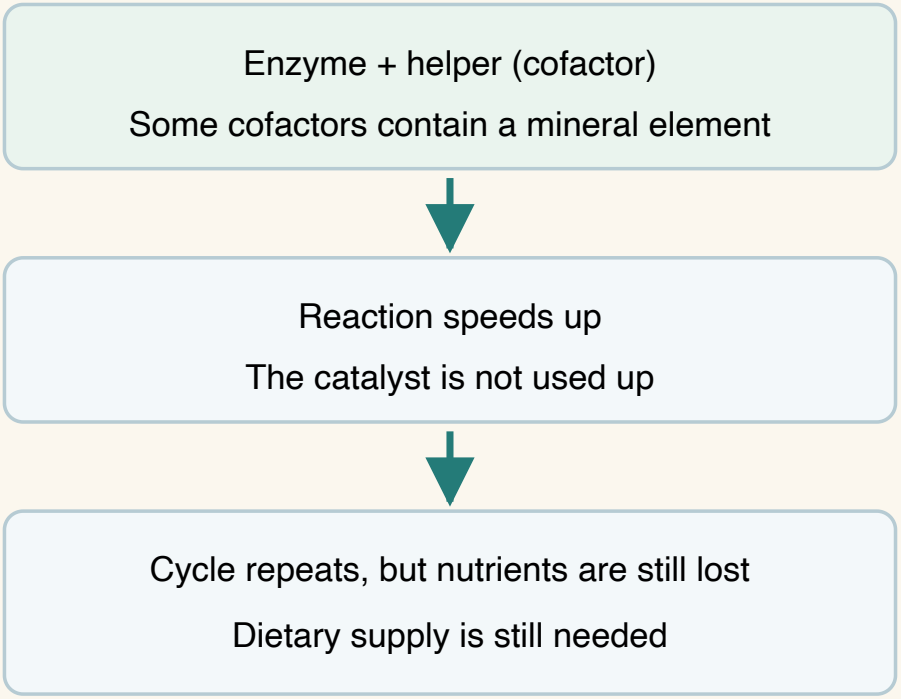
- Manganese

- Mineral roles
- Vitamin K
- Vitamin K, MedlinePlus

Enzymes and antioxidant protection

9. What is a cofactor?

- **Enzyme:** a biological catalyst that speeds up a chemical reaction.
- **Cofactor:** a non-protein helper required for an enzyme's activity.
- Some cofactors contain mineral elements. The helper enables the enzyme to perform its particular reaction.
- A working catalyst can support repeated reaction cycles. This helps explain how small mineral quantities can have large effects.
- However, not every enzyme needs a metal cofactor. Nutrients also undergo losses, so repeated catalysis does not remove dietary requirements.



Reuse does not remove dietary needs. Original explanatory diagram.

Every enzyme must contain a metal cofactor. True or False?

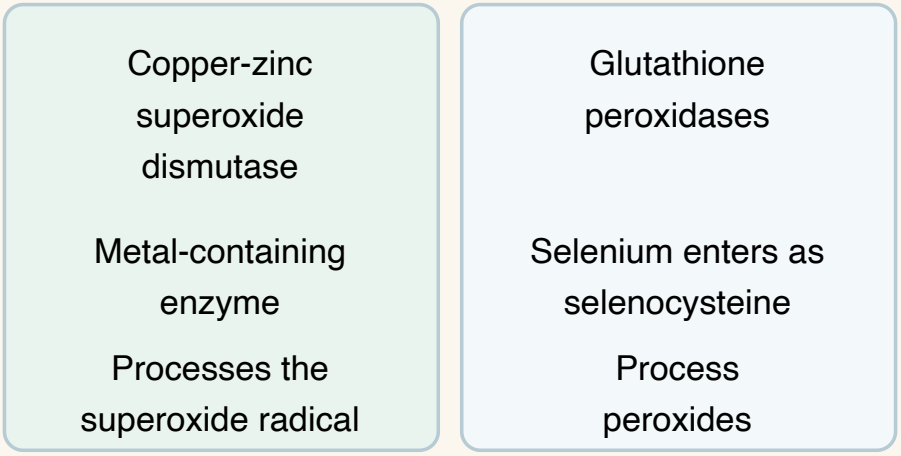
Sources:

- Enzyme regulation
- Enzymes and cofactors
- Catalysts
- Copper enzymes and losses

10. How do antioxidant enzymes differ?

- **Antioxidant protection** limits damage caused by reactive chemical substances. Free radicals have one or more unpaired electrons. Many free radicals are reactive.

- Copper-zinc **superoxide dismutase** helps process the reactive oxygen species called superoxide. Selenium-containing **glutathione peroxidases** help process peroxides.
- Copper-zinc superoxide dismutase is a metal-containing enzyme. Selenium enters these glutathione peroxidases through the amino acid selenocysteine.
- Calling both examples identical “metalloenzymes” hides that chemical difference. Their protective roles also do not prove that high-dose supplements improve health.



Different chemistry, similar protective job. Original explanatory diagram.

Sources:

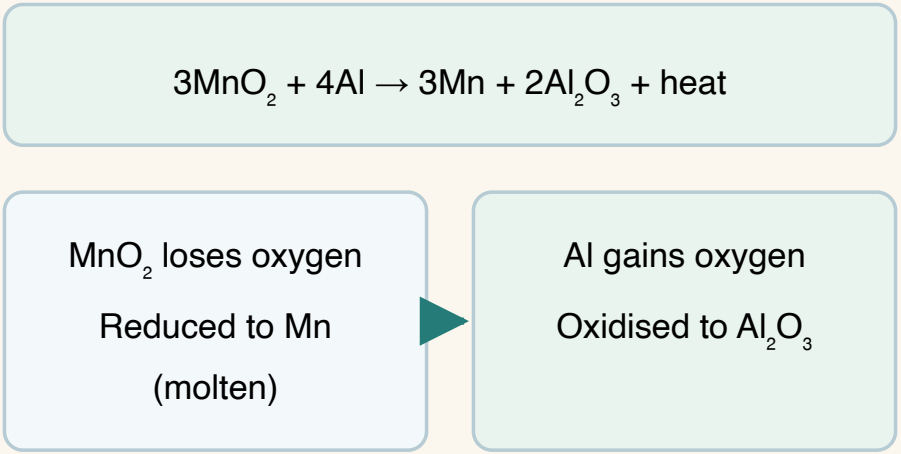
- Copper and oxidative damage
- Selenium-containing proteins
- Superoxide dismutase
- Selenocysteine

- Glutathione peroxidase 4 structure
- Unpaired electrons
- Antioxidants

Manganese in extraction chemistry

11. Why can aluminium extract manganese?

- **Aluminothermic reduction** uses aluminium to remove oxygen from another metal's oxide. Aluminium is more reactive than manganese.
- The balanced school reaction is **$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$ + heat**.
- MnO_2 means manganese dioxide. Al_2O_3 means aluminium oxide.
- Manganese dioxide loses oxygen and is reduced. Aluminium gains oxygen and is oxidised.
- The reaction releases substantial heat. Under the described extraction conditions, manganese is obtained in a molten state.
- This is an industrial chemistry example, not a classroom instruction for performing the reaction.



Oxygen moves from manganese to aluminium. Original explanatory diagram.

Aluminium is oxidised during the reduction of manganese dioxide. True or False?

Sources:

- Metals and non-metals
- CBSE reaction explanation
- NCERT chapter mirror

Plant criteria and human nutrition

12. What did Arnon and Stout propose in 1939?

- Arnon and Stout's **1939 criteria** concern essential elements in plant nutrition. The three tests separate genuine nutrient functions from incidental benefits.
- Without the element, the plant cannot complete its vegetative or reproductive life cycle.

- The deficiency is specific to that element. Only supplying the element prevents or corrects it.
- The element is directly involved in the plant's nutrition. It does not merely correct unfavourable soil or culture-medium conditions.
- For example, correcting soil conditions alone does not prove that an element performs an indispensable plant function.
- The broader question of essentiality also matters in human nutrition. However, plants and humans do not automatically share the same nutrient list.

Sources:

- Original 1939 paper
- Plant essentiality criteria

13. Why can too little and too much both harm?

- An essential nutrient is needed for a normal biological function. An inadequate supply can cause deficiency.
- Excess intake can also cause harm. Requirements and upper intake limits differ between nutrients and life stages.
- "Trace" therefore does not mean "take extra." Nor does excretion guarantee that every excess is harmless.
- The useful distinction is **enough for function**, not **as much as possible**. A nutrition lesson is not an individual supplement prescription.

An essential nutrient cannot be harmful in excess. True or False?

Sources:

- Zinc excess and requirements
- Zinc, MedlinePlus
- Selenium excess
- Copper regulation

Exam connections

14. Manganese: reaction heat changes the product's state

- In the Central Armed Police Forces Assistant Commandants examination, remember the distinction between **molten** and **solid** manganese.
- The aluminium reaction releases enough heat to obtain molten manganese under the stated extraction conditions. The biological role of manganese answers a different question.
- CAPF ACS 2021, Q29 — full paper.

Sources:

- Reaction and molten products
- Metals chapter

15. Molybdenum: connect the element with a place

- The **Climax mine** is in **Colorado, United States**. It is a molybdenum mine.
- A 1933 USGS report says Climax gave about 73 percent of the world’s molybdenum in 1924–1928.
- A 1972 Colorado Geological Survey guide uses 1969 data. It calls Climax the world’s largest single source of molybdenum.
- These are historical statements. A present-day “largest” claim needs a stated year and measure.
- For the Combined Defence Services examination, distinguish the mine’s location from molybdenum’s nutritional role.
- CDS-II 2020, Q38 — full paper.



Molybdenum ore from the Climax mine, Colorado. The dark grey bands are molybdenite. Photo by James St. John, CC BY 2.0, resized for this page, via Wikimedia Commons.

Sources:

- USGS report, 1933
- Colorado Geological Survey guide, 1972

Four questions to think through

Does a small daily requirement mean the body contains only that amount?

No. Daily intake is a flow over time. Total body content is the amount already present.

Why does fluoride’s dental benefit not settle strict essentiality?

A beneficial effect and an indispensable physiological requirement are different claims. The dental effect does not establish both.

Why do repeated catalytic cycles not remove dietary needs?

Catalysts can support repeated reactions. However, nutrients undergo losses, and the body still needs an adequate supply.

Why should a plant essential-element list not automatically become a human list?

The original tests concern plant functions and life-cycle completion. Human nutrient requirements need evidence about human physiology.

Check your understanding

Your 5 quick checks Answered 0 of 5 · Correct 0
This score resets when the page reloads.

Continue to the 8 MCQs

Practise eight trace-element MCQs

Use nutrient functions, chemical forms and the stated conditions to choose each answer.

Practice MCQs

1. A trace element is generally defined as one required in daily amounts below what threshold?

A. 100 mg

B. 10 grams

C. 1 gram

D. 10 mg

See answer ↓

2. Which nutrient is incorporated into thyroid hormones?

A. Molybdenum

B. Copper

C. Iodine

D. Zinc

See answer ↓

3. What is the most accurate statement about chromium in human nutrition?

A. Its essential role is not established

B. It is the oxygen-carrying component of haemoglobin

C. It can replace iodine in thyroid hormones

D. Every chromium compound is harmless

See answer ↓

4. Which pair distinguishes two antioxidant enzyme systems correctly?

A. Both enzymes work only because they contain iodine

B. Every enzyme must contain copper and zinc

C. Copper-zinc superoxide dismutase uses metals; selenium enters glutathione peroxidases through selenocysteine

D. Glutathione peroxidase contains aluminium instead of selenium

See answer ↓

5. What happens when manganese dioxide undergoes aluminothermic reduction?

A. Both manganese dioxide and aluminium only dissolve in water

B. Manganese gains oxygen and aluminium remains unchanged

C. Manganese dioxide is reduced and aluminium is oxidised

D. Heat must always be absorbed from the surroundings

See answer ↓

6. What did Arnon and Stout's 1939 essentiality criteria originally address?

A. Essential elements in plant nutrition

B. A universal nine-element list shared by all organisms

C. The current production rankings of mines

D. The safety of every mineral supplement

See answer ↓

7. Which statement correctly links manganese with a biological role?

A. It contributes to enzyme activity, bone formation and blood clotting

B. It replaces every other essential mineral

C. It is needed only for industrial reactions

D. It prevents all deficiency diseases at any intake

See answer ↓

8. Why does a small mineral requirement not justify taking unlimited supplements?

A. Every mineral has one identical intake limit

B. All excess minerals are immediately excreted without harm

C. Trace minerals are biologically optional

D. An essential nutrient can also be harmful in excess

See answer ↓

Answer Key

1. **A.** The expected threshold is 100 mg per day in the common nutrition classification. Ten milligrams is not that classification boundary. One gram and ten grams are much larger quantities. This threshold is not a universal safe supplement dose or a measure of total body content. ↑ Q1
2. **C.** Iodine is incorporated into thyroid hormones. Zinc and copper support enzyme functions but cannot replace that iodine. Molybdenum forms part of other enzyme cofactors, not the iodine component of thyroid hormones. ↑ Q2
3. **A.** Chromium has appeared in older essential-nutrient classifications, but an indispensable human role is not established. Iron, not chromium, is the haemoglobin mineral. Iodine is needed for thyroid hormones. Chromium compounds differ chemically, and hexavalent chromium is harmful. ↑ Q3
4. **C.** Copper-zinc superoxide dismutase is a metal-containing enzyme. Selenium is incorporated as selenocysteine in selenium-dependent glutathione peroxidases. Iodine and aluminium do not describe these enzyme systems. Not every enzyme requires copper and zinc. ↑ Q4
5. **C.** Aluminium removes oxygen from manganese dioxide. The oxide is reduced, while aluminium is oxidised to aluminium oxide. This is not simple dissolution. The reaction is exothermic and can produce molten manganese under the stated extraction conditions. ↑ Q5
6. **A.** The original criteria addressed plant nutrition. They concern life-cycle completion, a specific deficiency corrected by the element, and direct nutritional involvement. Mining rankings and supplement safety are different questions. Plant criteria do not establish one identical essential-element list for every organism. ↑ Q6
7. **A.** Manganese supports several enzymes and contributes to bone formation and blood clotting. Other nutrients also participate in those processes. Manganese has biological and industrial roles, but neither role makes it a universal mineral replacement or a cure for every deficiency. ↑ Q7
8. **D.** An essential nutrient supports normal function, but excess intake can cause harm. Requirements and upper limits differ between nutrients and life stages. Excretion does not guarantee safety. A small daily requirement does not mean that the nutrient is optional. ↑ Q8

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