UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6633518797

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **May/June 2010**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs, or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions in Section A and **one** question from Section B.
Circle the number of the Section B question you have answered in the grid below.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **19** printed pages, **3** lined pages and **2** blank pages.

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Section A

For Examiner's Use

Answer **all** the questions.

1 The flatback turtle, *Natator depressus*, is an endangered species that nests on northern Australian beaches.

Fig. 1.1 shows a flatback turtle.

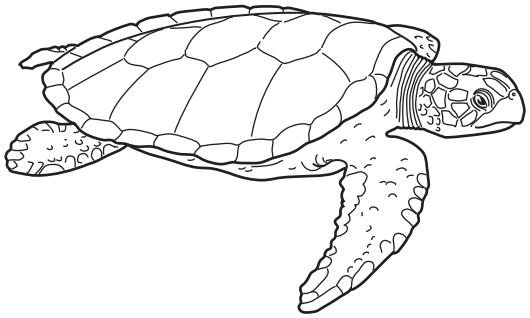


Fig. 1.1

Each female lays approximately 50 eggs per nest, which is a smaller number than all other species of marine turtle. The eggs are buried in the sand and when the hatchlings emerge each has a mass of approximately 43 g. Unlike most marine turtles, flatback turtles spend most of their time in coastal waters. This is where they feed and mate.

Fig. 1.2 shows the numbers of female flatback turtles nesting on a beach in northern Australia between 1993 and 2002.

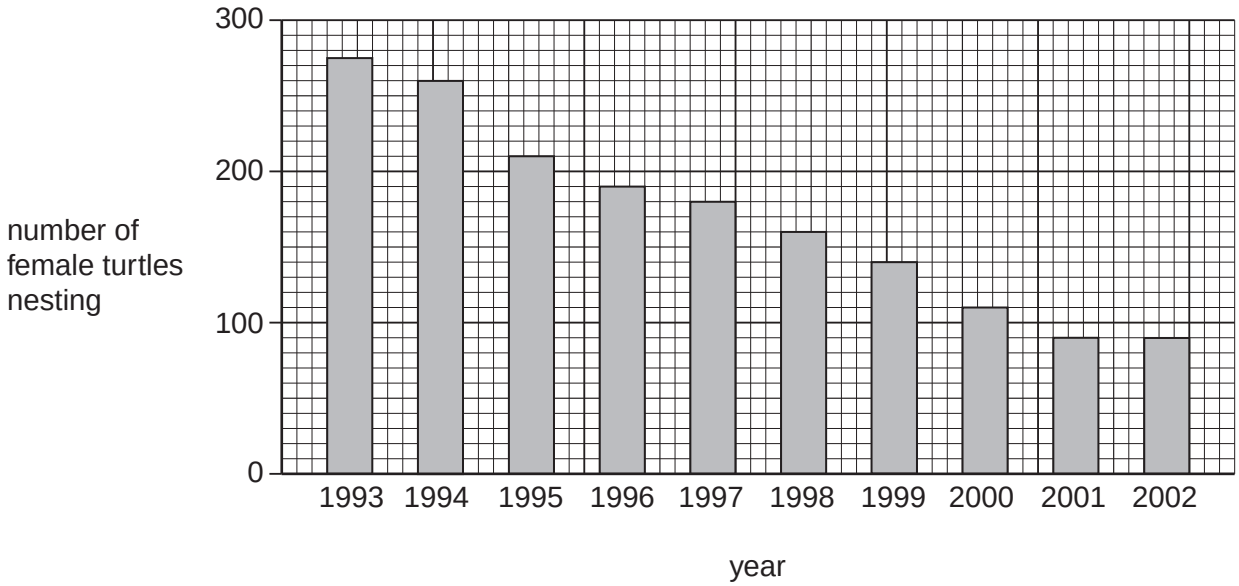


Fig. 1.2

(a) Calculate the mean **rate** of decrease in the numbers of females nesting between 1993 and 2002.

For Examiner's Use

Show all the steps in your calculation.

Answer..... [2]

(b) Suggest ways in which the flatback turtle could be protected.

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..... [5]

[Total: 7]

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[Turn over

2 **(a)** The glycoproteins CD28 and CD40 are found on the surface of T-lymphocytes (T-cells). They are binding sites for cell-signalling molecules and are essential for triggering the cloning of T-cells in an immune response.

For Examiner's Use

A monoclonal antibody (mAb), which could block the CD40 signalling pathway, was produced from hamsters using the hybridoma method.

Outline the procedure, starting with a hamster, for producing mAbs suitable for use in another mammal, such as a mouse.

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..... [4]

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(b) The ability of the mAb produced in **(a)** to prevent rejection of transplanted hearts in mice was compared with that of a protein, **P**, which blocks the CD28 signalling pathway.

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Four groups of mice were treated as follows:

- group **A** – no treatment
- group **B** – treated with protein **P** only
- group **C** – treated with mAb only
- group **D** – treated with both mAb and protein **P**.

Fig. 2.1 shows the percentage survival of the transplanted hearts in the four groups of mice over a period of 80 days.

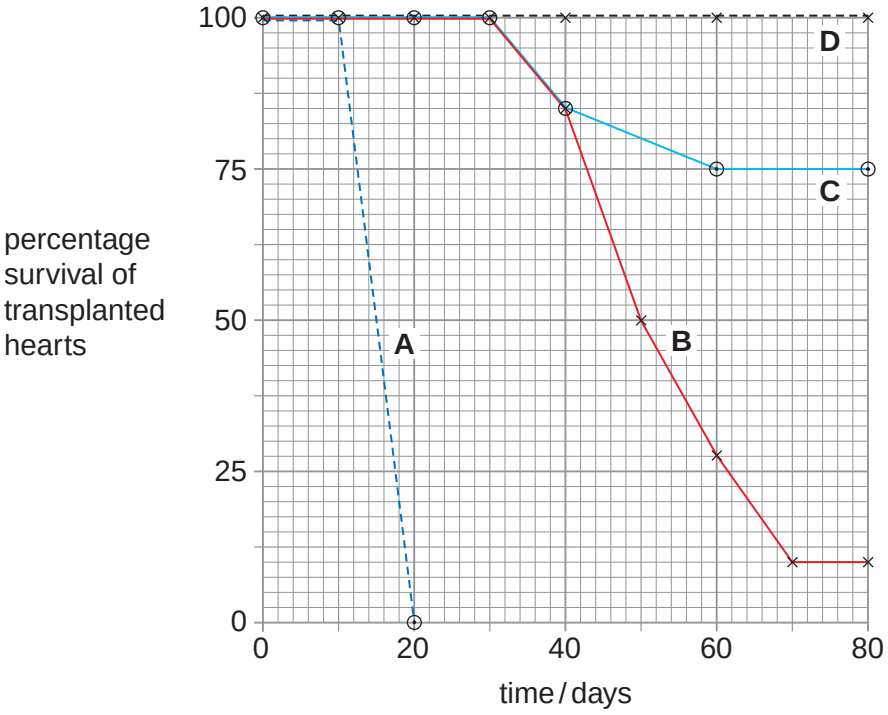


Fig. 2.1

With reference to Fig. 2.1

(i) describe the effectiveness of the four different treatments

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..... [4]

For Examiner's Use

(ii) suggest an explanation for the differences in survival of the transplanted hearts in groups **B** and **D**.

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(c) Examination of the transplanted hearts showed that the hearts in group **A** had significant damage to their coronary arteries, whereas in group **D** these blood vessels appeared normal.

Explain the importance of the coronary arteries of the heart.

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..... [3]

(d) State two uses of mAbs in humans, other than preventing rejection of transplanted tissue.

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2. .....

..... [2]

[Total: 15]

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3 Fig. 3.1 shows the structure of part of a seminiferous tubule of a human testis.

For Examiner's Use

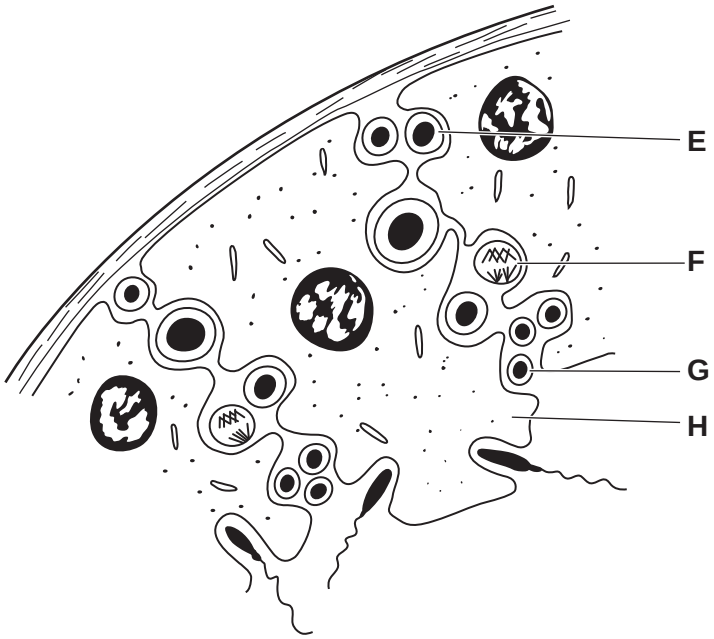


Fig. 3.1

(a) Name cells **E** to **H**.

E .....

F .....

G .....

H ..... [4]

(b) Describe how cell **F** is produced from cell **E** in the process of spermatogenesis.

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..... [4]

[Total: 8]

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4 Fig. 4.1 is a photomicrograph of a transverse section through the leaf of a C4 plant.

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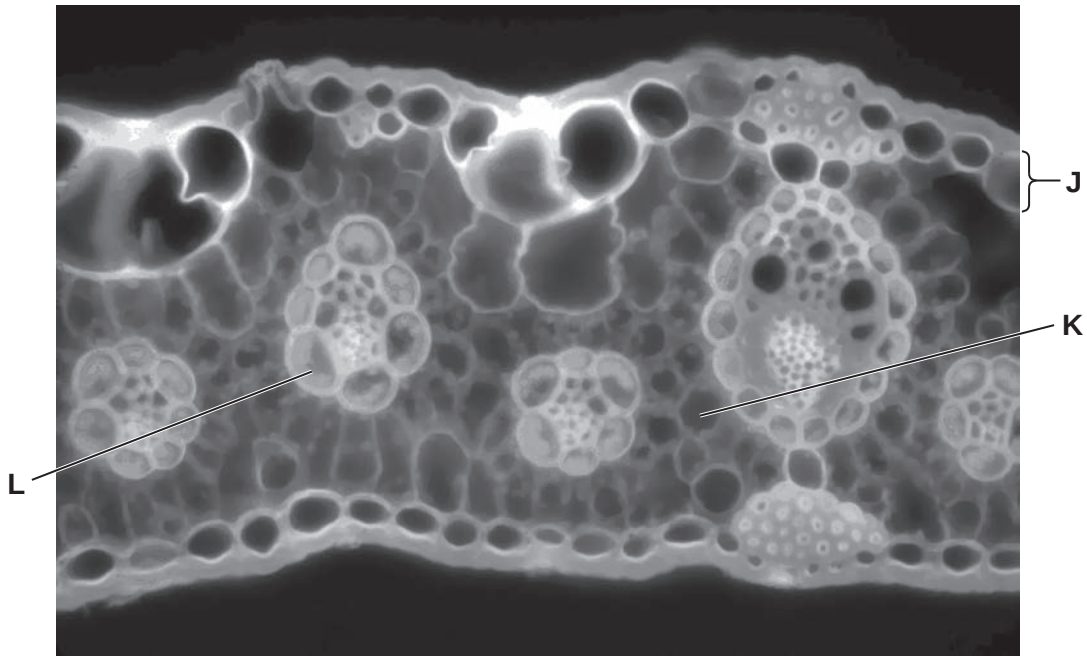


Fig. 4.1

(a) (i) Identify structures **J** to **L**.

J .....

K .....

L ..... [3]

(ii) Outline how this leaf anatomy adapts the plant for high rates of carbon fixation at high temperatures.

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For Examiner's Use

(b) Sorghum is a C4 plant and *Sorghum bicolor* is a major food crop in dry tropical regions. The leaves of *S. bicolor* are covered with a layer of wax made up of a mixture of esters and free fatty acids, with a melting point of 77–85 °C. Waxes from the leaves of non-tropical plants tend to have melting points lower than this. For example, wax from the bayberry, *Myrica* sp., has a melting point of 45 °C.

Suggest how the wax on sorghum leaves helps the plant to survive in dry, tropical regions.

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..... [2]

(c) An investigation was carried out into the response of sorghum to being kept at a low temperature for a short period of time. Soybean plants, which are better adapted than sorghum for growth in subtropical and temperate climates, were used for comparison.

Plants of sorghum and soybean were kept at 25 °C for several weeks and then at 10 °C for three days. The temperature was then increased to 25 °C again for seven days. Day length, light intensity and carbon dioxide concentration were kept constant throughout.

The uptake of carbon dioxide, as mg CO_2 absorbed per gram of leaf dry mass, was measured

- at 25 °C before cooling
- on each of the three days at 10 °C
- for seven days at 25 °C.

The results are shown in Table 4.1.

Table 4.1

plant	carbon dioxide uptake / mg CO_2 g^{-1}				
	at 25 °C, before cooling	at 10 °C			at 25 °C (mean over days 4 to 10)
		day 1	day 2	day 3	
sorghum	48.2	5.5	2.9	1.2	1.5
soybean	23.2	5.2	3.1	1.6	6.4

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For Examiner's Use

(i) Compare the **changes** in carbon dioxide uptake in sorghum and soybean during the three days at 10 °C.

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..... [2]

(ii) During the cooling period, the ultrastructure of the sorghum chloroplasts changed. The membranes of the thylakoids moved closer together, eliminating the spaces between them. The size and number of grana became reduced.

Explain how these changes could be responsible for the low rate of carbon dioxide uptake by sorghum even when returned to a temperature of 25 °C.

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..... [4]

[Total: 15]

5 Anole lizards are found throughout the Caribbean and the surrounding mainland. There are many species. Each species is found only on one island or a small group of islands, apart from *Anolis carolinensis* which is found in mainland Florida.

For Examiner's Use

Fig. 5.1 shows the distribution of four species of anole lizards.



Fig. 5.1

An investigation was carried out into the relationships between these four lizard species, using DNA analysis. The base sequences of a region of mitochondrial DNA from the four species were compared. The results are shown in Table 5.1.

The smaller the number, the smaller the differences between the base sequences of the two species.

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Table 5.1

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	A. brunneus			
A. brunneus		***A. smaragdinus***		
A. smaragdinus	12.1		***A. carolinensis***	
A. carolinensis	16.7	15.0		***A. porcatus***
A. porcatus	11.3	8.9	13.2	

(a) With reference to Table 5.1, state the species to which *A. brunneus* appears to be most closely related.

..... [1]

(b) The researchers put forward the hypothesis that the three species, *A. brunneus*, *A. smaragdinus* and *A. carolinensis*, have originated from three **separate** events in which a few individuals of *A. porcatus* spread directly from Cuba to three different places.

Explain how the results in Table 5.1 support the researchers' hypothesis.

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(c) Explain how a population of *A. porcatus* that became isolated on an island could evolve into a new species.

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[Total: 8]

For Examiner's Use

6 **(a)** Explain what is meant by the term *gene mutation.*

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(b) Rickets is a childhood disorder involving the softening and weakening of bones. It is usually caused by a lack of vitamin D, calcium ions or phosphate ions. A rare form of rickets that cannot be successfully treated with vitamin D therapy is caused by a mutant allele on the X chromosome.

Fig. 6.1 shows a pedigree chart for a family that has a history of this condition.

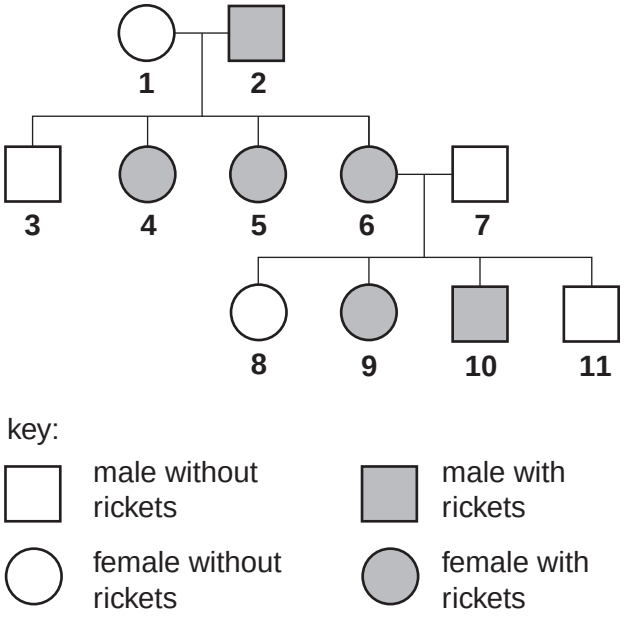


Fig. 6.1

Using the symbols

X^R for the mutant allele on the X chromosome
X^r for the non-mutant allele on the X chromosome

state the genotypes of the following individuals.

1 .....

3 .....

9 .....

10 ..... [4]

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(c) The gene in which this mutation occurs codes for a protein found in the cells of the proximal convoluted tubule of the kidney. This protein is involved in phosphate ion transport across membranes.

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Suggest why individuals with this mutant allele show symptoms of rickets.

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..... [2]

[Total: 8]

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For Examiner's Use

7 **(a)** The initial stages of respiration convert one molecule of glucose into two molecules of a 3C compound.

State

(i) the name given to these initial stages

..... [1]

(ii) where these stages occur in cells

..... [1]

(iii) the **total** number of ATP molecules formed during these stages.

..... [1]

(b) Most of the ATP formed in respiration is produced within the mitochondria by oxidative phosphorylation.

(i) State the location, in the mitochondrion, of oxidative phosphorylation.

..... [1]

(ii) Outline the process of oxidative phosphorylation.

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..... [5]

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[Turn over

(c) In an investigation, mammalian liver cells were homogenised (broken up) and the resulting homogenate centrifuged. Samples of the complete homogenate and samples containing only nuclei, only ribosomes, only mitochondria or only the remaining cytosol were incubated with:

1 glucose

2 pyruvate

3 glucose and cyanide

4 pyruvate and cyanide

Cyanide inhibits oxidative phosphorylation.

After incubation the presence or absence of carbon dioxide and lactate in each sample was determined.

The results are summarised in Table 7.1.

Table 7.1

	samples of homogenate									
	complete		only nuclei		only ribosomes		only mitochondria		only cytosol	
	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate
1 glucose	✓	✓	✘	✘	✘	✘	✘	✘	✘	✓
2 pyruvate	✓	✓	✘	✘	✘	✘	✓	✘	✘	✓
3 glucose and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓
4 pyruvate and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓

✘ = absent ✓ = present

(i) With reference to Table 7.1, name the two organelles not involved in respiration.

1. .....

2. ..... [1]

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(ii) Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but **not** when they are incubated with glucose.

For Examiner's Use

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(iii) Explain why, in the presence of cyanide, lactate is produced but carbon dioxide is not.

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[Total: 16]

For Examiner's Use

8 **(a)** Cystic fibrosis (CF) is an inherited disease.

(i) Explain briefly how two parents who do not have CF may have a child with CF.

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..... [2]

(ii) Describe **two** ways in which CF affects the lungs.

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..... [2]

(b) One potential way of treating CF is by using gene therapy.

(i) Outline, with reference to CF, what is meant by *gene therapy.*

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..... [2]

(ii) Describe one possible advantage and one possible disadvantage of using gene therapy to treat CF.

advantage .....

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disadvantage .....

..... [2]

[Total: 8]

Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Explain how the palisade mesophyll cells of a leaf are adapted for photosynthesis. [8]

(b) Outline the light-independent stage of photosynthesis. [7]

[Total: 15]

10 **(a)** Describe the structure of a kidney nephron and its associated blood vessels. [7]

(b) Explain how glomerular filtrate is formed. [8]

[Total: 15]

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