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Ocean Primary Producers: Cyanobacteria, Diatoms, and What Isn’t One

Free · Share

Ocean Primary Producers: Cyanobacteria, Diatoms, and What Isn’t One

Practice: 6 MCQs

At a glance

Four facts that settle most exam questions on this topic

01 **Two real producers**Cyanobacteria and diatoms both photosynthesize.
02 **Two consumers**Copepods and most foraminifera do not.
03 **Half of Earth’s oxygen**Ocean phytoplankton supply roughly this share.
04 **Upwelling**Deep, nutrient-rich water reaching sunlight.

Primary producer An organism that makes its own food from simple, non-living materials.
PhytoplanktonTiny drifting organisms that use sunlight to make food.
PhotosynthesisThe process of turning sunlight, water, and carbon dioxide into food.
UpwellingDeep, nutrient-rich ocean water rising toward the sunlit surface.

Contents

1. Who actually makes ocean food
2. The tricky middle: organisms that do both
3. Follow the energy, from sunlight to fish
4. Oxygen, carbon, and what they don't prove
5. Five groups, side by side
6. How exams test this
7. 4 questions to think through

8. 4 understanding checks
9. Related topics
0. 6 practice MCQs

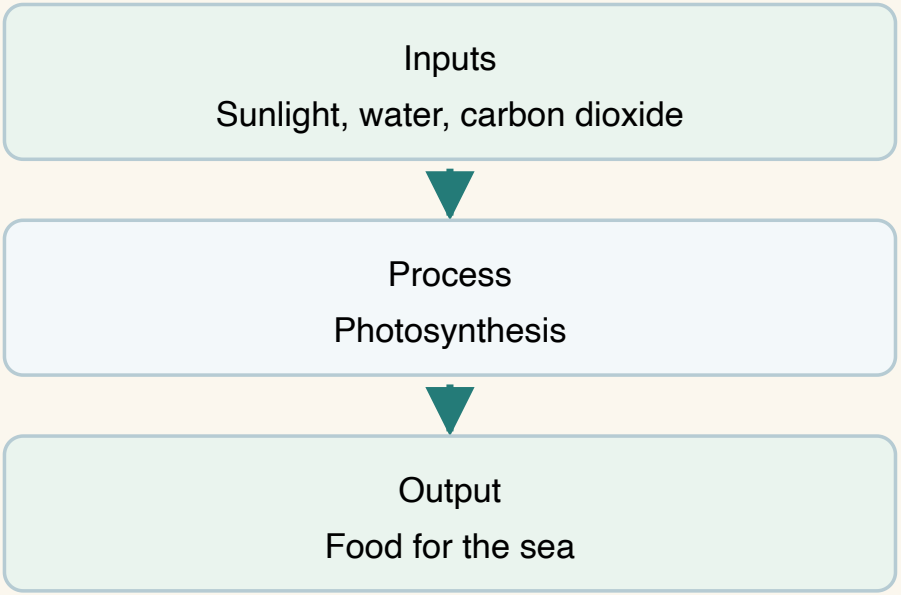
Who actually makes ocean food

A 2021 exam question named four groups: copepods, cyanobacteria, diatoms, and foraminifera. Only two of them are primary producers. Four groups, only two of them producers.

1. What Is a Primary Producer?

A primary producer makes its own food from simple raw materials. In the ocean, most producers use sunlight, water, and carbon dioxide to do this. Their food supports nearly every animal in the marine food web.

This process is called photosynthesis. Scientists also call producers autotrophs, which means “self-feeders”.



Producers start the food chain. Original explanatory diagram.

Sources:

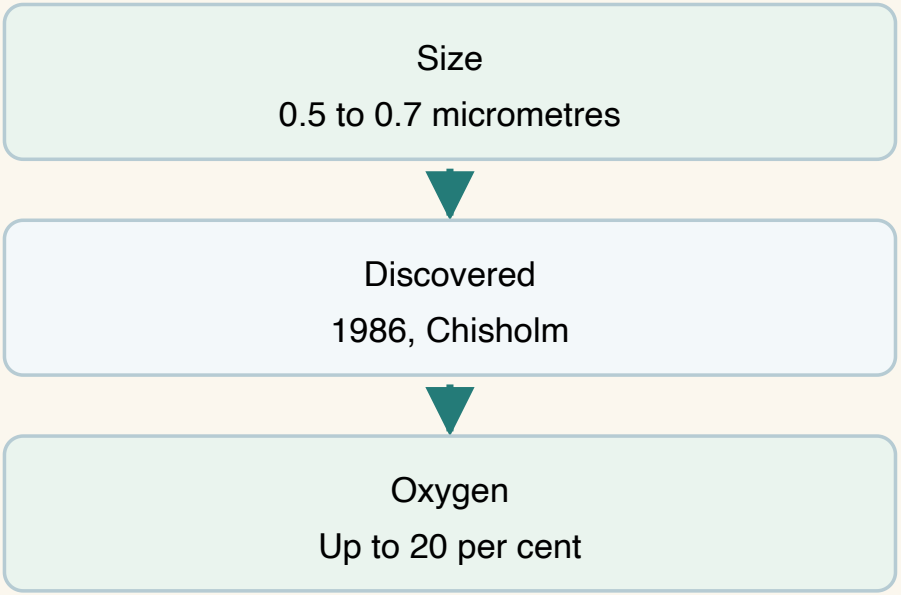
- Wikipedia: Marine primary production
- Wikipedia: Phytoplankton

2. Why Are Cyanobacteria Producers?

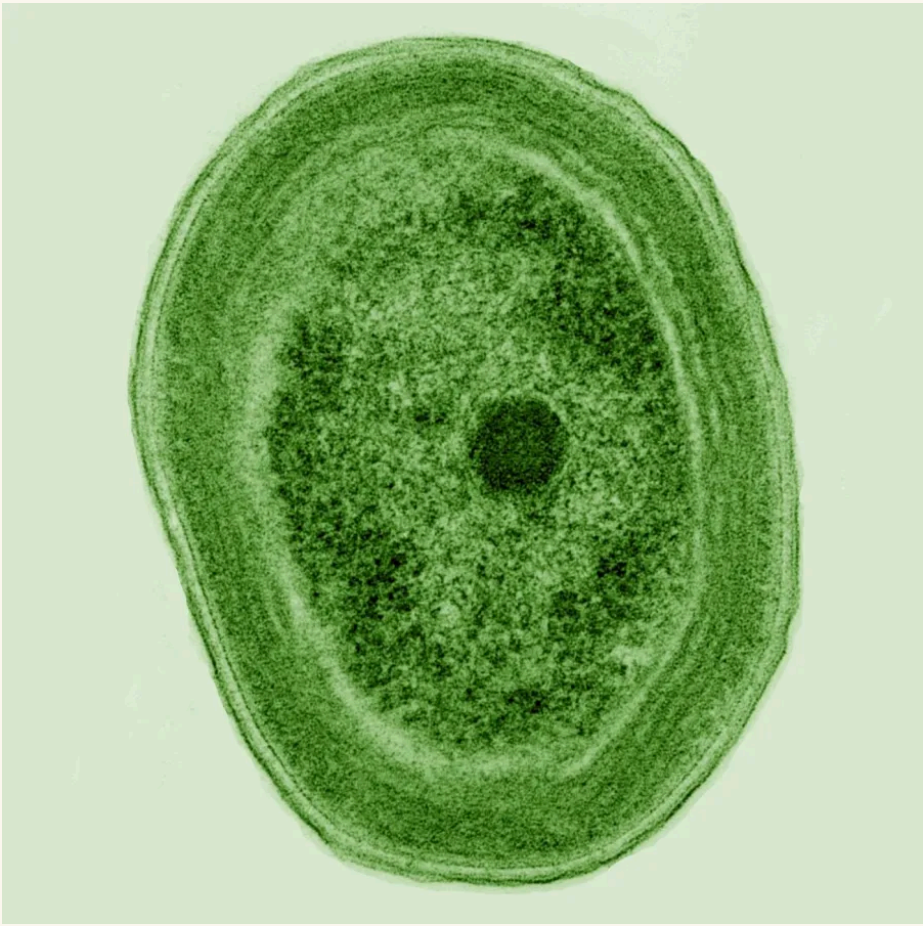
Cyanobacteria are bacteria that photosynthesize. They were the first organisms known to make oxygen. In the ocean, the best-known example is *Prochlorococcus*. That is a cyanobacterium of the kind named in the 2021 exam question.

They make food from sunlight, so they count as producers.

Prochlorococcus is tiny, only 0.5 to 0.7 micrometres across. It was discovered in 1986 by Sallie (Penny) Chisholm and her colleagues. It is probably the most abundant photosynthetic organism on Earth.



A tiny cell with a big job. Original explanatory diagram.



Prochlorococcus marinus under a transmission electron microscope, with added colour, by Luke Thompson of the Chisholm Lab (CC0), Wikimedia Commons.

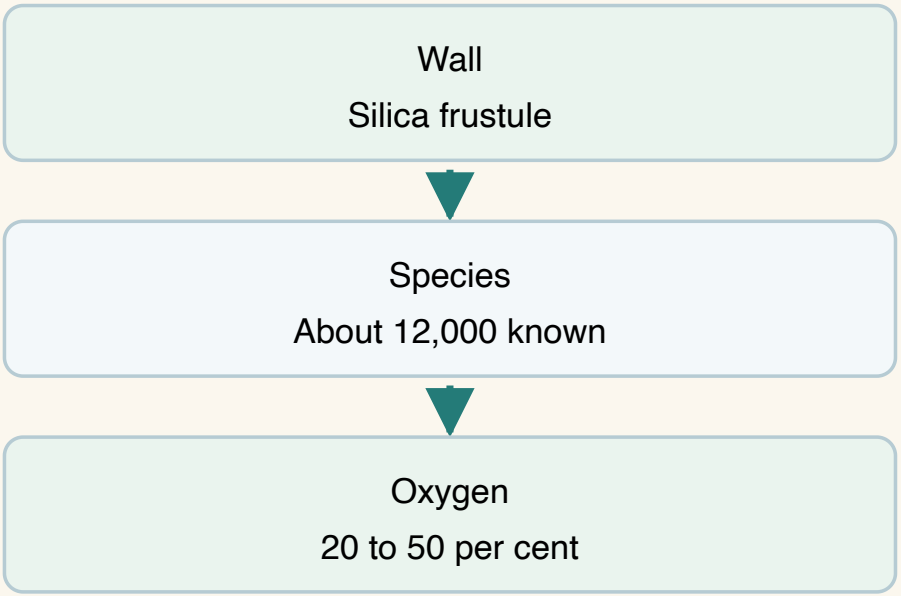
Sources:

- Wikipedia: Prochlorococcus
- Wikipedia: Cyanobacteria
- NOAA: ocean oxygen

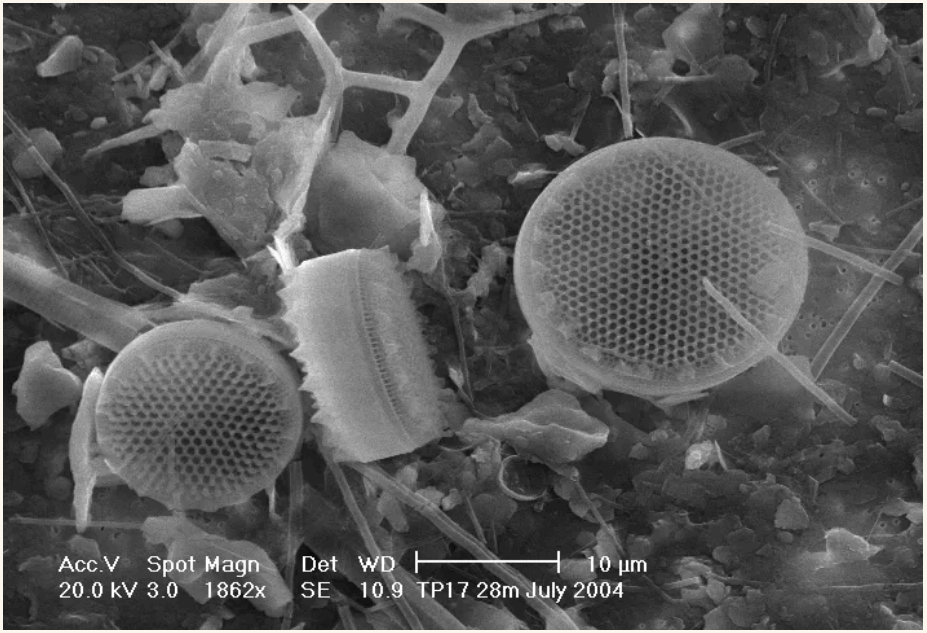
3. Why Are Diatoms Producers?

Diatoms are algae with glass-like silica shells. Each cell sits inside a wall of silica called a frustule.

Diatoms photosynthesize, so they are producers. About 12,000 species are known. Scientists estimate that diatoms make 20 to 50 per cent of the oxygen produced on Earth each year.



Glass houses that feed the sea. Original explanatory diagram.



Diatoms of the genus Chaetoceros, seen under a scanning electron microscope. Photo by Kostas Tsobanoglou, Wikimedia Commons (CC BY-SA 4.0).

Sources:

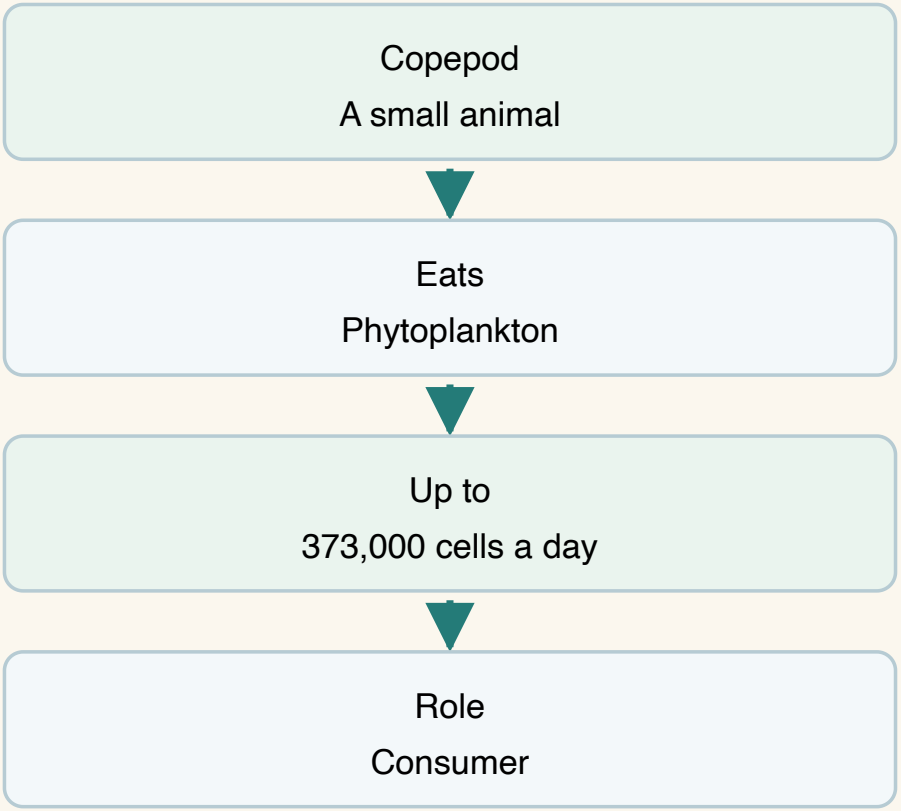
- Wikipedia: Diatom
- Wikipedia: Marine primary production

4. Why Are Copepods Not Producers?

Copepods are tiny crustaceans. They are animals. They cannot photosynthesize.

They eat plankton instead of making their own food. That makes them consumers, not producers.

Most free-living copepods eat phytoplankton. One copepod can eat up to 373,000 phytoplankton cells in a day. They pass energy from producers to fish.



Animals do not photosynthesize. Original explanatory diagram.



The copepod Calanus finmarchicus, photographed by Leïla Brunner (CC BY 4.0), Wikimedia Commons.

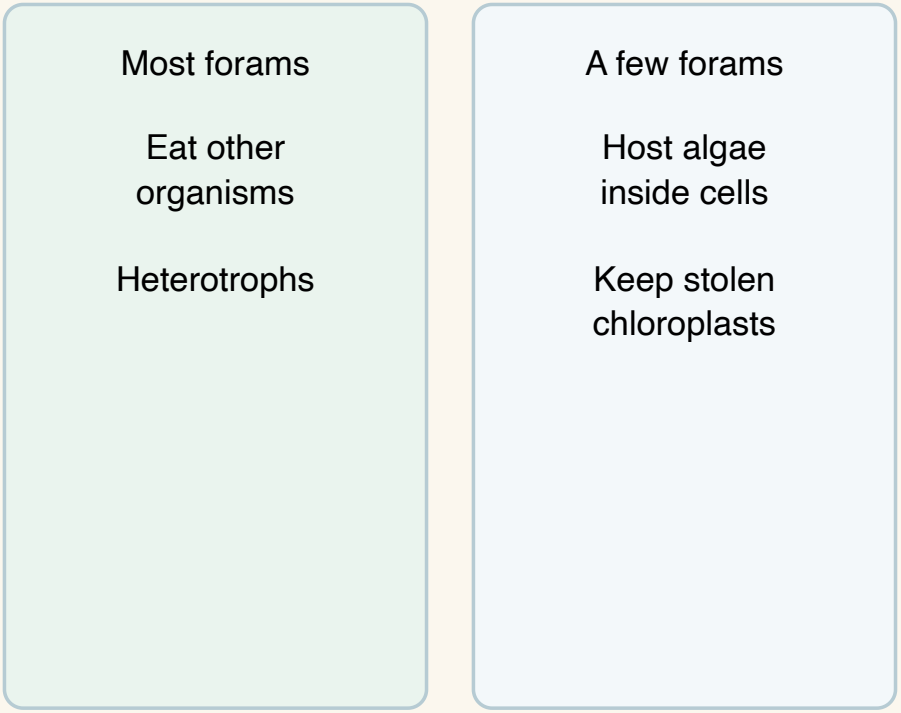
Sources:

- Wikipedia: Copepod

5. Why Are Foraminifera Usually Not Producers?

Foraminifera are mostly shelled, single-celled organisms. They are often called “forams”. Most of them are heterotrophs. They eat smaller organisms and bits of organic matter.

Some do host photosynthetic algae inside them, which adds a real biological wrinkle. Others keep chloroplasts from the algae they eat. Even so, most forams feed like consumers. That is why the exam treats them as non-producers.



Mostly consumers. Original explanatory diagram.

Cyanobacteria and diatoms are both classed as primary producers because they photosynthesize. True or False?

Sources:

- Wikipedia: Foraminifera

The tricky middle: organisms that do both

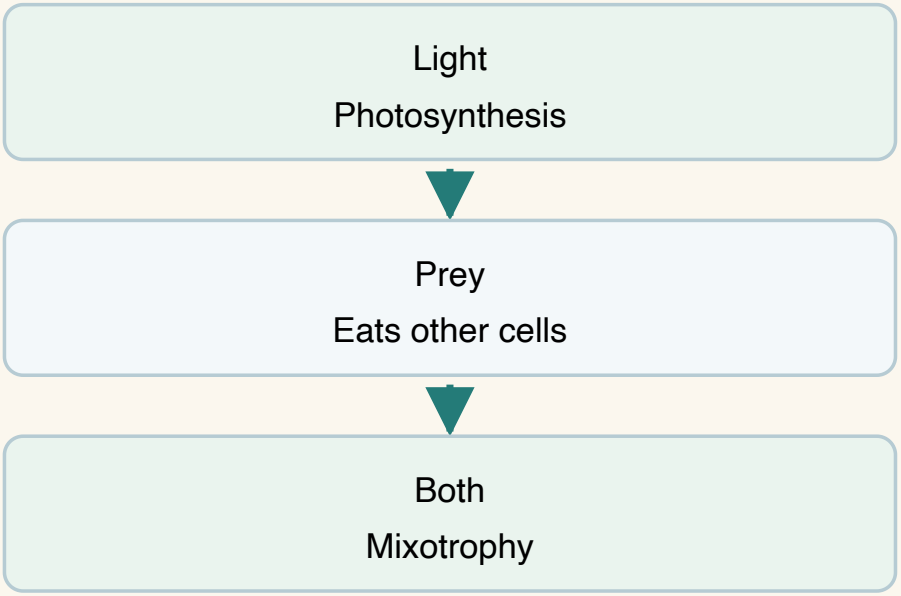
Dinoflagellates don’t fit neatly into either box.

6. What Is Mixotrophy?

Dinoflagellates are single-celled organisms common in ocean plankton. Many species photosynthesize, just like diatoms and cyanobacteria. But many dinoflagellates can also eat other cells directly. This is called mixotrophy: feeding both ways.

A mixotroph uses more than one way to get energy and carbon. It may photosynthesize and also eat other cells. Which way it leans depends on the conditions.

Scientists estimate that mixotrophs make up more than half of all microscopic plankton. So the clean “producer or consumer” split is not always clean in real water.



Two ways to feed. Original explanatory diagram.

Sources:

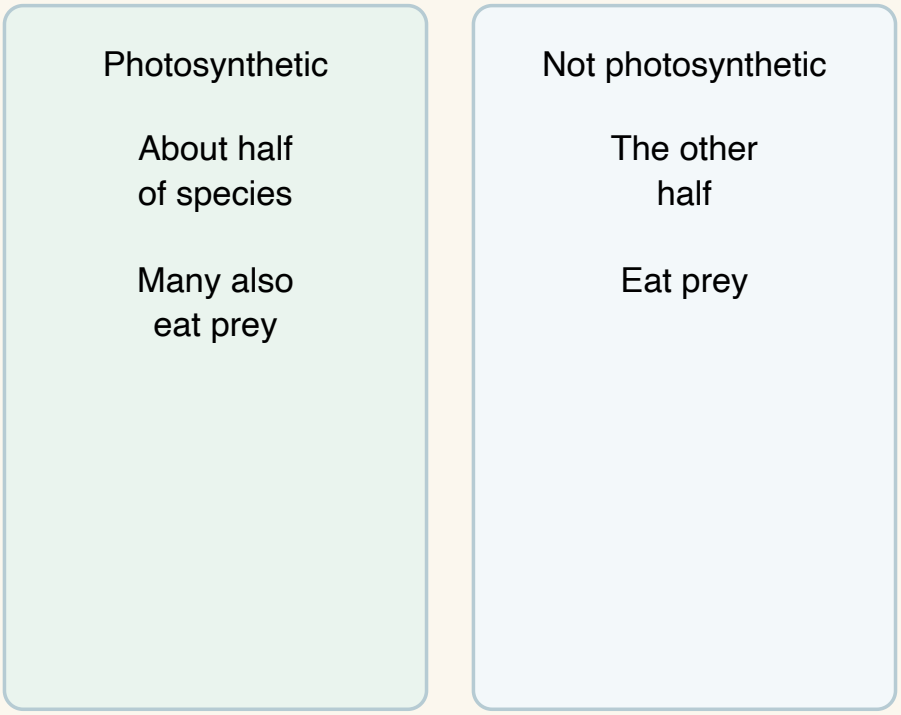
- Wikipedia: Mixotroph

7. Why Are Dinoflagellates Tricky?

Dinoflagellates are single-celled plankton, mostly marine. About half of the living species are autotrophs with chloroplasts. The other half do not photosynthesize.

Many of the photosynthetic ones are also mixotrophic. They combine photosynthesis with eating prey.

In bright, nutrient-rich water, a mixotrophic dinoflagellate mostly photosynthesizes. It behaves like a normal producer. In dim or nutrient-poor water, the same species shifts toward eating prey cells instead.



One group, many habits. Original explanatory diagram.



A dinoflagellate of the genus Ceratium. Photo by Bwiltz, Wikimedia Commons (licence CC BY-SA 4.0).

A mixotrophic dinoflagellate always behaves as a pure primary producer, no matter the conditions. True or False?

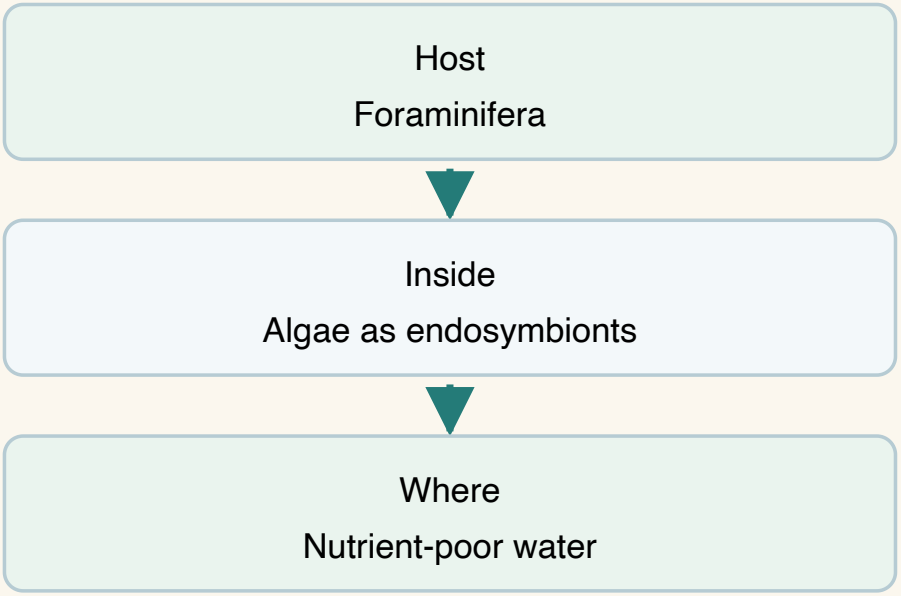
Sources:

- Wikipedia: Dinoflagellate

8. Can Foraminifera Be Part-Producers?

Yes, some can. Certain forams host algae as endosymbionts. These algae can be green algae, red algae, diatoms or dinoflagellates.

These mixotrophic forams are especially common in nutrient-poor ocean water. Even so, the group as a whole is mostly heterotrophic.



A partnership, not the rule. Original explanatory diagram.

Sources:

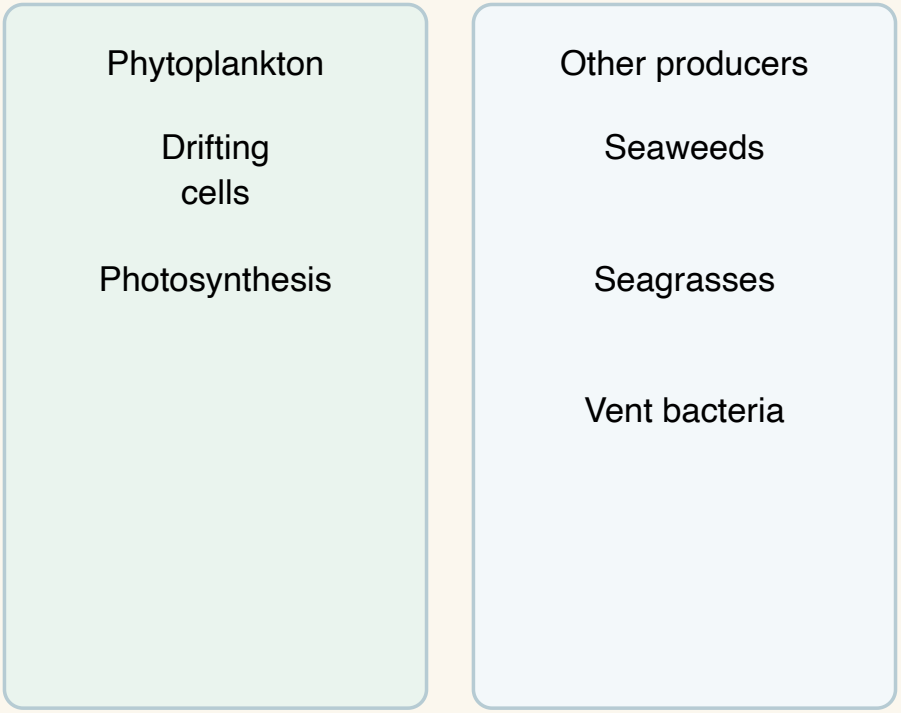
- Wikipedia: Foraminifera

9. Is "Phytoplankton" the Same as "Primary Producer"?

No. That does not make them the ocean's only producers. Seaweeds and seagrasses also produce food, especially in coastal waters.

Watch this trap: "primary producer" is not the same as "phytoplankton". Cyanobacteria and diatoms are both producers. Phytoplankton as a group includes several other organisms too.

In the ocean, almost all photosynthesis is done by algae and cyanobacteria. A small share comes from marine plants. Some bacteria at hot vents make food by chemosynthesis instead of sunlight.



Wider than phytoplankton. Original explanatory diagram.

Sources:

- Wikipedia: Marine primary production
- Wikipedia: Phytoplankton

Follow the energy, from sunlight to fish

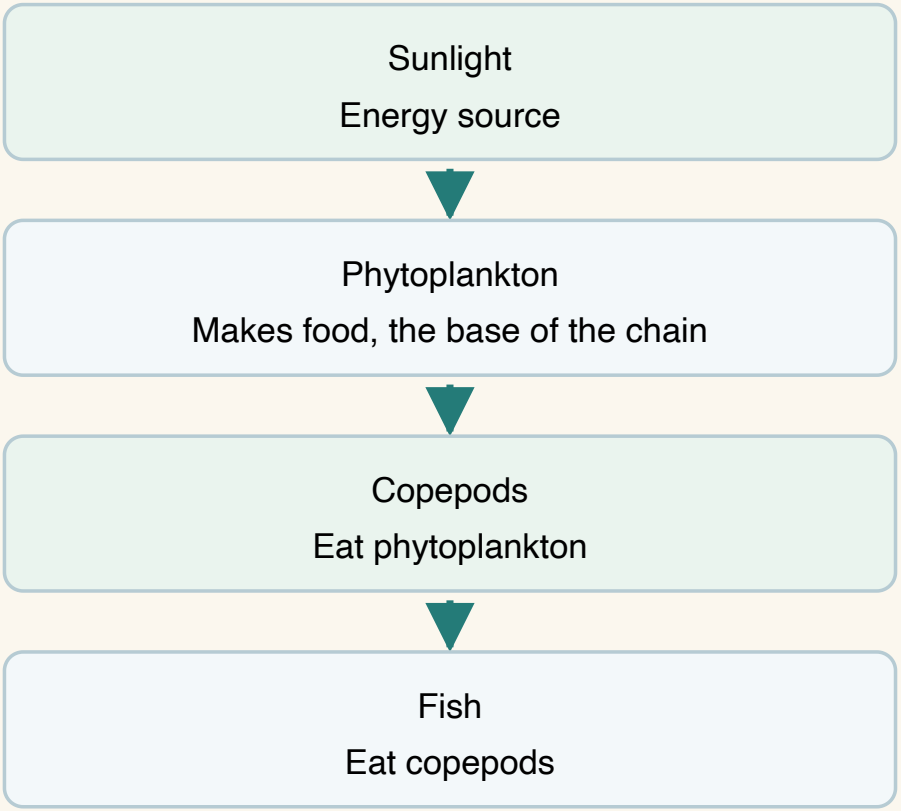
Why some waters are more productive comes down to light and nutrients.

10. How Does Energy Move from Sunlight to Fish?

The chain starts with sunlight. Phytoplankton use it to make food. Copepods eat the phytoplankton. Small fish eat the copepods, and larger animals eat the fish.

Each step passes some energy up. The base is always the producer.

Phytoplankton: makes food, the base of the chain.



Energy flows upward. Original explanatory diagram.

Sources:

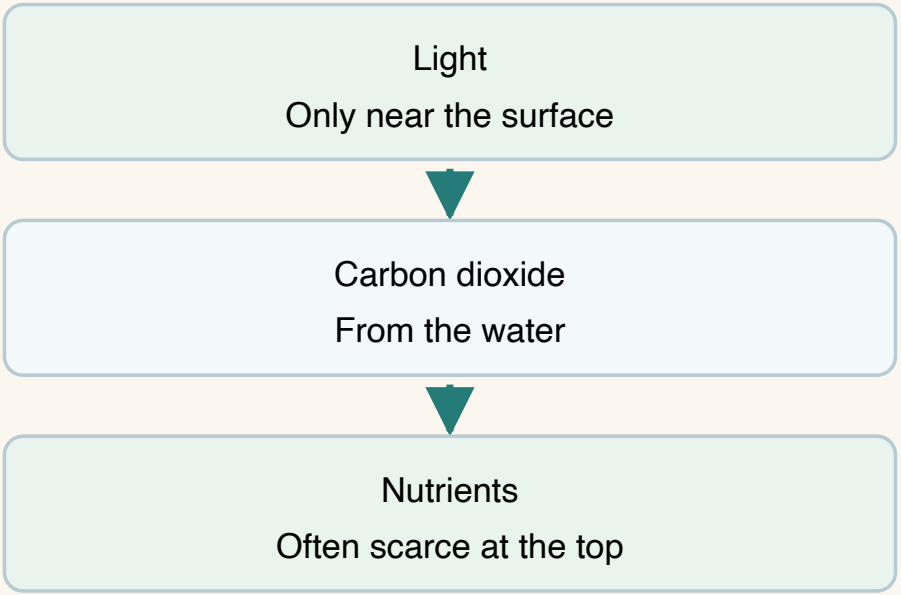
- Wikipedia: Upwelling

- Wikipedia: Copepod

11. What Do Ocean Producers Need?

In sunlit surface water, producers absorb carbon dioxide and nutrients. Sunlight supplies the energy for that process. This sunlit layer is called the euphotic zone.

Producers need both light and nutrients to grow. Deep water usually holds plenty of nutrients, but little light reaches it.



Light above, nutrients below. Original explanatory diagram.

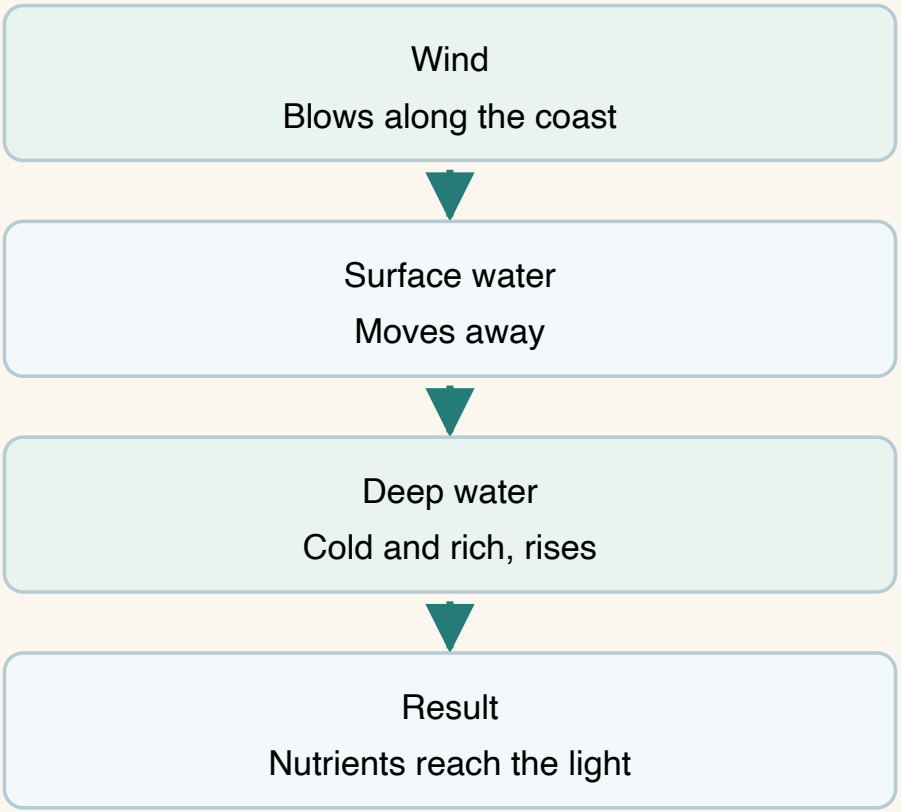
Sources:

- Wikipedia: Phytoplankton
- NOAA: upwelling

12. What Is Upwelling?

Upwelling is a process in which deep, cold water rises toward the surface. Winds and currents push nutrient-rich deep water up toward the sunlit surface. Winds that blow along a coast push surface water away, so water from below rises to replace it.

This water is cold and rich in nutrients. NOAA says these nutrients “fertilize” the surface water. Upwelling happens in the open ocean and along coasts.



Wind lifts nutrients up. Original explanatory diagram.

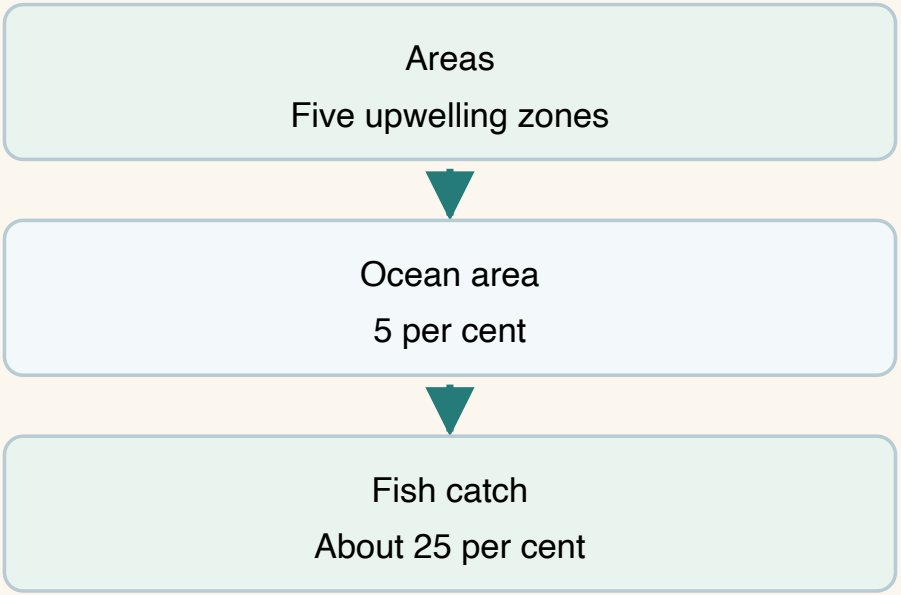
Sources:

- NOAA: upwelling
- Wikipedia: Upwelling

13. Why Do Upwelling Zones Have Rich Fisheries?

Nutrients let phytoplankton grow. That can trigger large phytoplankton blooms, and support rich fisheries nearby. More phytoplankton means more copepods and fish.

About 25 per cent of the world's marine fish catch comes from five upwelling areas. Together these cover only 5 per cent of the ocean.



Small area, large catch. Original explanatory diagram.

Sources:

- Wikipedia: Upwelling
- NOAA: upwelling

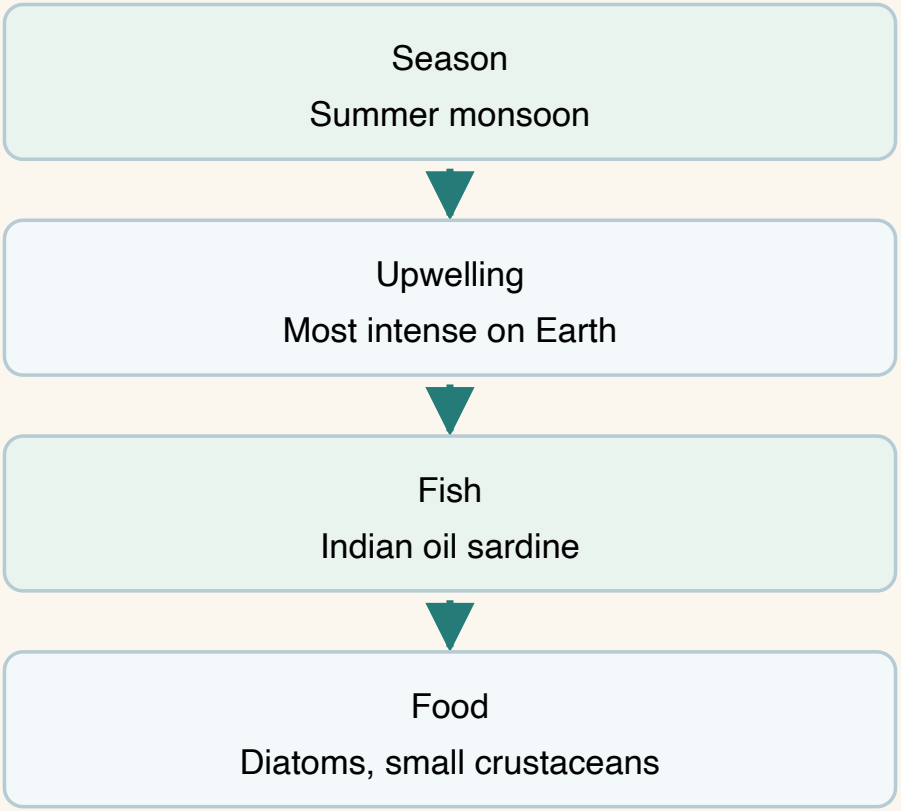
14. What Does the Arabian Sea Show?

A real example: the Arabian Sea.

India’s own coast shows upwelling working as expected. Southwest monsoon winds push nutrient-rich deep water up along this coast every year. Productivity in the Arabian Sea changes a lot through the year, because upwelling differs between monsoon seasons.

The upwelling in the summer monsoon is the most intense of any region on the planet. This upwelling supports one of the world’s most productive fishing grounds.

The Indian oil sardine lives off the west coast of India. It feeds mainly on phytoplankton, especially diatoms, and on small crustaceans. It feeds India’s Indian oil sardine fishery, one of the country’s largest catches by volume.



The monsoon feeds the sea. Original explanatory diagram.



The Indian oil sardine, Sardinella longiceps, photographed by Sannidhishetty (CC0), Wikimedia Commons.

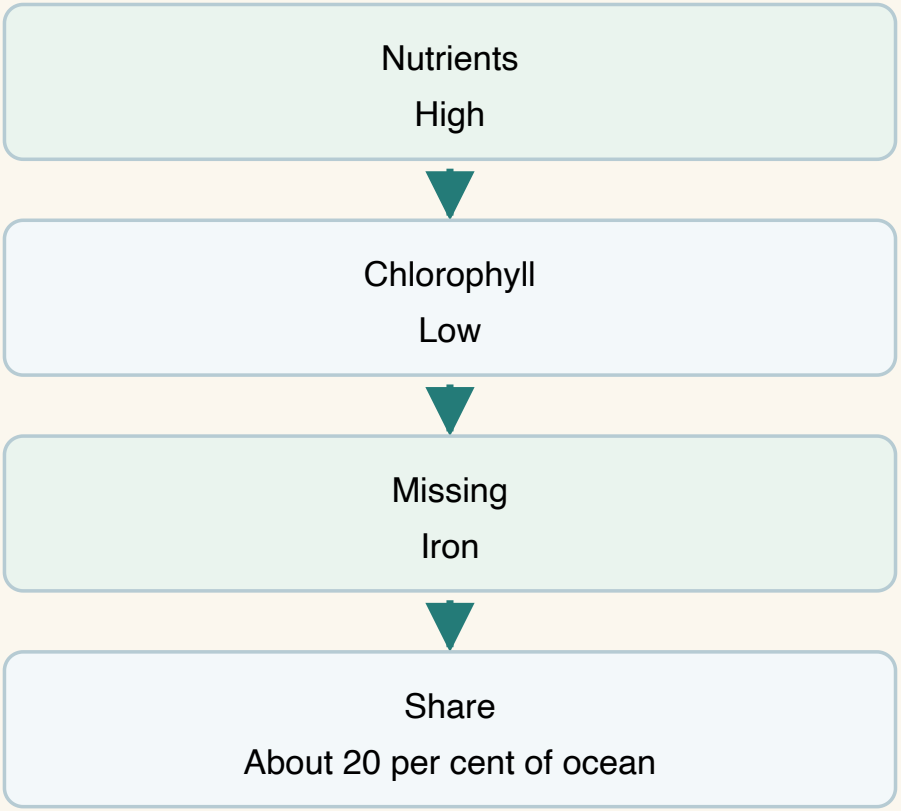
Sources:

- Wikipedia: Arabian Sea
- FishBase: Sardinella longiceps
- Wikipedia: Indian oil sardine

15. What Are HNLC Regions?

Nutrients alone do not guarantee a bloom. Some nutrient-rich waters stay surprisingly unproductive. The missing piece is often iron. Phytoplankton need iron in small amounts to photosynthesize efficiently.

Scientists call these places HNLC regions: High-Nutrient, Low-Chlorophyll. The eastern equatorial Pacific and the open Southern Ocean are two examples. Together, HNLC waters cover close to a fifth of the world’s ocean. That is about 20 per cent. Adding iron can trigger a bloom. Iron reaches the sea from dust storms, volcanoes, vents and upwelling.



Iron is the limit. Original explanatory diagram.

A region can have plenty of nutrients from upwelling and still support little plankton growth, due to iron scarcity. True or False?

Sources:

- Wikipedia: HNLC regions
- Wikipedia: Iron fertilization

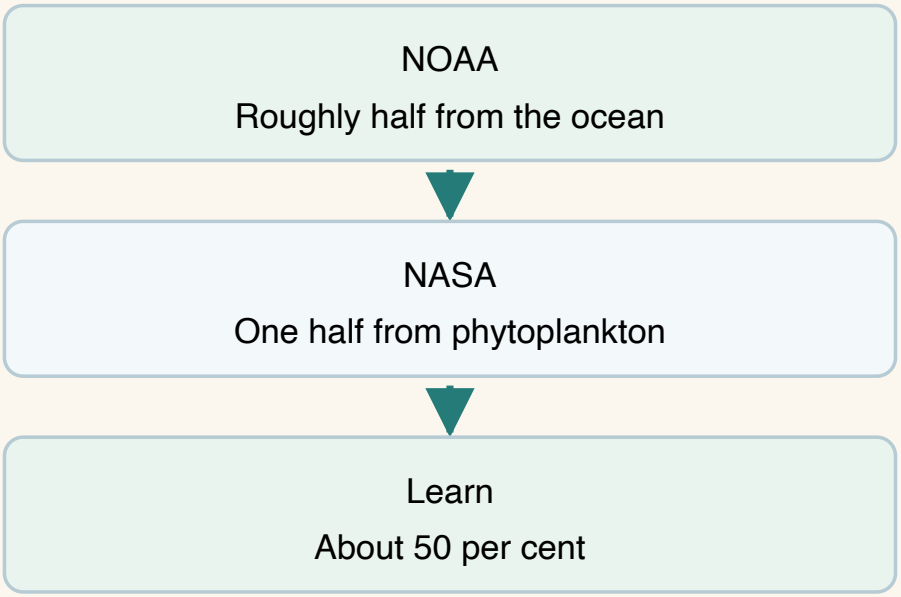
Oxygen, carbon, and what they don't prove

16. What Share of Earth's Oxygen Is Made in the

Ocean?

Ocean phytoplankton produce roughly half of Earth's oxygen. NOAA says roughly half of the oxygen production on Earth comes from the ocean. Most of this production is from oceanic plankton. NASA's ocean-colour pages say the same: phytoplankton make about half of the oxygen produced on Earth.

Wording differs between sources: "about half", "nearly half" and "one half". Learn it as about 50 per cent.



Two agencies, one figure. Original explanatory diagram.

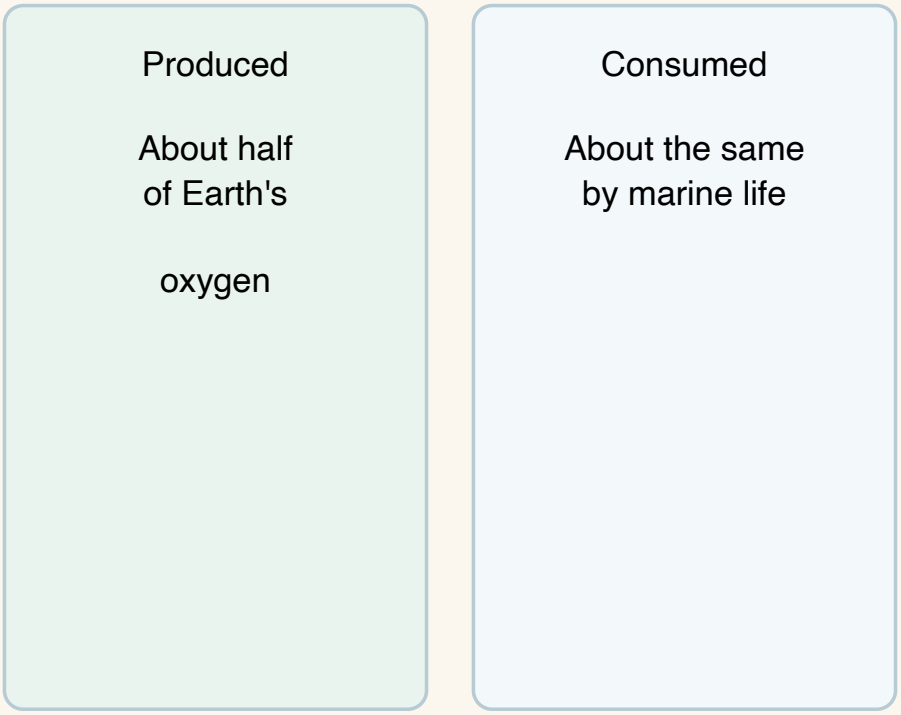
Sources:

- NOAA: ocean oxygen
- Wikipedia: Phytoplankton

17. Does the Ocean Add Half of Our Air's Oxygen?

No, and this is a popular trap. NOAA says about half of Earth’s oxygen comes from the ocean. It adds that about the same amount is consumed by marine life.

That figure describes total global production. It does not mean half the oxygen in any one breath came from the ocean.



Production is not net supply. Original explanatory diagram.

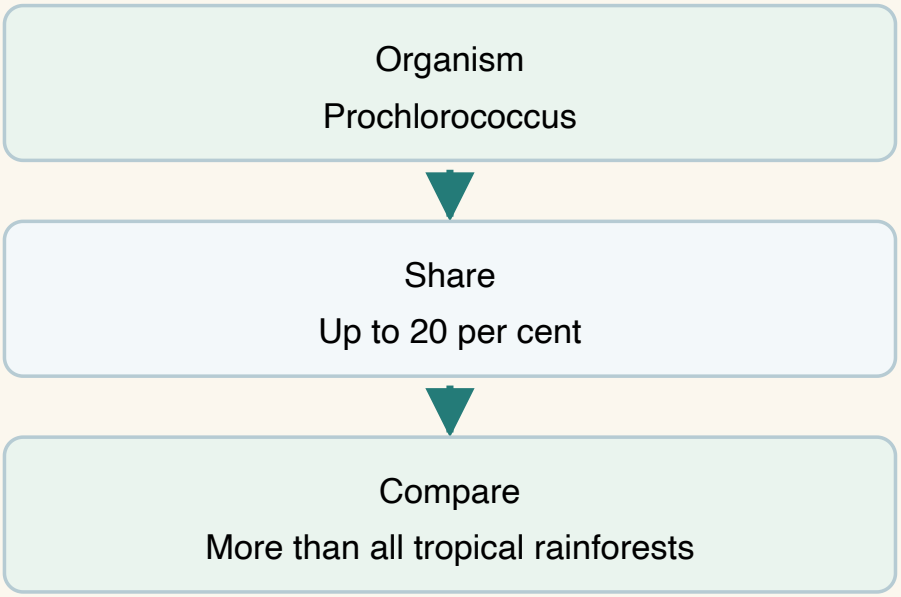
Sources:

- NOAA: ocean oxygen

18. Which One Organism Makes the Most Oxygen?

NOAA names *Prochlorococcus* as the smallest photosynthetic organism on Earth. It says this bacterium makes up to 20 per cent of the oxygen in the biosphere.

NOAA adds that this is more than all tropical rainforests on land combined. One tiny cell type beats the biggest forests.



Smallest cell, biggest share. Original explanatory diagram.

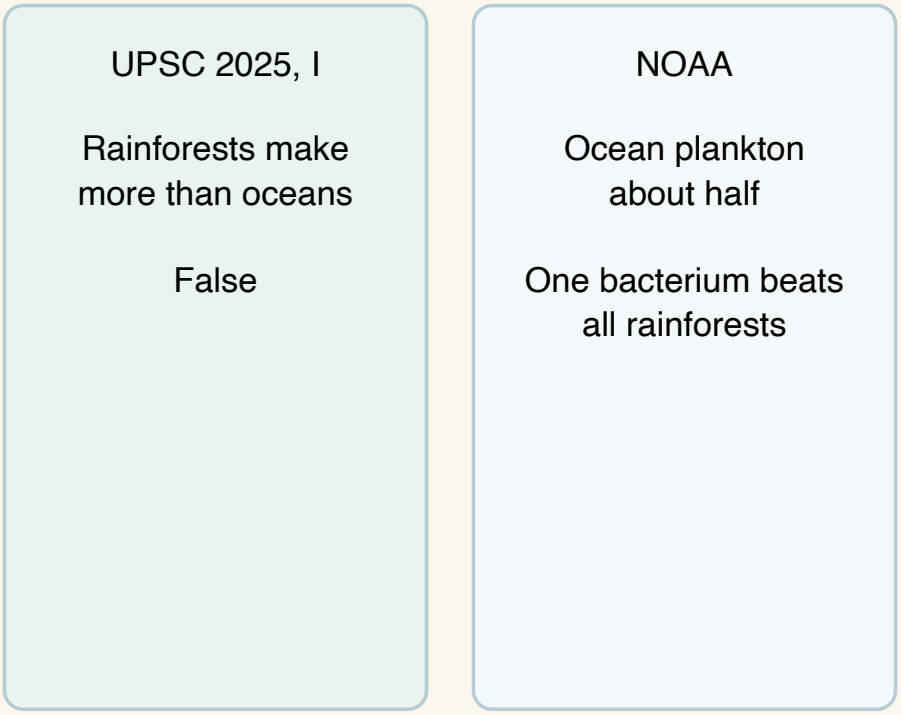
Sources:

- NOAA: ocean oxygen
- Wikipedia: Prochlorococcus

19. Do Rainforests Make More Oxygen Than the Ocean?

No. UPSC 2025 tested this directly. The ocean's plankton make about half of the oxygen produced on Earth. That is more than the land's tropical forests make.

NOAA says one ocean bacterium, *Prochlorococcus*, alone beats all tropical rainforests combined. Do not memorise "rainforests are the lungs of the Earth" as an exam fact.



The ocean wins. Original explanatory diagram.

Sources:

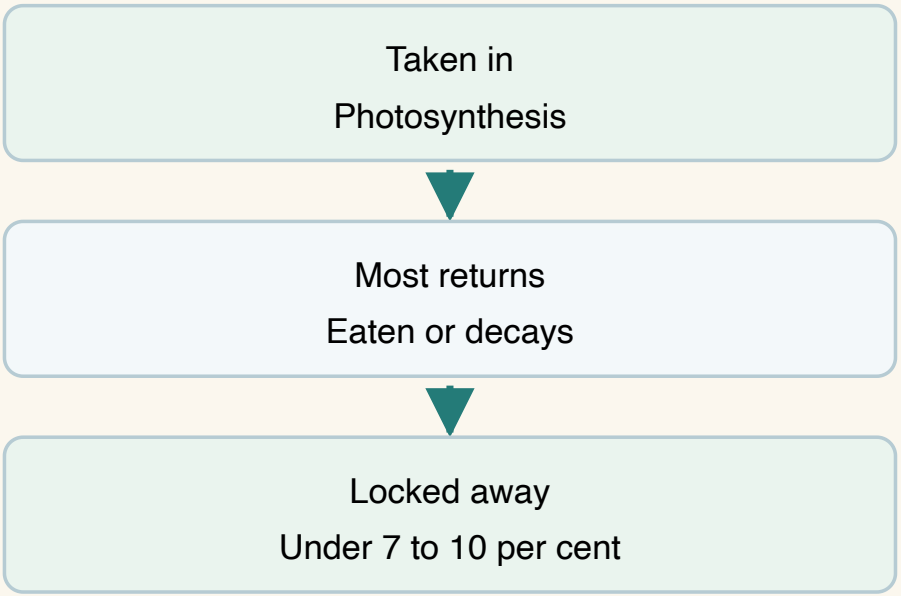
- NOAA: ocean oxygen
- mcqquestion.com: UPSC CSP 2025 paper

20. What Happens to the Carbon That Phytoplankton Take In?

Photosynthesis pulls carbon dioxide into living cells. Much of that carbon goes back to the water or air when organisms are eaten or decay.

Only some of it sinks into long-term storage. Only a small share reaches the deep ocean. Studies of iron-fed blooms suggest less than 7 to 10 per cent of the carbon is locked away. So ocean blooms are not a quick fix for carbon dioxide.

Warming affects blooms differently across regions and species. Do not assume every ocean will respond the same way to the same change.



Blooms are not a quick fix. Original explanatory diagram.

Sources:

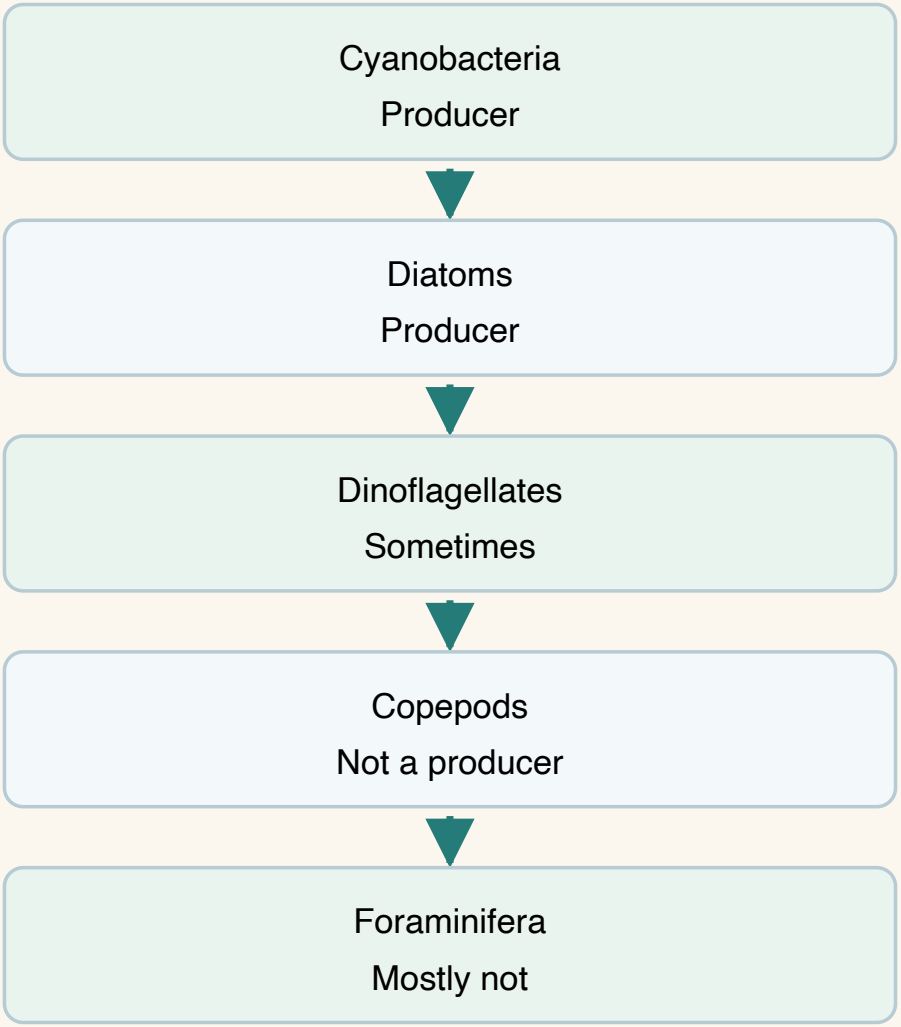
- Wikipedia: Iron fertilization

- Wikipedia: HNLC regions

Five groups, side by side

This table lines up every group this topic tests, in one place.

- **Cyanobacteria:** producer. They only photosynthesize. They sit at the base of the food web.
- **Diatoms:** producer. They are major photosynthetic primary producers. They have silica walls. A few species have lost photosynthesis.
- **Dinoflagellates:** sometimes. Producer or consumer, depending on conditions.
- **Copepods:** not producers. They eat phytoplankton and link producers to fish.
- **Foraminifera:** mostly not. A few host algae, but most don’t rely on it.



The whole exam list. Original explanatory diagram.

Every foraminifer counts as a straightforward primary producer, since some host photosynthetic algae. True or False?

Sources:

- Wikipedia: Marine primary production
- Wikipedia: Dinoflagellate

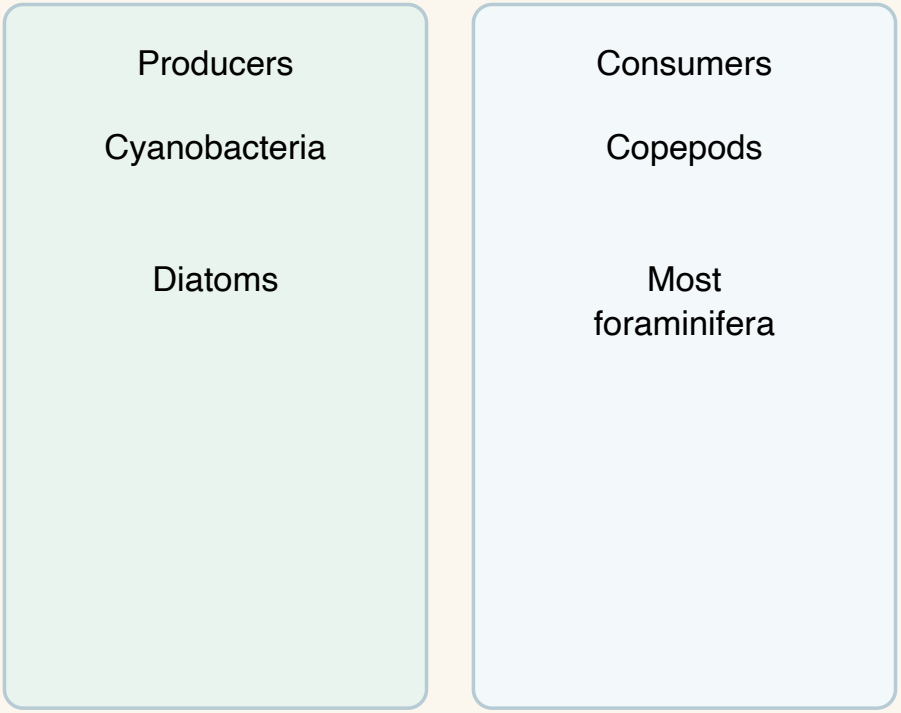
- Wikipedia: Foraminifera

22. Does the Exam Question Still Have One Right Answer?

Think it through: if dinoflagellates can act like producers or consumers, does the 2021 exam question still have one right answer?

Yes, for the four groups it actually named. Copepods and foraminifera were never in question. The real test was cyanobacteria and diatoms, both standard producer groups, and the exam treats them that way.

Dinoflagellates matter for a different reason. They show why examiners avoid naming a mixotroph, when a question needs one fixed answer. This is why “which of these is a producer” questions rarely name dinoflagellates. Their real answer depends on conditions, not one fixed label.



Option (b). Original explanatory diagram.

Sources:

- Wikipedia: Mixotroph
- Wikipedia: Dinoflagellate

The pattern examiners keep testing

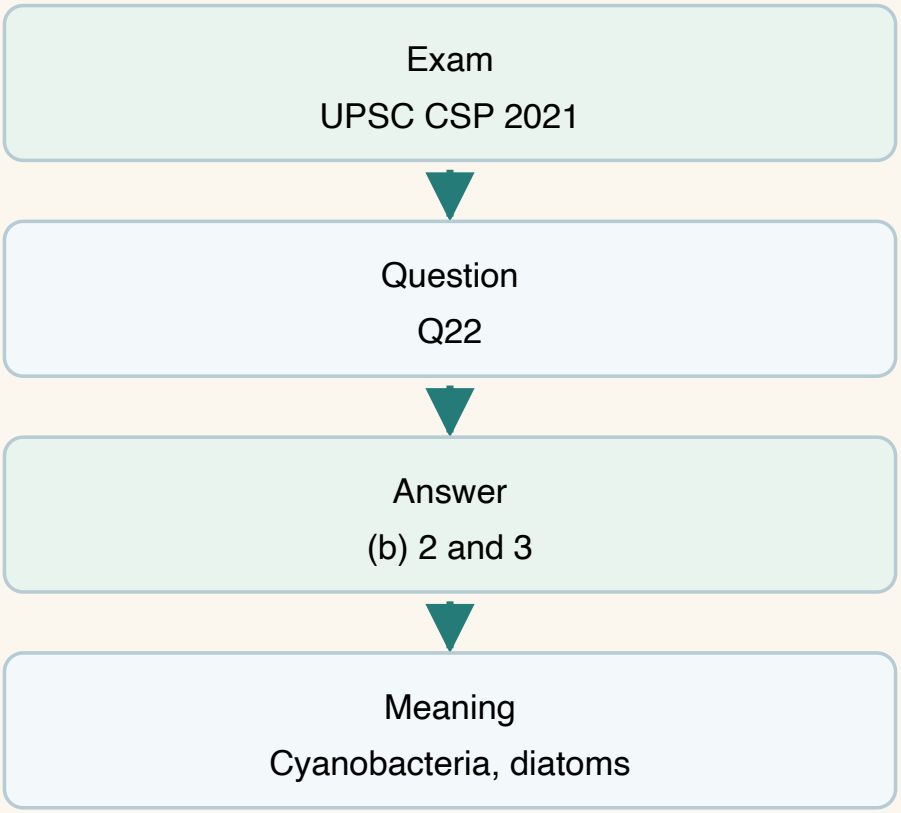
This topic gets tested by naming several similar-looking groups together, then asking which ones actually produce their own food.

23. How Did UPSC 2021 Ask It?

- UPSC CSP 2021, Q22: copepods, cyanobacteria, diatoms, and foraminifera. Which are primary producers?

UPSC Civil Services Prelims 2021, Question 22, listed four organisms: copepods, cyanobacteria, diatoms and foraminifera. It asked which are primary producers in the food chains of oceans.

The answer is (b), 2 and 3. These are cyanobacteria and diatoms. Option (a) wrongly adds copepods. Options (c) and (d) wrongly add foraminifera.



Learn the code and the names. Original explanatory diagram.

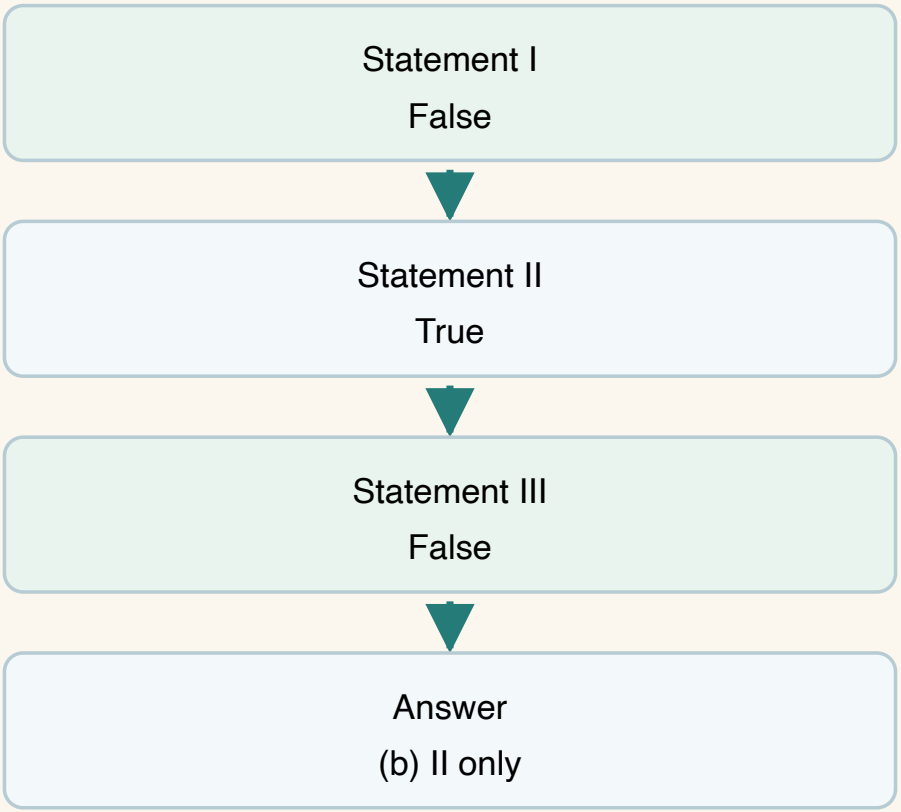
Sources:

- UPSC CSP 2021 General Studies Paper I
- mcqquestion.com: UPSC CSP 2021 paper

24. How Did UPSC 2025 Ask About Oxygen?

UPSC Civil Services Prelims 2025 gave three statements. Statement I said rainforests produce more oxygen than oceans. Statement II said marine phytoplankton and photosynthetic bacteria make about 50 per cent of the world's oxygen. Statement III said well-oxygenated surface water holds several times more oxygen than air.

The answer is (b), II only. Statement I is false. Statement III is false because water holds far less oxygen than air.



Two false traps. Original explanatory diagram.

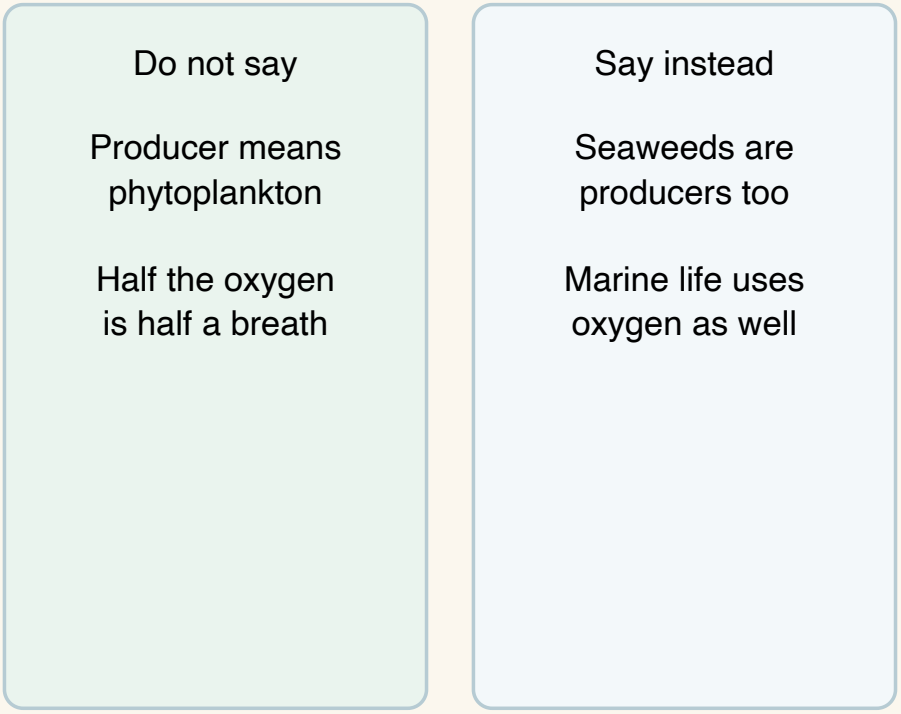
Sources:

- NOAA: ocean oxygen
- mcqquestion.com: UPSC CSP 2025 paper

25. Three Traps to Avoid

Do not say “primary producer” and “phytoplankton” mean the same thing. Seaweeds and seagrasses are producers too.

Do not call every photosynthetic-looking organism a pure producer. Mixotrophs like dinoflagellates can switch to being consumers. Do not read “half the oxygen” as “half of each breath”. NOAA says marine life uses about as much as the ocean makes.



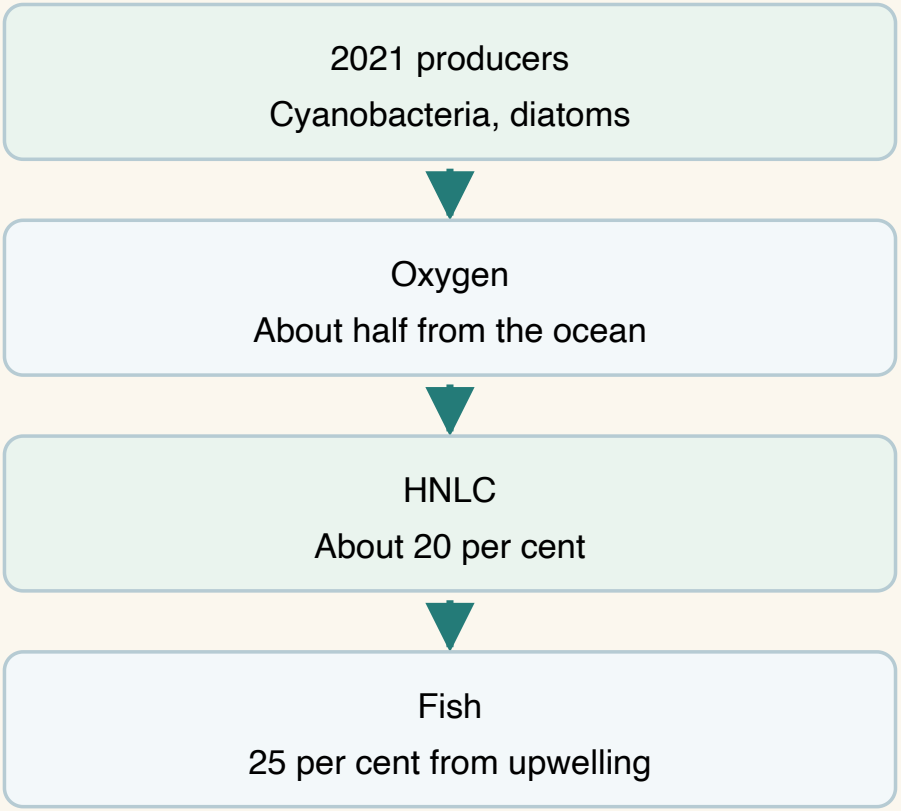
Check the wording. Original explanatory diagram.

Sources:

- Wikipedia: Marine primary production
- NOAA: ocean oxygen

26. Facts to Remember

- Producers in the 2021 question: cyanobacteria and diatoms.
- Consumers in the 2021 question: copepods and most foraminifera.
- Ocean share of oxygen production: about half.
- HNLC regions: about 20 per cent of the ocean. Iron is the missing nutrient.
- Upwelling areas: five of them give about 25 per cent of the fish catch from 5 per cent of the ocean.



A short memory list. Original explanatory diagram.

Sources:

- NOAA: ocean oxygen
- Wikipedia: Upwelling

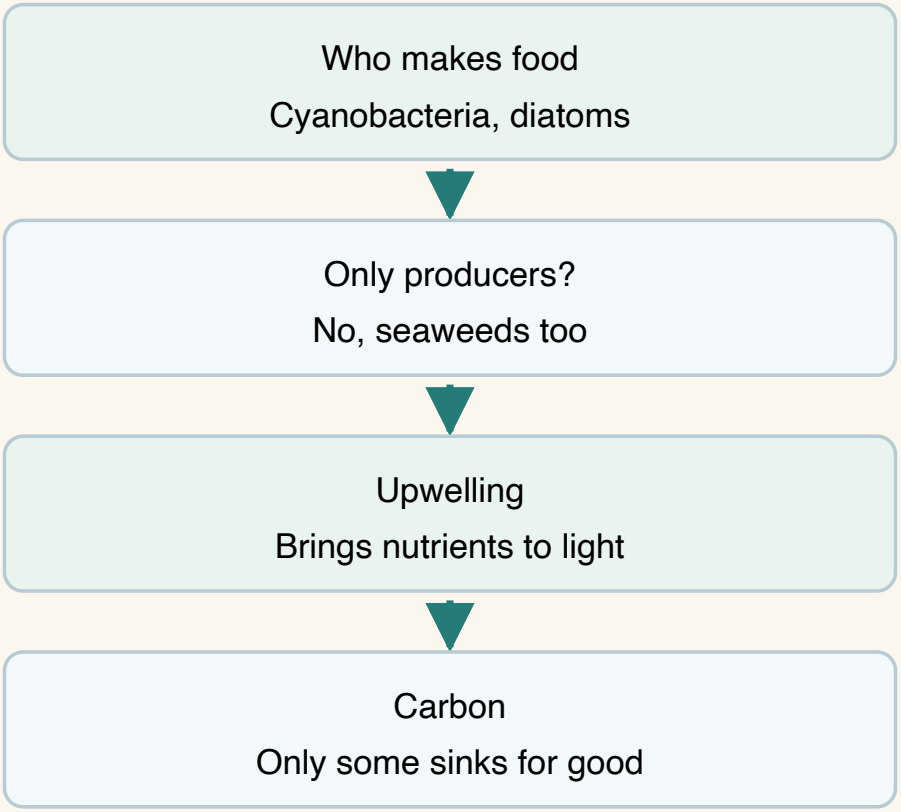
27. Quick Answers

Which two groups from the 2021 question actually make their own food? Cyanobacteria and diatoms. Both photosynthesize, unlike copepods or most foraminifera.

Are cyanobacteria and diatoms the ocean's only producers? No. Seaweeds and seagrasses also produce food, especially near the coast.

Why does upwelling matter for fisheries? It brings nutrients into sunlit water, so more phytoplankton can grow, which then feeds copepods and fish.

Does ocean photosynthesis lock carbon away for good? No. Most of that carbon returns to the water or air later. Only some sinks into long-term storage.



Short answers to learn. Original explanatory diagram.

Sources:

- NOAA: upwelling
- Wikipedia: Iron fertilization

Four questions to think through

The 2021 question did not name dinoflagellates. Why might examiners avoid them?

Many dinoflagellates photosynthesize and also eat prey. Their label depends on conditions. A question needs one fixed answer, so examiners name steady producers like cyanobacteria and diatoms.

The ocean makes about half of Earth's oxygen. Does that mean half of each breath comes from it?

No. NOAA says marine life consumes about as much oxygen as the ocean produces. Production is one number. What remains in the air is another.

Why can nutrient-rich water still hold little phytoplankton?

Phytoplankton also need iron. In HNLC regions, which cover about 20 per cent of the ocean, iron is scarce. So growth stays low despite plenty of other nutrients.

Why are upwelling zones so important for fishing?

Upwelling lifts nutrients to the sunlit surface. Phytoplankton grow, then copepods and fish follow. Five upwelling areas give about 25 per cent of the world's marine fish catch from 5 per cent of the ocean.

Check your understanding

Your 4 quick checks Answered 0 of · Correct
This score resets when the page reloads.

Continue to the 6 MCQs

Practise six MCQs on ocean producers

Try 6 practice questions on ocean producers, food chains, and oxygen production.

Practice MCQs

1. Consider copepods, cyanobacteria, diatoms, and foraminifera.

Which of these are primary producers in ocean food chains?

A. Cyanobacteria and diatoms

B. Diatoms and foraminifera

C. Copepods and cyanobacteria

D. Copepods and foraminifera

See answer ↓

2. What unique feature do diatoms have that distinguishes them among phytoplankton?

A. No cell wall at all

B. The ability to fly

C. A completely transparent body

D. A unique cell wall made of silicate

See answer ↓

3. Why are copepods classified as consumers rather than primary producers?

A. They are actually a type of algae

B. They photosynthesize like plants

C. They produce their own food from sunlight

D. They feed on phytoplankton like diatoms and cyanobacteria

See answer ↓

4. Most foraminifera obtain nutrition in which way?

A. Through photosynthesis like plants

B. By consuming algae, bacteria, and other small organisms

C. By absorbing sunlight directly

D. By fixing nitrogen from the air

See answer ↓

5. Roughly what share of Earth's oxygen do marine phytoplankton like cyanobacteria and diatoms produce?

A. About half

B. Nearly 100 percent

C. Less than 1 percent

D. About 5 percent

See answer ↓

6. With reference to the planet Earth, consider the following statements:

1. Rain forests produce more oxygen than that produced by oceans.

2. Marine phytoplankton and photosynthetic bacteria produce about 50% of world's oxygen.

3. Well-oxygenated surface water contains several folds higher oxygen than that in atmospheric air.

Which of the statements given above is/are correct? [UPSC CSP 2025]

A. I and II

B. II only

C. I and III

D. None of the above statements is correct

See answer ↓

Answer Key

1. **A.** UPSC 2021 asked this. Cyanobacteria and diatoms photosynthesize, so they are primary producers. Copepods are animals that eat plankton. Most foraminifera feed like consumers. ↑ Q1
2. **D.** A diatom's cell wall is made of silica. This glass-like wall is called a frustule. No other major phytoplankton group is defined by it. ↑ Q2
3. **D.** Copepods are small crustaceans. They cannot photosynthesize. Most free-living copepods eat phytoplankton, so they are consumers. ↑ Q3
4. **B.** Most foraminifera are heterotrophs. They eat smaller organisms and organic matter. A few host algae, but that is not the usual way they feed. ↑ Q4
5. **A.** NOAA says roughly half of the oxygen production on Earth comes from the ocean. Most of it comes from plankton. NASA's phytoplankton pages say the same. ↑ Q5
6. **B.** Only statement II is correct. Marine phytoplankton and bacteria make about half of the oxygen produced on Earth. Statement I is false because the ocean makes more than land forests. Statement III is false because water holds far less oxygen than air. ↑ Q6

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