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Nitrogen-Fixing Plants: Which of the Six Actually Qualify

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Nitrogen-Fixing Plants: Which of the Six Actually Qualify

Air is about 78% nitrogen gas, but plants cannot use it directly. Some plants get help from bacteria in their roots. **UPSC 2022 asked which of six plants fix nitrogen.**



Alfalfa is a legume. Photo by Juan Carlos Fonseca Mata, CC BY-SA 4.0.

At a Glance

Four facts to hold on to.

01
Fixers

Alfalfa, chickpea, clover.

02
Helper

Rhizobium bacteria in root nodules.

03
Enzyme

Nitrogenase.

04
UPSC 2022

Answer: 1, 3 and 4 only.

Nitrogen fixation Turning N_2 gas into ammonia.
SymbiosisA partnership that helps both partners.
NoduleA root swelling that houses bacteria.
Green manureA crop ploughed back to enrich soil.

What Nitrogen Fixation Means

Must Know

Why plants cannot use air nitrogen

- Air is about 78% nitrogen gas (N_2).

- Its two atoms share a very strong bond.
- Plants cannot break it with their own enzymes.
- They absorb nitrogen mainly as ammonium or nitrate.
- Microbes use an enzyme called **nitrogenase** to turn N_2 into ammonia.
- This uses a lot of energy.

Which microbes fix nitrogen?

- Some bacteria fix nitrogen while living free in soil or water. Certain cyanobacteria do.
- Others live with plants in symbiosis. The plant supplies sugars. The microbe supplies nitrogen.
- Legumes are in the pea and bean family. Many form root nodules.
- Bacteria called **rhizobia** live in the nodules.
- Alder trees partner with Frankia bacteria.
- The water fern Azolla hosts a nitrogen-fixing cyanobacterium.
- Sources: NMSU, legume nitrogen fixation and NCERT mineral nutrition.

> **Quick check 1.** Alfalfa, chickpea and clover can form nitrogen-fixing nodules. *(True or False?)* See answer ↓

How the Root Partnership Works

Good to Know

Nodule formation and oxygen

- Rhizobia respond to chemicals from a legume root.

- Root hairs curl around them. An infection thread carries them in.
- Root cells divide and form a nodule.
- Oxygen can damage nitrogenase, yet the bacteria need oxygen for energy.
- The protein **leghaemoglobin** keeps free oxygen low.
- Active nodules often look pink inside because of it.

The six plants in the UPSC question

Plant	Fixes nitrogen?	Why
1 Alfalfa	Yes	Legume with root nodules
2 Amaranth	No	No such nodules
3 Chickpea	Yes	Pulse crop with nodules
4 Clover	Yes	Fodder legume with nodules
5 Purslane (Kulfa)	No	No such nodules
6 Spinach	No	No such nodules

“No” refers to this root-nodule partnership. These plants still absorb nitrogen from soil.

> **Quick check 2.** Plant roots perform nitrogen fixation without microbes. *(True or False?)* See answer ↓

Exam Edge

Previous Year Questions

UPSC 2022 asked which are nitrogen-fixing plants.

Asked before

PYQ 1 · UPSC CSP 2022, Q48

Which of the following are nitrogen-fixing plants?

(a) 1, 3 and 4 only
(b) 1, 3, 5 and 6 only
(c) 2, 4, 5 and 6 only
(d) 1, 2, 4, 5 and 6

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Quick check 3. UPSC 2022 included spinach among the correct plants. *(True or False?)* See answer ↓

Quick check 4. Nitrogenase converts nitrogen gas into usable nitrogen compounds. *(True or False?)* See answer ↓

What Fixation Does and Does Not Guarantee

Great to Know

- A legume uses much of its fixed nitrogen for its own growth.
- The next crop gains only what remains in roots, leaves and residues.
- Removed grain and fodder carry nitrogen away.
- Green manure releases nutrients as it decays.
- When soil already has plenty of nitrate, a legume may form fewer or less active nodules.
- An inoculant adds bacteria to seeds or soil. The strain must suit the crop, and heat or drying can kill it.
- Acid soil, waterlogging, drought and nutrient shortages reduce fixation.
- Source: NMSU, inoculating legumes.

Exam reminders

- “Nitrogen-fixing plant” means a plant-microbe partnership.
- Legumes are common hosts, not the only ones.
- Fixation does not give the next crop an instant supply of fertiliser.

Think it through: why does a nitrogen-fixing crop not hand all its nitrogen to the next crop?

The legume first uses nitrogen to build its own leaves, stems and seeds. Harvest then removes grain or fodder, with nitrogen inside. Only roots and leftover residues add nitrogen to the soil, and they release it slowly as they decay.

Quick check 5. Nodule oxygen must be controlled because nitrogenase is oxygen-sensitive. *(True or False?)* See answer ↓

Quick check 6. Fixed nitrogen always passes completely to the next crop. *(True or False?)* See answer ↓

Quick check 7. Soil conditions and bacterial strain can change fixation rates. *(True or False?)* See answer ↓

Quick Q&A

Which enzyme?

Nitrogenase.

Which bacteria?

Rhizobia.

Oxygen guard?

Leghaemoglobin.

UPSC 2022 answer?

1, 3 and 4 only.

Non-legume host?

Alder, Azolla.

Practice: Nitrogen-Fixing Plants: Which of the Six Actually Qualify

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Practice MCQs

1. Which of the following are nitrogen-fixing plants?
1. Alfalfa
2. Amaranth
3. Chickpea
4. Clover
5. Purslane (Kulfa)
6. Spinach

A. 1, 3 and 4 only

B. 1, 3, 5 and 6 only

C. 2, 4, 5 and 6 only

D. 1, 2, 4, 5 and 6

See answer ↓

2. Legumes like alfalfa, chickpea, and clover fix nitrogen through a symbiotic relationship with which organism in their root nodules?

A. Earthworms

B. Mycorrhizal fungi only

C. Rhizobium bacteria

D. Cyanobacteria exclusively

See answer ↓

3. Why do farmers often rotate legume crops like clover or alfalfa with other crops?

A. Legumes attract pests that harm the following crop

B. Legumes require no sunlight and can be grown indoors between seasons

C. Legumes naturally enrich the soil with nitrogen, reducing fertiliser need for the next crop

D. Legumes deplete soil nitrogen faster than any other crop

See answer ↓

Answer Key

1. **A.** Alfalfa, chickpea, and clover are legumes that fix nitrogen through symbiosis with Rhizobium bacteria. Amaranth, purslane, and spinach are not legumes and cannot fix nitrogen. ↑ Q1
2. **C.**
   Legumes such as clover and alfalfa host bacteria called rhizobia in root nodules. Inside the nodules, the bacteria convert nitrogen from the air into ammonia. The plant can use ammonia as a nutrient. The plant feeds the bacteria with carbon compounds called dicarboxylates.
   ↑ Q2
3. **C.** Legumes fix nitrogen, so the soil gains nitrogen. Northern Indian farmers grew legumes as fodder and wheat in the next season. That helped the soil regain nitrogen. A Nature Communications paper links legume rotations with healthier soil. ↑ Q3

Quick-check answers

1. **True.** ↑ 1
2. **False.** ↑ 2
3. **False.** ↑ 3
4. **True.** ↑ 4
5. **True.** ↑ 5
6. **False.** ↑ 6
7. **True.** ↑ 7

Previous year answers

1. **(a) 1, 3 and 4 only**

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