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Hydrogels

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Hydrogels

Practice: 8 MCQs

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1. What is a hydrogel?

1.1 Water and a connected network

A hydrogel is a gel swollen with water, usually within a connected polymer network. A polymer is a large molecule built from repeating smaller units.

Crosslinks are connections that join parts of the network. The network holds its form while water enters and swells it.

Imagine a three-dimensional net holding water throughout its structure. This analogy explains the combination of water-rich material and a connected framework.

A hydrogel is therefore more than a puddle of water. Its network influences strength, swelling and the movement of substances through the gel.

True or False: Water alone is a hydrogel.

Sources:

- IUPAC: hydrogel
- Wichterle and Lím, 1960
- Tough hydrogels

2. Does every hydrogel contain 90% water?

2.1 Calculate the sample's water fraction

No. Water content depends on the material and its condition. A value near 90% describes some hydrogels, not a universal definition.

Different networks hold different amounts of water. A drying gel also loses water, changing its composition.

For a stated sample, water content by mass can be calculated directly:

Water percentage = water mass ÷ total hydrated-sample mass × 100.

Suppose a 100 g sample contains 90 g of water. Its water percentage is 90 ÷ 100 × 100 = **90%**.

Here, g means grams. Both masses must use the same unit. This calculation describes the sample, not every hydrogel.

True or False: The term hydrogel guarantees exactly 90% water by mass.

Sources:

- IUPAC: hydrogel

- Tough hydrogels
- FDA silicone-hydrogel lens record

3. How can a hydrogel control drug release?

3.1 Diffusion and designed release

A hydrogel can act as a carrier that releases a drug over time. The drug may sit within the network or interact with its polymer chains.

Diffusion means the spreading of molecules through random motion. A concentration difference can drive net movement from a more concentrated region to a less concentrated region.

The network's spacing can affect how readily a drug moves through it. Interactions between the drug and network also matter.

A designed carrier can slow release compared with an immediately available drug solution. However, controlled release does not always mean a perfectly constant release rate.

Some designs also use network breakdown or a response to an external trigger. The release pattern depends on the drug and the particular material.

Hydrogel-based drug delivery includes actual medical products. For example, Dextenza contains dexamethasone in a polyethylene-glycol-based hydrogel. The product illustrates a drug carried within an engineered gel.

True or False: Every hydrogel releases every drug at the same constant rate.

Sources:

- Diffusion through polymer gels
- Pulsatile drug-release hydrogel

- Stimulus-responsive hydrogels
- FDA Dextenza label
- Diffusion terminology

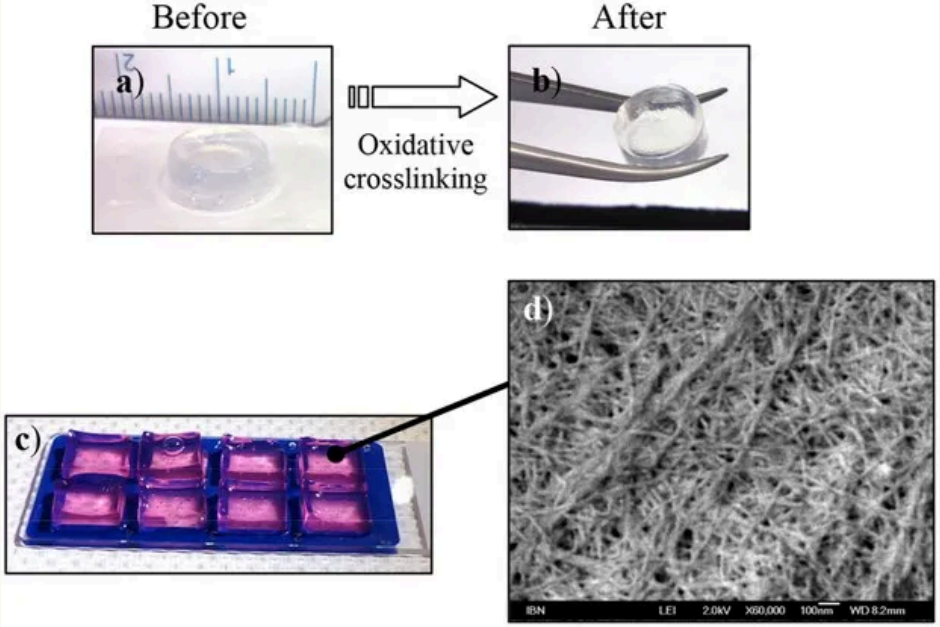
4. Why use hydrogels in wound dressings?

4.1 Moisture management depends on the dressing

Hydrogel wound dressings can help maintain moisture at a wound surface. This is one reason water-rich gels are useful in wound-care materials.

The dressing's composition and structure influence its performance. Findings from one experimental dressing cannot guarantee faster healing for every wound.

A hydrogel dressing also need not contain a drug. The gel itself can serve as a moisture-managing material.



An experimental hydrogel wound dressing. Image: Seow et al., Scientific Reports 6:32670 (2016), Wikimedia Commons, CC BY 4.0.

Sources:

- FDA hydrogel wound-dressing category
- Experimental peptide wound dressing

5. Why are hydrogels used in contact lenses?

5.1 Material properties affect performance

Hydrogel materials are used to make soft contact lenses. The lens must combine suitable shape, flexibility and optical performance.

Oxygen transmission through the lens also matters for the cornea. This is a material property that must be evaluated for the particular lens.

High water content alone does not tell us every lens's oxygen performance. Silicone-hydrogel lenses have a different material composition from conventional hydrogel lenses.

A historical milestone

Otto Wichterle and Drahoslav Lím published **Hydrophilic Gels for Biological Use** in **1960**. Their work on poly(2-hydroxyethyl methacrylate), or **PHEMA**, helped establish hydrogel materials for soft lenses.

True or False: All hydrogel contact lenses have identical oxygen-transmission properties.

Sources:

- FDA silicone-hydrogel lens record
- Wichterle and Lím, 1960

6. What do hydrogels offer tissue engineering?

6.1 Supporting cells in laboratory models

A scaffold is a supporting structure for cells. Hydrogel scaffolds can provide a water-rich, three-dimensional environment for laboratory cell growth.

Researchers can adjust the gel's structure to study cell movement and tissue formation. For example, hydrogel systems have supported networks of human bone cells in laboratory experiments.

A successful cell-culture experiment is not automatically a proven treatment in people. Tissue-engineering applications range from research models to specialised biomedical systems.

Sources:

- Hydrogel scaffolds for human bone-cell networks
- Hydrogel microinterfaces and cell migration

7. Can hydrogels cool surfaces or reduce friction?

7.1 Tested capability depends on conditions

Specially designed hydrogel systems have been studied for cooling and lubrication. These applications depend on the formulation and operating conditions.

In some cooling designs, stored water evaporates and removes heat. Other designs capture atmospheric moisture as part of a repeated cycle.

Hydrogel-based aqueous systems have also reduced friction in laboratory tests. Such results show lubrication capability in the tested system. They do not make every hydrogel a suitable industrial lubricant.

Likewise, a cooling experiment does not establish routine use in a vehicle's air-conditioning circuit. Research capability and established commercial use are different claims.

True or False: A laboratory cooling result proves routine use in car air-conditioning systems.

Sources:

- Hydrogel passive cooling
- Hydrogel moisture-capture properties
- Hydrogel-based aqueous lubricant
- Hydrogel surface-lubrication mechanism

9. Apply the distinction in exam questions

9.1 Distinguish an experiment from routine use

Controlled drug delivery is an established hydrogel application. Wound dressings and soft contact lenses provide further biomedical examples.

Read an application claim at the level stated. A specially designed research material is not evidence of routine use in every commercial system.

Retain the UPSC 2024 hydrogel question.

Sources:

Questions learners often ask

Why can a water-rich hydrogel keep a recognisable shape?

Its connected network provides structure. Water swells the network while the connections help hold the material together.

Is 90% water a definition or a sample property?

It is a sample property. Hydrogels differ in water content and material composition.

Does controlled release always mean constant release?

No. Controlled release means the system is designed to influence delivery. Its release rate can still change over time.

Why should an experimental application carry a qualification?

An experiment supports the specific material and conditions tested. It does not establish the same performance in every device or patient.

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

Continue to the 8 MCQs

Practice MCQs

1. A 100 g hydrated hydrogel sample contains 90 g of water. What is its water content by mass?

A. About 10%

B. About 50%

C. About 90%

D. About 25%

See answer ↓

2. Which description best identifies a hydrogel?

A. A dry metal mesh

B. Any liquid that contains a dissolved drug

C. A gel swollen with water, usually within a polymer network

D. Pure water without a supporting network

See answer ↓

3. What is the role of crosslinks in a hydrogel?

A. They guarantee one fixed water percentage

B. They connect parts of the supporting network

C. They make all gels identical

D. They turn every drug into water

See answer ↓

4. Why can two hydrogels release the same drug at different rates?

A. Every gel must release drugs at a constant rate

B. Water never affects drug movement

C. The word hydrogel specifies one release schedule

D. Their network spacing and drug interactions can differ

See answer ↓

5. Which function explains a use of hydrogel wound dressings?

A. Guaranteeing faster healing for every wound

B. Removing the need to evaluate a formulation

C. Replacing every other wound-care material

D. Helping maintain moisture at the wound surface

See answer ↓

6. Which statement about hydrogel contact lenses is correct?

A. They can differ in oxygen-transmission properties

B. Every lens contains exactly 90% water

C. Only water content determines every lens property

D. A hydrogel lens needs no performance evaluation

See answer ↓

7. A hydrogel supports human cell growth in a laboratory.

Which conclusion follows directly?

A. The tested material can support cells under the studied conditions

B. Every hydrogel has identical cell effects

C. The material cures all human tissue damage

D. The scaffold needs no further testing

See answer ↓

8. A study demonstrates hydrogel cooling on a test surface. What further claim requires separate evidence?

A. The study tested a particular cooling design

B. Water can be present in the studied gel

C. The material is routinely used in vehicle air-conditioning systems

D. The experiment has defined operating conditions

See answer ↓

Answer Key

1. **C.** Water content is water mass divided by total hydrated-sample mass, multiplied by 100. Here, 90 ÷ 100 × 100 gives 90%. The other percentages do not match the stated masses. This example does not imply that every hydrogel contains 90% water. ↑ Q1
2. **C.** A hydrogel combines water with a gel network, usually made from polymers. Pure water lacks that network. A dry metal mesh contains no swelling water, and a drug solution need not form a gel. ↑ Q2
3. **B.** Crosslinks connect the network and help maintain its structure during swelling. They do not prescribe one universal water fraction or make every gel identical. Their role is structural, rather than converting drugs into water. ↑ Q3
4. **D.** Network spacing and interactions can alter how readily a drug moves through a gel. Different designs can therefore produce different release patterns. Controlled release does not require every material to follow the same constant rate. ↑ Q4
5. **D.** Hydrogel dressings can help manage moisture at the wound surface. Their performance depends on the formulation and the wound context. This use does not establish universal superiority or guarantee faster healing in every case. ↑ Q5
6. **A.** Hydrogel lenses differ in composition and design, which affect their performance. Oxygen transmission must be evaluated for the particular lens. Neither the word hydrogel nor one water-content figure specifies every optical and material property. ↑ Q6
7. **A.** The experiment supports a conclusion about the tested material and conditions. Laboratory cell growth does not by itself establish a treatment for patients. Different gel structures and compositions can produce different cell responses. ↑ Q7
8. **C.** A test demonstrates performance within its stated design and conditions. Routine use in vehicle air-conditioning systems is a separate deployment claim. Cooling research alone does not establish that commercial use. ↑ Q8

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