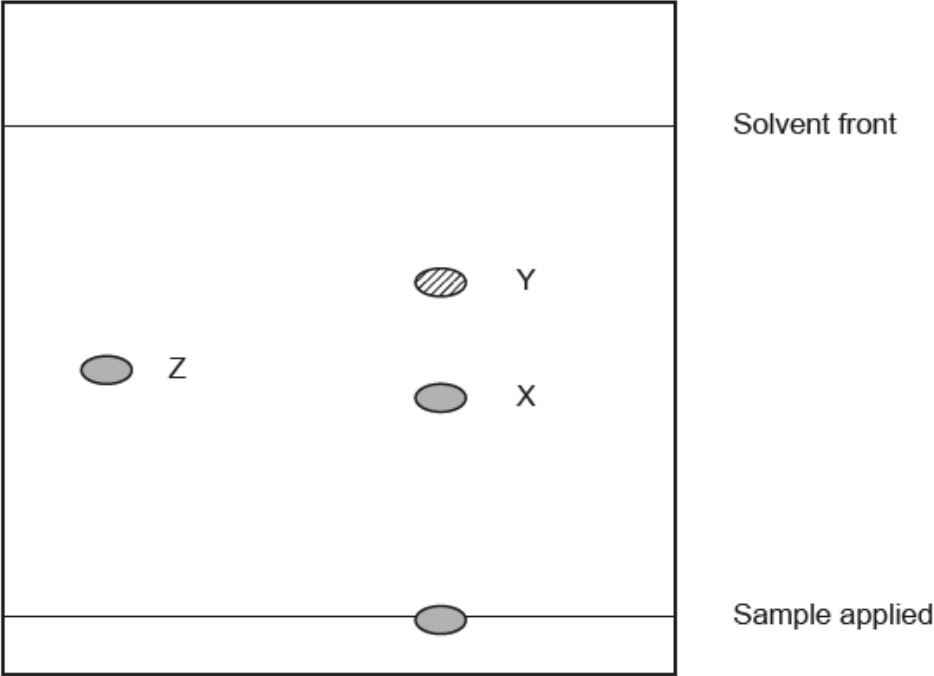


C1.3 Photosynthesis [45 marks]

1. [Maximum mark: 1]
The diagram shows a chromatogram of the pigments in a leaf.
Substance Z is known to have an R_f of 0.5.



Pigment	Colour	R_f
Carotene	Yellow	0.95
Phaeophytin	Yellow-grey	0.83
Chlorophyll <i>a</i>	Blue-green	0.65
Chlorophyll <i>b</i>	Green	0.45

What are pigments X and Y?

	X	Y
A.	Chlorophyll <i>a</i>	Phaeophytin
B.	Chlorophyll <i>a</i>	Carotene
C.	Chlorophyll <i>b</i>	Carotene
D.	Chlorophyll <i>b</i>	Chlorophyll <i>a</i>

[1]

2. [Maximum mark: 1]

Bromothymol blue is an indicator that is initially blue and turns yellow when CO₂ is present. Tests were carried out varying the presence of a plant (*Elodea canadensis*) and a snail (*Marisa cornuarietis*) in an aquatic environment. What condition would produce a blue colour after sampling the water?

- A. Plant kept in the dark without snail
- B. Plant and snail kept in the dark
- C. Plant kept in the light without snail
- D. Snail with no plant

[1]

3. [Maximum mark: 1]

What occurs during photosynthesis?

- A. Water is oxidized by releasing two electrons to NADPH.
- B. Glycerate-3-phosphate (GP) is oxidized by releasing two electrons to photosystem II.
- C. NAD is reduced by accepting two electrons from ATP.

D. NADP is reduced by accepting two electrons from photosystem I.

[1]

4. [Maximum mark: 1]

The Calvin cycle continues throughout the life of a plant. In this cycle, triose phosphate is produced, which is used to form glucose. In total, how many RuBP molecules are regenerated in the process of creating one glucose molecule?

A. 2

B. 6

C. 10

D. 14

[1]

5. [Maximum mark: 1]

Which group(s) produce(s) oxygen as a by-product of photosynthesis?

I. Algae

II. Cyanobacteria

III. Fungi

A. I only

B. I and II only

C. II and III only

D. I, II and III

[1]

6. [Maximum mark: 1]

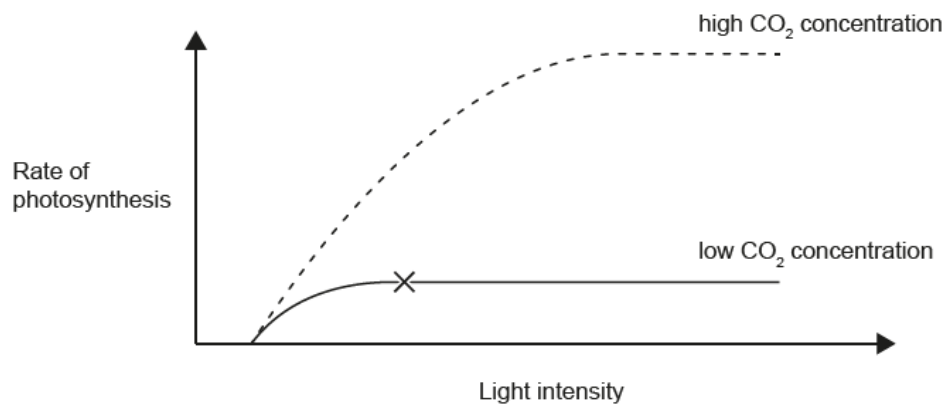
What is an advantage of free-air carbon dioxide enrichment experiments (FACE)?

- A. The carbon dioxide uptake by plants is controlled.
- B. Temperature can be controlled.
- C. Water can be controlled.
- D. Data can more accurately represent future rates of photosynthesis.

[1]

7. [Maximum mark: 1]

The graph shows the effect of light intensity on the rate of photosynthesis of a green plant at different CO_2 concentrations. The temperature is kept constant at 25°C .



What is the limiting factor at X?

- A. Chlorophyll
- B. CO_2 concentration
- C. Temperature
- D. Light intensity

[1]

8. [Maximum mark: 15]

All cells require a supply of energy and can transform the energy that they obtain in different ways.

- (a) Explain the properties of ATP that make it useful for distributing energy within cells. [3]
- (b) Describe how cells in plants use light energy to produce ATP. [7]
- (c) Compare and contrast how different types of heterotrophs obtain the energy that they need to produce ATP. [5]

9. [Maximum mark: 1]

Which of these energy conversions is/are possible in living organisms?

- I. Light to chemical
- II. Chemical to heat
- III. Heat to light

A. I only

B. I and II only

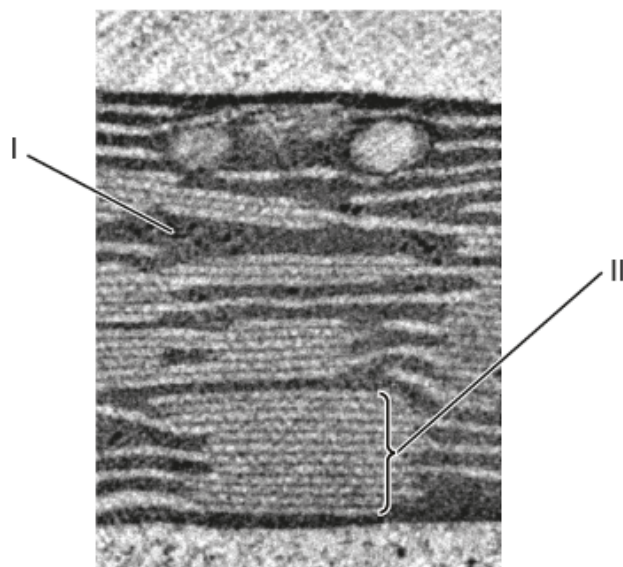
C. II and III only

D. I, II and III

[1]

10. [Maximum mark: 1]

The image shows part of a chloroplast and was produced by electron tomography.



[Source: Yuv345, 2020. 10-nm-thick STEM tomographic slice from a lettuce chloroplast. [image online] Available at: https://commons.wikimedia.org/wiki/File:Lettuce_Chloroplast_STEM.jpg. Source adapted.]

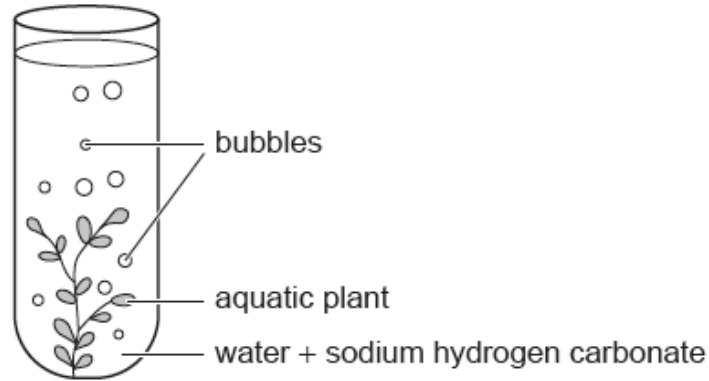
What is the name of I and which reactions of photosynthesis occur in II?

	Name of I	Reactions in II
A.	Matrix	Light-independent reactions
B.	Stroma	Light-independent reactions
C.	Matrix	Light-dependent reactions
D.	Stroma	Light-dependent reactions

[1]

11. [Maximum mark: 1]

A photosynthesis experiment was carried out using an aquatic plant. The image shows the contents of the test tube after being exposed to light and room temperature for 30 minutes.

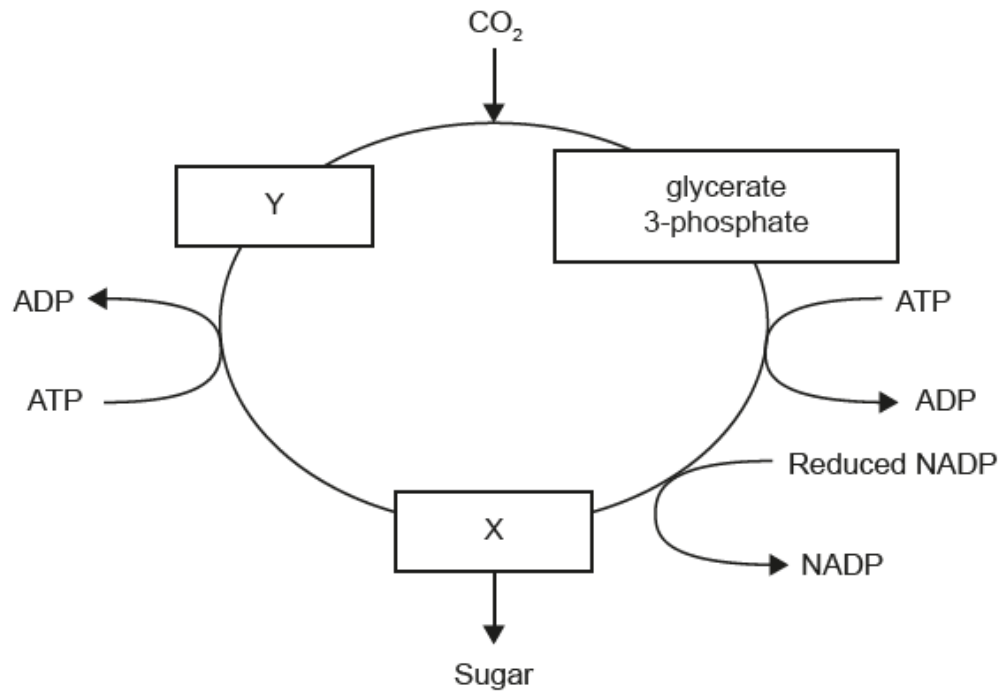


What explains the presence of bubbles?

- A. Oxygen is formed when carbon dioxide combines with chlorophyll.
- B. Carbon dioxide is formed during the light-dependent reaction.
- C. Oxygen is released when light splits water molecules in chloroplasts.
- D. Carbon dioxide is released from dissociation of sodium hydrogen carbonate.

[1]

- 12.** [Maximum mark: 6]
The diagram shows the Calvin cycle.



(a) Identify the molecules X and Y.

X: Y:	[2]
----------------------	-----

(b) A product of the Calvin cycle is transported in the phloem.

(b.i) State the name of the molecule that is transported.

[2]

[1]

.....

.....

.....

(b.ii) Explain how this molecule is transported from leaves to roots.

[3]

.....

.....

.....

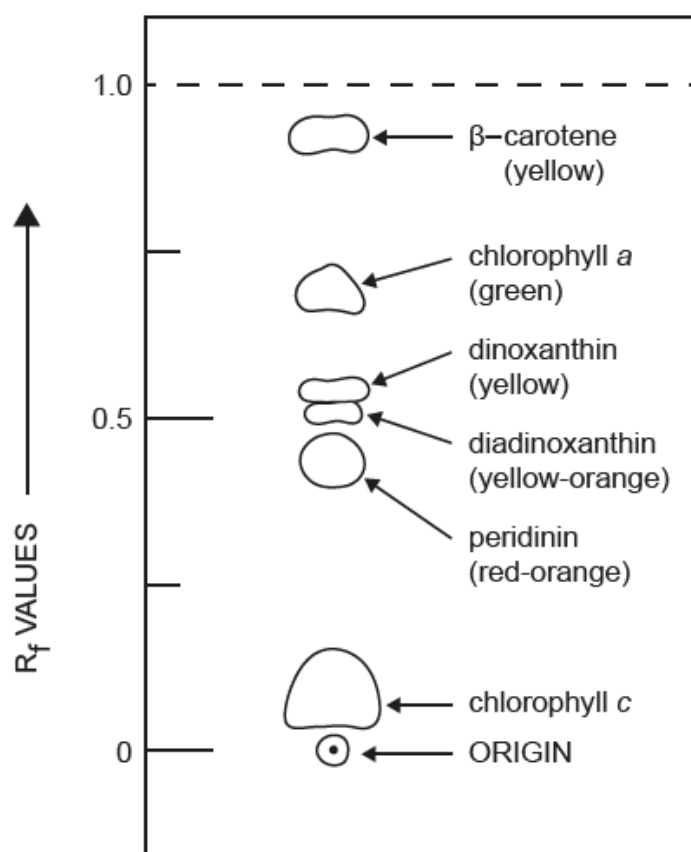
.....

.....

.....

13. [Maximum mark: 5]

The diagram represents the pigment fractions in a thin layer chromatography of the alga *Gambierdiscus toxicus*.



[Source: Indelicato, S.R. and Watson, D.A., 1986. Identification of the Photosynthetic Pigments of the Tropical Benthic Dinoflagellate *Gambierdiscus toxicus*. *Marine Fisheries Review* 48(4), pp. 44–47. Source adapted.]

- (a) Identify the pigment that is most soluble in the solvent used in the chromatography.

[1]

.....

.....

.....

- (b) Describe the process used to obtain this chromatogram.

[3]

.....

.....

.....

.....

.....

.....

- (c) State the equation used to obtain an R_f value.

[1]

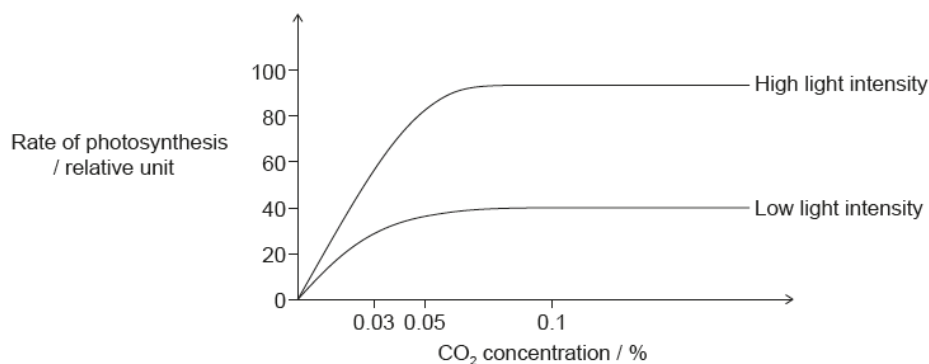
.....

.....

.....

14. [Maximum mark: 1]

The graph shows the effect of limiting factors on the rate of photosynthesis.



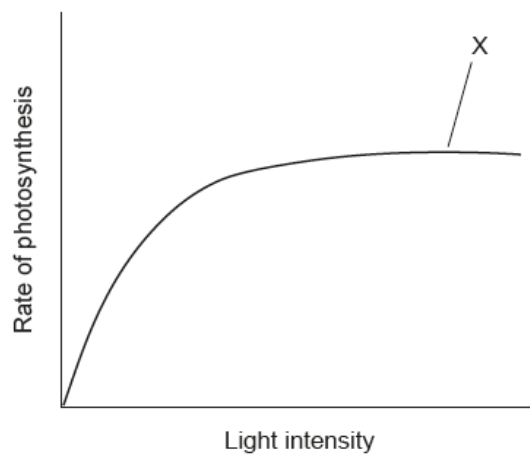
What can be concluded from this graph?

- A. At a CO_2 concentration of 0.1 % and a low light intensity, temperature is the only limiting factor.
- B. At a CO_2 concentration of 0.1 % and a low light intensity, light intensity is the only limiting factor.
- C. At a CO_2 concentration of 0.03 % and a low light intensity, both CO_2 concentration and temperature are limiting factors.
- D. At a CO_2 concentration above 0.1 %, there are no limiting factors.

[1]

15. [Maximum mark: 1]

The graph shows the effect of increasing light intensity on the rate of photosynthesis during an experiment carried out at optimum temperature and normal atmospheric CO_2 concentration.



Which factor could be limiting photosynthesis at point X on the graph?

- A. Light intensity
- B. Carbon dioxide concentration

C. Temperature

D. Nutrient availability

[1]

16. [Maximum mark: 1]

Which of the following processes require(s) ATP during photosynthesis?

I. The splitting of water molecules

II. The regeneration of ribulose biphosphate (RuBP)

III. The maintenance of a proton gradient between the thylakoid space and the stroma

A. I only

B. II only

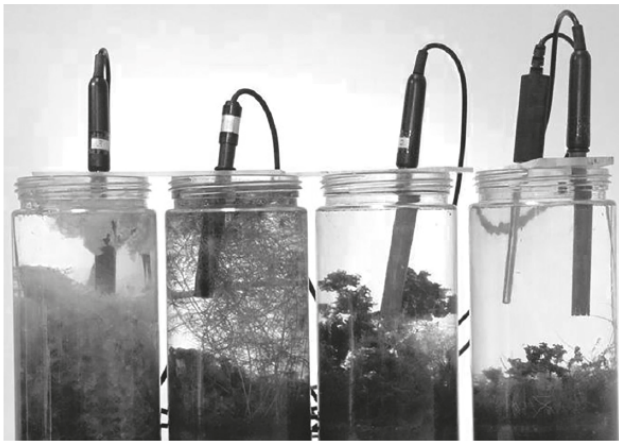
C. I and II

D. II and III

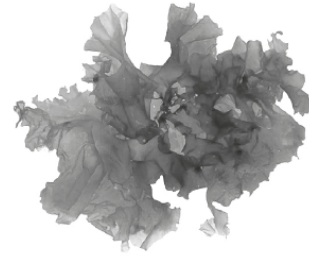
[1]

17. [Maximum mark: 5]

Growth rates of marine algae can be investigated using experimental mesocosms such as those shown.



Gracilaria, a red alga



Ulva, a green alga

[Source: Mosley, L., Reid, R., 2015. Figure 9. [image online] Available at:

https://www.researchgate.net/figure/Variation-in-mesocosmplant-composition-and-probes-for-continuous-monitoring-of-pH-Eh_fig5_328661328.

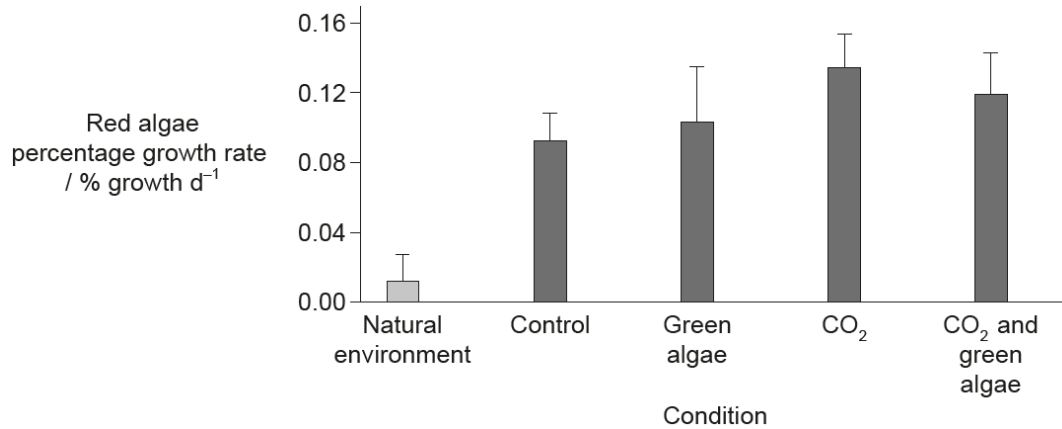
University of Hawai'i at Mānoa, 2003. *Grac parvis herb2*. [image online]. Available at:

http://www.hawaii.edu/reefalgae/invasive_algae/rhodo/grac%20parvis%20herb%202.jpg [Accessed 22 August 2019].

Novák, J., n.d. *Ulva lactuca L. – Sea Lettuce*. [image online] Available at: <https://www.biolib.cz/en/image/id7080/>

[Accessed 22 August 2019].]

Data are shown for percentage growth rates of red algae, grown in their natural environment and using mesocosms. The conditions investigated included competition from green algae and from elevated CO₂, as well as competition from green algae combined with elevated CO₂.



[Source: Young, C.S. and Gobler, C.J., 2017. The organizing effects of elevated CO₂ on competition among estuarine primary producers. *Nature*, [online] Available at: <https://www.nature.com/articles/s41598-017-08178-5> [Accessed 22 August 2019]. Source adapted.]

- (a) Outline the effect of elevated CO₂ on the percentage growth rate of the red algae.

[2]

.....

.....

.....

.....

.....

.....

- (b) Suggest a possible reason for the elevated percentage growth rates of red algae in the mesocosms compared with the percentage growth rate in their natural environment.

[1]

.....

.....

.....

- (c) Describe how the photosynthetic pigments in the algae can be identified.

[2]

.....

.....

.....

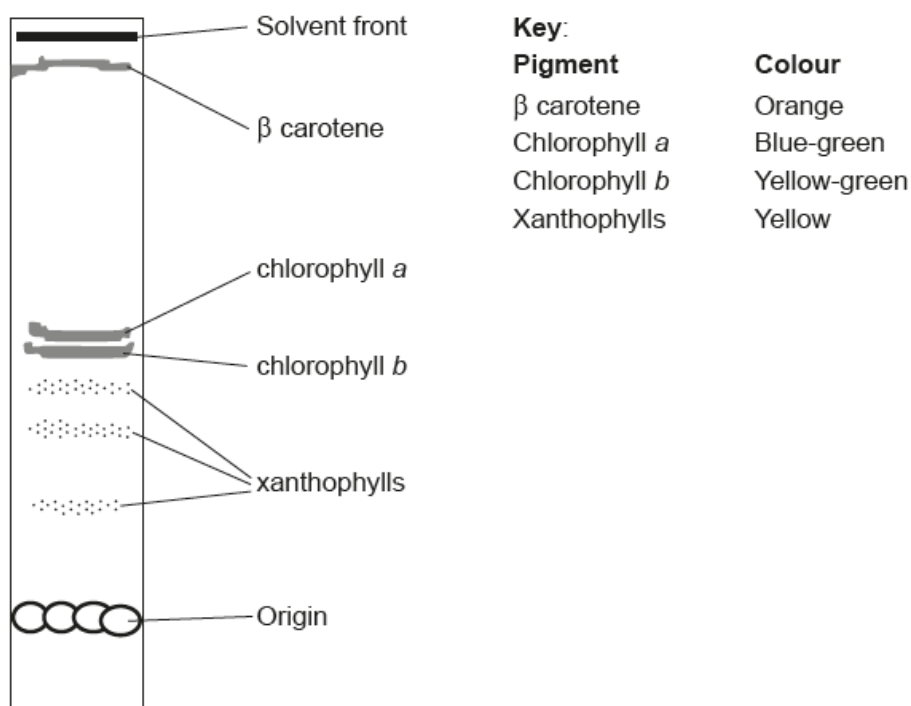
.....

.....

.....

18. [Maximum mark: 1]

The image shows the separation of photosynthetic pigments in a spinach leaf by thin layer chromatography and the colours that appear on a chromatogram.



[Source: Motten, AF, 1995. *Diversity of photosynthetic pigments*. [PDF online] Available at: <https://www.ableweb.org/biologylabs/wp-content/uploads/volumes/vol-16/6-motten.pdf> [Accessed 31 August 2022]. Source adapted.]

What colour is the pigment with Rf value 0.2?

- A. Yellow
- B. Yellow-green
- C. Blue-green
- D. Orange

[1]