What is in a soil?

Soil composition affects water, oxygen and nutrients available to roots. Distinguish the whole soil from its mineral fraction, and particle sizes from the way particles are arranged.

1. SOLIDS AND PORE SPACE



45% minerals

5% organic matter

25% water

25% air

Illustrative mineral-soil composition by volume, not a universal recipe. Air and water occupy pores; their shares change as soil wets and dries. Organisms live throughout the soil and contribute to its organic matter.

2. TEXTURE: SAND, SILT AND CLAY

Sand	0.05-2 mm	Largest; often gritty, with rapid drainage.
Silt	0.002-0.05 mm	Intermediate; often smooth or flour-like.
Clay	Less than 0.002 mm	Smallest; high surface area per unit mass.

USDA size ranges. Texture percentages use the dry mass of sand, silt and clay, excluding organic matter and coarse fragments; the three percentages total 100%.

3. STRUCTURE: HOW PARTICLES FIT TOGETHER

Structure is the arrangement of particles into aggregates. Roots, fungi and organic matter can help stabilize these clusters. Compaction compresses pores and can restrict water movement and root growth without changing the sand-silt-clay percentages. Texture and structure are not synonyms.

Loam is not equal thirds, and it has no fixed organic-matter percentage.

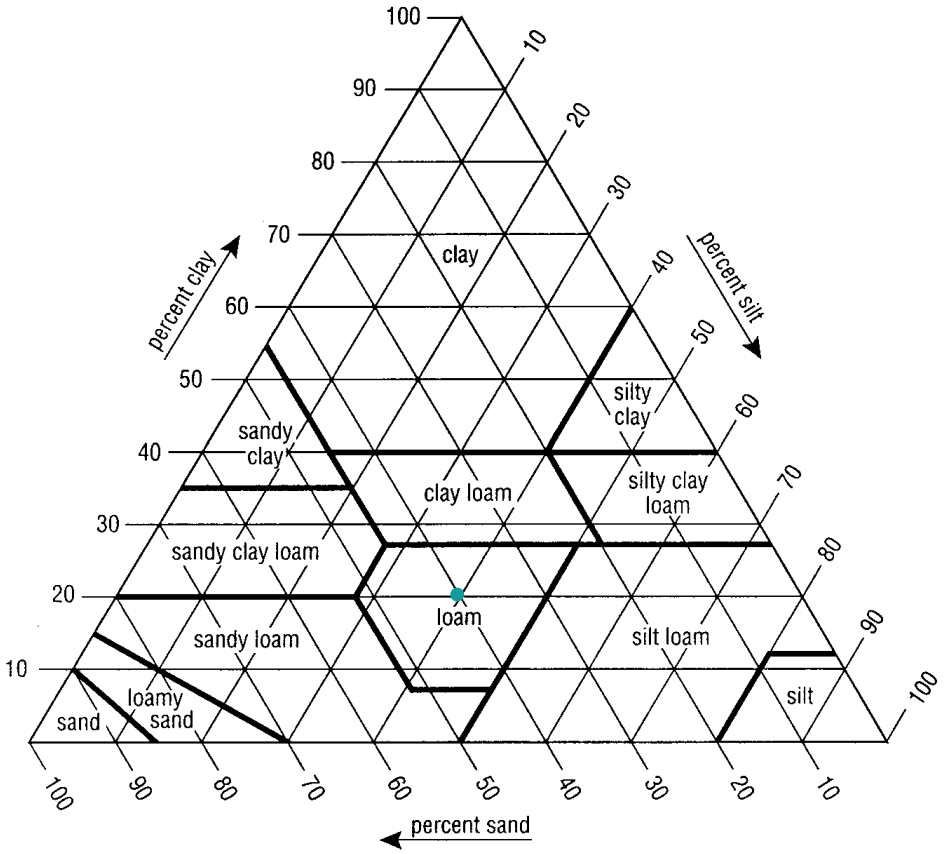
Composition and structure: University of Maryland Extension, Soil Basics.
Particle sizes and texture definitions: USDA NRCS, Soil Quality Test Kit Guide.

Scope: College Board AP Environmental Science CED, Topic 4.3, p. 82.

Read the soil texture triangle

Each point represents one combination of sand, silt and clay that totals 100%. The outlined regions name the USDA textural classes; do not choose a class using only the largest percentage.

1. FOLLOW THE GRID DIRECTION FOR EACH PERCENTAGE



2. WORKED EXAMPLE: 40% SAND, 40% SILT, 20% CLAY

A. Follow the 20% clay line horizontally across the triangle.

B. From 40% sand on the base, follow the grid line up and left.

C. The intersection is the loam dot. Check the 40% silt line, which runs down and left from the right edge, passes through the same point.

Mass check: 80 g sand + 80 g silt + 40 g clay = 200 g. Sand = (80 / 200) x 100 = 40%. Loam can balance drainage and water retention, but texture alone does not guarantee fertility.

Figure reproduced from USDA NRCS, Soil Quality Test Kit Guide, Fig. 5, p. 77.
Texture classification tool: USDA NRCS, Soil Texture Calculator.

Scope: College Board AP Environmental Science CED, Topic 4.3, p. 82.

From properties to decisions

Water storage, water movement and nutrient availability are different properties. A useful soil investigation measures the property relevant to irrigation, fertilizer use or root growth.

1. PORE SPACE IS NOT THE SAME AS DRAINAGE

Porosity	The fraction of total soil volume occupied by pores.
Permeability	How readily fluid moves through connected pores.
Water retention	How much water remains held under specified conditions.

A clay-rich soil can have high total porosity yet drain slowly through tiny pores. Large, connected pores in sandy soil usually allow faster drainage. Aggregation, cracks and compaction also matter.

2. RETAINED WATER IS NOT ALL AVAILABLE TO PLANTS

At saturation, pores are filled with water. After free drainage, soil is near field capacity. Some remaining water is held too tightly for roots to extract; plant-available water lies between field capacity and permanent wilting point. Clay often holds more total water than sand, but not necessarily more plant-available water than loam.

3. CHOOSE A TEST THAT ANSWERS THE QUESTION

Physical	Measure infiltration as water depth entering soil per unit time; use it to assess water entry and runoff risk.
Chemical	Measure pH with a calibrated meter; use lab nutrient tests to guide fertilizer or lime decisions.
Biological	Measure respiration (carbon dioxide release) to indicate biological activity, with temperature and moisture controlled.

Use replicated, representative samples from the same depth and horizon. Keep test conditions consistent. pH changes nutrient availability; more fertilizer does not automatically correct a pH problem.

Water storage and availability: University of Minnesota Extension, Soil-water basics.
Physical, chemical and biological tests: USDA NRCS, Soil Quality Test Kit Guide.

Scope: College Board AP Environmental Science CED, Topic 4.3, p. 82.