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INTERNATIONAL EXAMINATIONS

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

GCE Advanced Subsidiary Level and GCE Advanced Level

# MARK SCHEME for the November 2003 question papers

## 9700 BIOLOGY

| | |
|---|---|
| **9700/01** | **Paper 1 (Multiple Choice), maximum raw mark 40** |
| **9700/02** | **Paper 2 (Theory 1), maximum raw mark 50** |
| **9700/03** | **Paper 3 (Practical 1), maximum raw mark 25** |
| **9700/04** | **Paper 4 (Theory 2 (A2 Core)), maximum raw mark 50** |
| **9700/05** | **Paper 5 (Practical 2 (A2)), maximum raw mark 30** |
| **9700/06** | **Paper 6 (Options (A2)), maximum raw mark 50** |

These mark schemes are published as an aid to teachers and students, to indicate the requirements of the examination. They show the basis on which Examiners were initially instructed to award marks. They do not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the *Report on the Examination*.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2003 question papers for most IGCSE and GCE Advanced Level syllabuses.

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INTERNATIONAL EXAMINATIONS

**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 40

SYLLABUS/COMPONENT: 9700/01

BIOLOGY
Paper 1 (Multiple Choice)

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| *Question Number* | *Key* | *Question Number* | *Key* |
|---|---|---|---|
| 1 | **C** | 21 | **B** |
| 2 | **A** | 22 | **A** |
| 3 | **C** | 23 | **D** |
| 4 | **B** | 24 | **D** |
| 5 | **C** | 25 | **A** |
| 6 | **A** | 26 | **D** |
| 7 | **D** | 27 | **A** |
| 8 | **A** | 28 | **C** |
| 9 | **C** | 29 | **A** |
| 10 | **A** | 30 | **D** |
| 11 | **C** | 31 | **D** |
| 12 | **D** | 32 | **C** |
| 13 | **B** | 33 | **C** |
| 14 | **B** | 34 | **B** |
| 15 | **D** | 35 | **C** |
| 16 | **B** | 36 | **C** |
| 17 | **D** | 37 | **C** |
| 18 | **C** | 38 | **B** |
| 19 | **C** | 39 | **D** |
| 20 | **A** | 40 | **B** |

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**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9700/02

BIOLOGY
Paper 2 (Theory 1)

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## KEY

| | |
|---|---|
| a semi colon ; | indicates a separation of marking points |
| an oblique line / | indicates alternative wording or acceptable alternative |
| R | means reject |
| A | means accept |
| AW | means 'alternative wording' |
| underlined with a straight line | accept this word only, no alternative word is acceptable |
| **D** | represents quality mark(s) awarded for diagrams, as indicated on the Mark Scheme |
| **L** | represents mark(s) awarded for labels on diagrams, as indicated on the Mark Scheme |
| ora | or reverse argument accepted. |

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| Question | Expected Answers | Marks |
|---|---|---|
| 1 (a) | thicker wall;<br>smaller / narrower lumen;<br>more muscle / more elastic tissue / more / thicker tunica media;<br>ref to 'crinkly' / crenulated / wavy / folded, lining / endothelium / tunica intima; R. epithelium<br>ref to wall to diameter ratio e.g. thicker wall to diameter ratio;<br>more collagen fibres / more tunica adventitia / externa;<br>circular / rounded shape compared to irregular shape;<br>A. converse points for vein | **max 3** |
| (b) | provide a large surface area / surface area to volume ratio;<br>for gas exchange / carbon dioxide out and oxygen in;<br>short diffusion distance across capillary wall / one cell thick capillary wall / 1-2μm c. wall / thin endothelium; R. epithelium R. thin wall unqualified<br>small size enables blood to be as close as possible to lung cells / air in alveolus / capillaries in close contact with alveolus (wall);<br><br>(so) diffusion is efficient / takes place easily / maximises efficiency of diffusion; | **max 3** |
| (c) | destroys / paralyses / inhibits / weakens cilia; R. kill<br>mucus glands / goblet cells produce more mucus;<br>tar contains carcinogens / chemicals which damage DNA / genes / oncogenes;<br>ref cancer / tumour;<br>epithelium / lining replaced by scar tissue; | **max 3** |
| | | **[Total 9]** |

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| Question | Expected Answers | Marks |
|---|---|---|
| 2 (a) | 14 147; | 1 |
| (b) | 3.74%; | 1 |
| (c) | more energy available at lower trophic levels / less energy available at higher levels / energy lost between trophic levels;<br>any two figs from fig. 3.1 to qualify above statement (comparison req, no units needed);<br>therefore can sustain a larger population;<br>greater variety of food / not have to rely on one food source;<br>less chance of starvation / more chance of survival / less competition for food;<br>may feed on detritus / dead organisms / waste materials (dead leaves, faeces, urine); | max 2 |
| (d) | breakdown / decay / feed on / digest / secrete hydrolytic enzymes onto, organic molecules / dead plant / animal / excreted / egested, material; R. decomposing<br>starch / cellulose, to sugars;<br>respire;<br>release carbon dioxide;<br>protein to amino acids;<br>deamination (of amino acids);<br>(release) ammonia ($NH_3$) / ammonium ions ($NH_4^+$) / ammonium compounds / ammonification;<br>(becomes available for) nitrification / ammonia -> nitrite -> nitrate / ammonia -> nitrates / ammonium -> nitrates;<br>R. nitrifying / named bacteria unqualified / ammonia -> nitrite | max 4 |
| | | [Total 8] |

| Question | Expected Answers | Marks |
|---|---|---|
| 3 | *Vibrio cholerae / V. cholerae*; (correct spelling required) ignore upper case / lower case<br>diarrhoea (phonetic spelling req); A. vomiting / 'rice water' only R. loss of fluid / loss of water and salts<br>(contaminated) food / water; R. drinks R. cooking utensils<br>immune response;<br>antibodies / immunoglobulins; | |
| | | [Total 5] |

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**Question** **Expected Answers** **Marks**

**4 (a)** *one mark per row*

| statement | starch | glycogen | cellulose |
|---|---|---|---|
| glycosidic bonds between monomers | ✓ | ✓ | ✓ |
| monomer is β glucose | ✗ | ✗ | ✓ |
| stored within chloroplasts | ✓ | ✗ | ✗ |
| stored in muscle cells | ✗ | ✓ | ✗ |
| exists in two forms - branched and unbranched chain | ✓ | ✗ | ✗ |

Do not penalise where <u>all</u> ✗ <u>or</u> ✓ s are omitted
Do penalise each row if a mixture of ✗ , ✓, and blanks

**5**

**(b)** take samples at <u>timed</u> intervals e.g. every minute;
test with iodine <u>solution</u> / potassium iodide <u>soln</u> / **or** Benedicts ;
determine the end point, eg continue until no blue / black (colour) / yellow / brown appears **or** continue until brick red / colourless ;
<u>time</u> taken to reach end point e.g. record the time;
ref to use of colorimeter (for precise results) (for both experiments) **or** standards / green -> yellow -> orange -> red;
plot amount of starch remaining **or** glucose / maltose / reducing sugar produced / transmission / absorption against time / sketch graph with labelled axes;
ref to initial rate / rate calculation (e.g. $^1/_t$ or gradient from graph);

**max 4**

**[Total 9]**

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| Question | Expected Answers | Marks |
|---|---|---|

**5 (a)** *max 3 for glycoproteins and carrier proteins combined*

*glycoproteins*
receptors / receptor molecules;
for hormones / neurotransmitters / named hormone / neurotransmitter (e.g. insulin, acetyl choline, noradrenaline);
idea of (cell surface) antigens / (cell surface) markers / cell recognition / cell adhesion;
help to stabilise membrane structure / forms H bonds with water molecules;

*carrier proteins*
allow named substance (e.g. glucose / amino acids) / polar substance / ion(s) / hydrophilic / water soluble substance (to pass through membrane);
(ref) against concentration gradient / active transport;
energy / ATP (req for transport);
(and) facilitated diffusion / faster than simple diffusion (for ions / polar molecules);

*cholesterol*
maintains / regulates fluidity of membrane / prevents membrane being too rigid or fluid / mechanical stability (qualified) / prevent ions / polar / water soluble / named molecule, passing / leaking through membrane;

**max 4**

**(b)** *max 3 for each of the following*
**A**
active transport;
carrier / transport protein;
(pumped) against concentration gradient / low to high conc;
using energy / ATP;
detail (eg binding to specific receptor sites / idea of conformational change);
**B**
diffusion; R. facilitated difffusion
ATP not used; R. energy not needed
through lipid bilayer / phospholipids / hydrophobic region;

**max 4**

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| Question | Expected Answers | Marks |
|---|---|---|
| 5 (c) | (bacteria) adhere / stick / bind / attach , to surface (of phagocyte);<br>ref to receptors / receptor proteins (on phagocytes) / (detect) bacteria 'marked' by antibodies / opsonins;<br>ref to pseudopodia / extensions of cytoplasm; R. invagination unqualified<br>engulfed / enveloped / endocytosis / phagocytosis, to form vacuole / vesicle / phagosome;<br>A. marking points from annotated diagram(s) | max 2 |
| (d) | contain (hydro)lytic / digestive / named enzymes / digestion of bacteria / pathogens; | 1 |
| | | [Total 11] |

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| Question | Expected Answers | Marks |
|---|---|---|
| 6 (a) | greater / increased / more demand for energy / ATP;<br>in muscles;<br>aerobic respiration; | max 2 |
| (b) | oxygen debt; R. deficit A. dept<br>lactate / lactic acid;<br>respired in the liver; A. heart<br>converted to glucose / pyruvate / glycogen;<br>(re)oxygenation of myoglobin;<br>(re)oxygenation of haemoglobin;<br>increased / still high rate of, metabolism / respiration (after exercise); | max 4 |
| (c) | rejection / ref to immune system; R. may not match unqualified<br>shortage of donors;<br>shortage of, trained personnel / appropriate facilities;<br>idea of high cost of surgery / aftercare / drugs; A. expensive<br>greater risk of surgery; | max 2 |
| | | [Total 8] |

Total mark for paper = 50

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**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 25

SYLLABUS/COMPONENT: 9700/03

BIOLOGY
Paper 3 (Practical 1)

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| Qn | G | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|
| 1 a i | | W1 less than W2 & W3;<br>W2 most sugar;<br>W3 less than W2; **but see additional guidance**<br><br>W4 brick red/ most sugar indicated;<br>W5 less than S4;<br>W6 less than S4 & S5; | 4 | Check order with supervisor's notes for W1 W2 and W3<br>Please write SC in margin if mark scheme is modified to match Supervisors Comments.<br><br>6correct = 4 5 =3 4=2 3 = 1 |
| 1 a ii | | 1 glucose solution made up to 10;<br>1 new solution made up to 2; | 1<br>1 | |
| 1 a iii | | 3 from:<br>same volume of juice;<br>same volume of reagent;<br>heat for same amount of time;<br>at same temperature; | max 3 | |
| 1 a iv | | standards or comparison; | 1 | Reject control or fair test |
| 1 b | | order of concentrations in fruits correct;<br>correct value range for S1;<br>correct value range for S2;<br>correct value range for S3; | 1<br>1<br>1<br>1 | Read range from student's table of results. |
| 1 c | | non reducing sugar / not a quantitative test; | 1 **15** | |
| 2 a | | Plan diagram with no cells and at least 5 clear single lines;<br>Upper epidermis labelled;<br>palisade tissue labelled;<br>spongy mesophyll labelled;<br>lower epidermis labelled;<br>stoma labelled;<br>vascular / AW, tissue labelled; | max 6 | |
| 2 b | | **palisade** **spongy mesophyll**<br>long / narrow /cubical round / ± rounded ;<br>large small ;<br>chloroplasts no / few chloroplasts ;<br>packed loose ;<br>large vacuole smaller/less defined vacuole; | max 4<br>**10** | Reject non comparative statements.<br>Leaf upside down then max 2 |
| | | | **Paper25** | |

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**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9700/04

BIOLOGY
Paper 4 (Theory 2 (A2 Core))

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**Question 1**

**(a)** **1** sun leaves reach compensation point / zero gas exchange at higher light intensity;
**2** rate of photosynthesis increases more rapidly in sun leaves ;
**3** $CO_2$ uptake is greater in shade leaves (ora) at low light intensity ;
**4** higher rate of photosynthesis / $CO_2$ uptake in sun leaves (ora) at higher light intensity ;
**5** more respiration in sun leaves (ora) at zero or low light intensity;
**6** $CO_2$ uptake levels off in shade leaves (ora) ; **3 max**

*accept $CO_2$ uptake for photosynthesis and vice versa*
*accept $CO_2$ production for respiration and vice versa*

**(b)** light no longer limiting ;
some other factor limiting ;
example carbon dioxide concentration / temperature / ref:chlorophyll ; **3**

**(c)** at low light intensity little or no effect / light (dependent reaction) limiting rate ;
at high light intensity increasing temperature will increase the rate of photosynthesis ;
ref. (effect of temperature on the rate of) enzyme controlled reactions / light independent stage ;
detail – e.g. named enzyme (RuBISCO) / ref. Calvin Cycle ;

*ignore reference to sun / shade leaves* **3 max**

**Total : 9**

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**Question 2**

**(a)** cytoplasm ;
matrix in mitochondria ; **2**

**(b)** coenzyme ;
carries electrons / protons / hydrogen ions / hydrogen / H / 2H / $H^+$ ; **R** $H_2$
to electron transfer chain / AW ;
from glycolysis / link reaction / Krebs cycle ;
role of NAD in conversion / oxidation of triose phosphate to pyruvate in glycolysis ;
role of NAD in anaerobic respiration ; **3 max**

**(c)** in absence of oxygen electron transfer chain does not work ;
oxygen final acceptor at end of electron transfer chain ;
reduced NAD cannot be oxidised ; **3**

**(d)** aerobic respiration produces more ATP / (ora);
to produce the same amount of ATP more glucose broken down in glycolysis ;
glycolysis is the only part of respiration used / no ETC or oxidative phosphorylation ; **2 max**

**Total : 10**

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**Question 3**

**(a)**
increases rapidly / sharply ;
to a maximum of 7.0 - 7.5 / a rise of approximately 3 ;
then falls below original value ;
recovering from 240 minutes / AW ; **3 max**

**(b)**
**(i)**
increase in glucose stimulates beta cells ;
in islets of Langerhans / pancreas ; **2**
**(ii)**
as glucose level drops ;
beta cells no longer stimulated / insulin secretion stops ;
Insulin is broken down ; **2 max**

**(c)**
secreted by alpha cells ;
when blood glucose levels low ;
cause glycogen to be converted to glucose ;
raise blood glucose ;
correct ref: negative feedback / idea that glucagons action is opposite to insulin ; **3 max**

**Total : 10**

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**Question 4**

**(a)** parental genotype ;
gametes ;
offspring genotype ;
offspring phenotype ;
*penalise once if other symbols used* **4**

**(b)** suffer from vitamin K deficiency / require too much vitamin K ; **1**

**(c)** warfarin will kill rats without resistance - homozygous recessive ;
homozygous dominant rats require too much vitamin K ;
heterozygous rats most likely to survive and produce offspring ;
only 50% of offspring will be heterozygous ; **3 max**

**(d)** results in a different codon / triplet ;
(may) result in change of amino acid ;
different primary protein structure ;
this may result in change in protein function ;
suitable example e.g. sickle cell anaemia ; **3 max**

**Total : 11**

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**Question 5**

**(a)** globin / protein to amino acids ;
haem to iron ;
iron stored / reused ;
residue / remainder to bile pigments / biliverdin / bilirubin ;
pass into bile ;
excreted ; **4 max**

**(b)** $NH_2$ / amino group removed ;
to ammonia ;
and keto acid / oxo produced ;
ref: ammonia to urea ; **3 max**

**(c)** *alternative mark schemes*

**1** ethanol / alcohol ;
oxidized ; **R** broken down
to ethanal / acetaldehyde in ;
ref: respiration / fat synthesis;

**OR**

**2** ammonia ;
combines with CO2 ;
to produce urea ;
via ornithine cycle ;

**OR**

**3** lactate ;
oxidised ;
by dehydrogenase ;
to pyruvate ;

**OR**

**4** hydrogen peroxide ;
to water and oxygen ;
by catalase ; **R** hormones **3 max**

**Total : 10**

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**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 30

SYLLABUS/COMPONENT: 9700/05

BIOLOGY
Paper 5 (Practical 2 (A2))

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| Qn | G | Expected Answers | Marks | Additional Guidance |
|---|---|---|---|---|
| 1 a | | Table headed **time** with units**;**<br>Table headed **distance** travelled with units;<br>5 realistic measurements recorded between 1 – 100 mm; | 1<br>1<br>1 | Reject fractions of a mm |
| 1 b i | | answer correct = 2;;<br>working correct but wrong answer =1; | 1<br>1 | Must be mm $min^{-1}$ |
| 1 b ii | | $CO_2$ absorbed by soda lime;<br>Oxygen used by peas / respiration;<br>$CO_2$ given off by peas;<br>Reduced pressure / volume moves liquid; | 1<br>1<br>1<br>1 | |
| 1 c i | | Temperature change;<br>RQ < 1 / correct description of RQ; | max 1 | |
| 1 c ii | | RQ = $CO_2$ / $O_2$;<br>bi / 10 – 0.02 ---------- ; bi / 10<br>answer correct ; | 1<br>1<br>1 **13** | Accept bi – 0.2 ---------- bi |
| 2 a | | Quality (ie does it look like the slide?) with glomerulus & tubule and cells;<br>Both glomerulus and tubule drawn;<br>Circular glomerulus with podocytes shown;<br>Tubule with nuclei < 0.5 - > 0.1glomerulus width;<br>Bowmans capsule labelled;<br>Podocyte labelled;<br>Nucleus labelled;<br>Glomerulus OR tubule labelled | max 5 | Please refer to photomicrograph of kidney made from a typical UCLES slide. |
| 2 b | | 130 – 300;<br>µm; | 1<br>1 **7** | |
| 3 | | 10 from<br>1 Correct use of equipment;<br>2 Range of at least three suitable temperatures;<br>3 Mix / add milk and renin;<br>4 Same vols of milk and renin for each temp;<br>5 Leave for same time / time measured;<br>6 Repeat;<br>7 Average determined;<br>8 Indication of positive result;<br>9 Method of recording data;<br>10 Scientific knowledge ie kinetic energy of molecules;<br>11 Would it work? | 10 | Reject boiling |
| | | | **Paper30** | |

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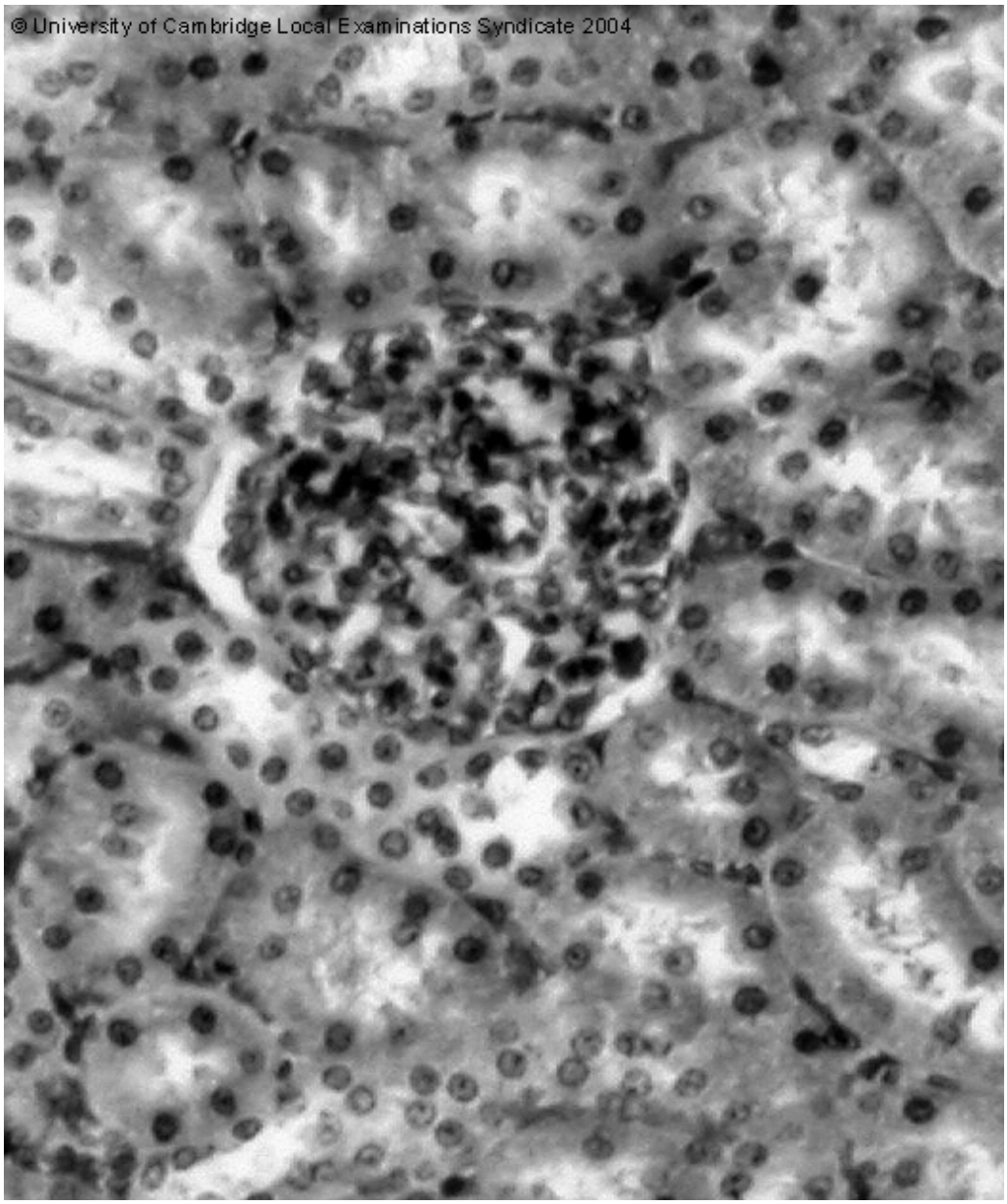


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**November 2003**

**GCE AS/A LEVEL**

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9700/06

BIOLOGY
Paper 6 (Options (A2))

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## Option 1 - BIODIVERSITY

**1** (a) (i) A (spore) capsule;
B thallus / leaf;
C rhizoid; 3

(ii) H labelled anywhere other than seta and capsule;
D labelled anywhere on seta / capsule; 2

(iii) rhizoids / C;
no true, roots / stems / leaves or thalloid A thallus;
sporophyte composed of capsule and seta; max 1

(b) (i) any **two** of: temperature / light intensity / air movements /
growth medium / named component of medium / $CO_2$ concentration; 2

(ii) *R. loreus* grows more slowly than *D. majus* in almost all conditions;

both species grow faster in high humidity;
this effect greater for *D. majus;*
except at 1W1D;

both species grow faster, when watered for more continuous period /
in 6W6D;
this effect greater for *D. majus /* this effect decreases for *R. loreus*
as watering regime gets longer;

appropriate figs; (accept converse throughout) max 3

(c) (bryophytes have) no cuticle;
so water (vapour) lost from surfaces (more easily);
rate of loss greater at lower humidities;

(bryophytes) do not have, vascular tissue / xylem;
(so) water transport less efficient / cannot replace lost water efficiently;

no true roots / only have rhizoids;
so cannot absorb water so effectively; max 4

**Total 15**

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**2** (a) (i) *feature drawn in correct position **and** labelled*
cell wall **and** cell (surface) / plasma, membrane **and** nucleus;
chloroplast;
starch grains (in chloroplast);
vacuole(s);
cellulose (cell wall);
pyrenoid; max 4

(ii) answer in range x 2000 to x 15000;
(A) scale line / bar, between 2mm and15mm per 1 μm 1

(b) (i) cilia;
macro- and micronucleus;
cytostome;
(definite shape due to) pellicle; max 3

(ii) *Vorticella* gains organic nutrients / glucose / sugar from *Chlorella / C* photosynthesises;
*Chlorella* gains nitrogen source / other named substances, from *Vorticella;* 2

(c) (i) need light;
for photosynthesis; 2

(ii) release oxygen (from photosynthesis); 1

(d) animal feed;
(spread onto land as) fertiliser;
produce, biogas / methane; 2 max

**Total 15**

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**3** (a) (i) high biodiversity;
ref to wide range of genetic variety;
(many) species / plants / animals, can only live in these forests;
danger of <u>many</u> species becoming extinct if habitat lost;
undiscovered species could be source of
new medicines / drugs / genes;

loss may increase soil erosion;
as tropical rainforests grow in areas of high rainfall;
as tropical rainforests grow in areas of on thin soils;

loss could affect (local or global) climate;
as their transpiration affects humidity of air;
if forests are lost then (may be) less rainfall;

because they take carbon dioxide from atmosphere;
can be considered to be carbon sinks;
loss could result in global warming; max 6

(ii) growing human populations ;
expectations of higher standard of living;
clear land for, agriculture / cash crops / raiding / AW;
slash and burn / plantations;
wood used for fuel;
logging;
tropical hardwoods have high value;
clear land for building, towns / roads; max 6

(iii) make reserves;
qualified (e.g. description of types of reserves);
reserves need to be, large / linked;

ecotourism;
provides money that can be used for conservation;

international ban on trade in endangered (rainforest) species / CITES;
example of rainforest species listed in CITES;
quotas/international regulations, on use of wood from rainforests;
educate consumers (so they can choose not to buy it);
provide international aid to countries with tropical rainforests;

find ways of making sustainable use of tropical rainforests;
allow only selective felling;
limit quantity of timber felled per time period; max 8

**Total 20**

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**3** (b) (i) diploblastic / wall composed of only two layers of cells;
acoelomate;
ectodermis + endodermis;
mesogloea;
radial symmetry;
single opening / mouth;
tentacles;
enteron / gut cavity;
lined with flagellated cells;
and enzyme-secreting cells;
nematocysts / cnidocytes;
musculo-epithelial cells;
nerve net / nerve cells (in mesogloea);
polymorphism; max 8

(ii) heterotrophic;
is a predator / carnivorous / captures (small) animals / feeds on zooplankton;

nematocysts / cnidocytes, capture prey;
detail of action;
tentacles push prey into gut cavity;
digestion occurs within gut cavity;

enzymes secreted / extracellular digestion;
detail, e.g. flagella help mixing;
intracellular digestion; max 6

(iii) cnidarian has larger surface area to volume ratio (than fish);
cnidarian has, only two layers of cells / small body;
every cell in contact with water;
(so) $O_2$ / $CO_2$ diffuses, to / from water, directly in / out of cells;

fish needs gills to increase area for gas exchange;
(so) $O_2$ / $CO_2$ can diffuse to / from water to / from blood;
most of fish body surface is not permeable;

fish is more metabolically active than cnidarian;
fish moves, more / faster;
therefore greater respiration rate in fish;
needs oxygen supplied at faster rate; max 6

**Total 20**

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## Option 2 - BIOTECHNOLOGY

**1** (a) ref reduction of disease;
specific relevant example e.g. cholera / typhoid;
reduced, pollution / eutrophication;
improved, potability / taste / smell;
AVP / e.g. fluoride to reduce tooth decay; max 3

(b) (i) aerobic vs. anaerobic;
(R aerobic unqualified)
(R anaerobic unqualified) 1

(ii) secondary treatment / follows sedimentation;
(aerobic) respiration;
bacteria / fungi / named e.g.;
ciliated protozoa / nematode worms / named e.g.;
remove organic matter; max 3

(iii) methanobacterium / methanococcus / methanothrix;
(anaerobic) respiration / fermentation;
(produces) methane and carbon dioxide;
with traces of $H_2S$ / $H_2O$ / $H_2$;
AVP; max 3

(c) (i) need light;
for photosynthesis; 2

(ii) release oxygen (from photosynthesis) 1

(d) animal feed / single cell protein;
(spread on land as) fertiliser;
produce biogas / methane; max 2

**Total 15**

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**2** (a) feeding the worlds hungry by increasing agricultural production;
making it cheaper to grow crops, so they are affordable;
making it easier to grow crops;
making new foods with desirable characteristics / e.g. improved taste / appearance / nutritional value;;
waste used to produce a product; max 3

unknown long term health effects e.g.allergies;
introduced for the benefit of the producer / less regard for consumer, e.g. transportation / longevity;
use of pesticides, qualified;
use of antibiotics, qualified;
use of growth hormones, qualified;
idea of gene leakage to other species;
reduction of genetic diversity, qualified; max 3

(b) demonstrate that the product is safe;
compare it with its conventional counterpart;
more transparent to the public;
overcome fears; max 2

(c) contains no genetically engineered ingredients;
not grown using inorganic / chemical fertilisers / named fertiliser;
not grown using pesticides; max 2

(d) farmers can choose the optimal time to spray / only need to spray once;
less glyphosate is needed;
compared with selective weedkillers;
using fewer chemicals is beneficial for the environment;
saves energy;
lower use of farm machinery;
higher crop yield ;
improved crop quality;
efficiency in terms of manpower; max 5

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**3** (a) (i) the pregnancy rate is high;
experience of parenthood is shared by the couple;
one parent has a biological link to the child;
genetic link to the child;

male can attend insemination;
simple / painless procedure;
does not require surgery / stay in hospital;

public opinion in favour of process;
anonymity of donor;
some couples prefer to adoption;
can be used if male is fertile but carries a known genetic disease;
max 6

(ii) some people / religious groups opposed to process;
naturally / ethically, wrong;
feelings of guilt / relationship to the child;
husband has no genetic link to child;
impact on partners relationship;
right of child to know parents identity;
pass on genetic disease;
remarks about child's likeness to parents; max 6

(iii) seeds collected;
orthodox seeds;
stored at a temperature of -18$^{o}$ C;
dried to moisture content below 7%;

storage life doubled for every 5$^{o}$C reduction;
storage life doubled for every 2% reduction in humidity;
may be X-rayed to check embryo present;
sealed in moisture proof container;

regular monitoring of viability / appropriate specified frequency;
regeneration / recollection;
when viability falls below an acceptable level/specified;

recalcitrant seeds can not withstand low humidity / temperature;
not stored by this method; max 8

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**3** (b) (i) enzyme attached to insoluble material;
physical methods;
chemical methods;
immobilised on ceramic / polymer gels;
trapped behind membranes / dialysis tubing;
or encapsulated;

alginate solution;
using a syringe, drop mixture on calcium chloride;
wash with water;
enzyme dipped into substrate / substrate run over enzyme (in column);
which is circulated / in a continuous flow;
giving maximum contact with enzyme;

max 7

(ii) immobilised enzymes can be controlled more easily;
have a long shelf life / more stable;
protection from proteolysis;
protection from thermal denaturation;

do not get washed out of the reactor/can be reused;
not diluted by the medium;

similar to the way they act in cells;
attached to membranes;
only part of the molecule exposed;

product free from contaminating enzyme molecules;
ideal for continuous process;
able to operate at a wider pH range than in solution; max 7

(iii) type of immobilisation e.g. entrapping in alginate;
add to substrate;
test e.g. Benedicts / iodine, relevant to named enzyme;
positive/negative result, relevant to named test;
name of cell / enzyme, e.g. yeast / sucrase;
pack column with alginate beads;
method of preventing beads from falling through e.g. glass wool / gauze bags / sieve to collect up beads (after set time);
collect known volume / place in known volume;
at set intervals / for a set time; max 6

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## Option 3 - GROWTH, DEVELOPMENT AND REPRODUCTION

**1** (a) (i) A exine R'extine'
B intine
C male gametes/male nuclei
D vegetative nucleus/tube nucleus *half marks rounded up* 2

(ii) ref. double fertilisation;
one fuses with female gamete;
to give diploid, embryo / zygote;
one fuses with, the fusion nucleus/two polar nuclei;
to give triploid endosperm nucleus; max 4

(iii) rough/AW, exine; 1

(b) (i) so no stigma secretion present/so only known substance(s) present; 1

(ii) to test that lipids were responsible for effect;
not other substances in the normal secretion;
*[lipids, alone/solely, responsible = 2]*

to test that triglycerides were responsible for effect;
not, breakdown products/products of digestion, of lipids;
to test that, plant/stigma/pollen, does not have to break down lipids; 4

(iii) purified lipids have, same/slightly greater (A figs), effect as normal secretion;
so lipids responsible for pollen tubes penetrating style;
unsaturated triglycerides responsible;
especially triglyceride 2;
when used alone more effective (A figs) than, normal secretion/purified lipids; max 3

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**2** (a) (i) anterior pituitary gland;

(ii) anterior pituitary gland;

(iii) interstitial cells/Leydig cells, (of testis);

[*pituitary* + *pituitary* + *testis* = *1*] 3

(b) (i) significant rise in both at age 10 - 12 years;
plateau in both at ages 16 / 17 years;
ref. figures;
triggered by GnRF;
from hypothalamus;
steep rise triggers puberty;
LH / ICSH stimulates synthesis of testosterone;
FSH stimulates spermatogenesis; max 4

(ii) significant rise at age 10 / 11 - 14 years;
rise less steep age 14 - 18 years;
ref. figures;
triggered by rise in LH(ICSH);
testis increases in size at the same time;
responsible for secondary sexual characteristics; max 4

(c) (i) $\frac{28.0 - 8.0\ g}{4\ y}$ = 5; g per year; 2

(ii) $\frac{20}{4} \times \frac{1}{8}$ or $\frac{5}{8}$ ; = 0.625 (0.63 s.f.); 2

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**3** (a) (i) named prokaryote;
binary fission; (R mitosis)
DNA replicates;
detail replication; (e.g. enzyme/replication fork/replicates in both directions round loop)
DNA separates;
ref. role mesosomes in separation;
septum/cross-wall, forms;
clone/genetically identical;
ref. time scale;
replication of plasmids;
growth to maximum, size/length; max 7

(ii) named microorganism;
nutrient medium;
sterile conditions;
temperature controlled;
other condition controlled; (pH/aeration)
measuring/sampling, at intervals;
way of making sure sample is homogeneous;
several repeats/averages;
colorimeter/haemocytometer/dry mass/diameter colony/number of colonies;
need for dilution;
detail 1 of method; (calibration of colorimeter/volume of haemocytometer)
detail 2 of method; (e.g. absorbance/count)
graph results; max 7

(iii) *problems with one technique used in (ii) e.g.*
*optical density*
sterility/unwanted organisms;
uniformity of samples;
total count;
dead cells;
detail;;
AVP;; [e.g.dry mass only real measure]

*haemocytometry*
sterility/unwanted organisms;
uniformity of samples;
total count;
dead cells;
detail;;
AVP;; [e.g.dry mass only real measure]

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*counting colonies*
sterility/unwanted organisms;
uniformity of samples;
viable count;
colony diameter does not include depth;
detail;; [e.g. irregular shaped colonies]
AVP;; [e.g.dry mass only real measure]

*dry massing*
sterility/unwanted organisms;
uniformity of samples;
dead cells;
detail;; [e.g. separating organisms from medium]
AVP;;[e.g. counting colonies only viable measure]

max 6

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**3** (b) (i) suitable seed;
major factors = water, oxygen, suitable temperature;
suitable apparatus;
control with oxygen, water and suitable temperature;
experiments with only one factor altered;
unsuitable temperature experiment;
prechilling;
minus oxygen experiment;
minus water experiment;
pseudoreplicates (several seeds per control/condition);
replicates (more than one control/condition);
averages/% germination;
dark/light/different wavelengths experiment; *(A ref. to light intensity wavelength although technically not a major factor*) max 7

(ii) immature embryo needing time for development;
needs infection by specific fungus;
testa mechanically restrictive;
testa impermable to water;
testa impermeable to oxygen;
testa needing, scarification/digestion/microorganism action;
need fire;
inhibitor in testa needing leaching;
inhibitor in fruit needing separation of seed;
ref. ABA (as common inhibitor);
need prechilling;
need, light/dark;
need particular wavelength of light;
ref. phytochrome;
ref. GA; max 7

(iii) germination can be linked to season;
(need for prechilling) prevents germination in short favourable spell in prolonged unfavourable period;
some only germinate when, at/near top of, soil;
some only germinate when buried;
some only germinate when, gap in canopy/fire has cleared vegetation;
some only germinate after sufficient rain;
prevents wasteful germination;
reduces competition / allows time for dispersal;
spreads germination time of given batch of seeds;
if first batch killed others follow;
insurance against no seed set in any one year; max 6

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## Option 4 - APPLICATIONS OF GENETICS

**1** (a) inbreeding depression;
loss of, vigour/fertility;
loss of genetic diversity;
increase in homozygosity/decrease in heterozygosity;
increased expression of deleterious recessive alleles; max 3

(b) DNA extracted from, suitable cell/named cell;
fragmented by restriction enzyme(s);
gel electrophoresis;
smallest fragments furthest/largest fragments least far;
Southern blotting;
banding pattern visualised; max 4

(c) shows relationships;
similar bands = genetic similarity;
most diverse chosen to breed/most similar not bred;
to maintain heterozygosity/prevent homozygosity; max 3

(d) (i) to produce desirable change in phenotype;
for benefit of man;
by artificial selection;
of parent(s) showing desired features; max 2

(ii) selective breeding reduces genetic diversity;
captive breeding needs to maintain maximum diversity;
selective breeding chooses parents on grounds of particular phenotype/characteristics;
captive breeding parents should not be chosen for particular phenotype/characteristics;
weak/unattractive, organisms may house needed alleles;
captive breeding is solely for the benefit of the species; max 3

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**2** (a) (i) economy/efficiency;
saves waste of materials;
saves waste of, energy/ATP;
cell can be making other useful, proteins/materials; max 2

(ii) random/chance/spontaneous;
<u>mutation</u>;
different, enzyme/metabolic pathway;
mutant mites survive and reproduce;
pass mutation to offspring;
fitter;
increase in resistance allele frequency;
ref. recessive mutation v. dominant mutation; max 4

(b) measure production of mRNA;
detail;
measure production of, protein/polypeptide, coded for;
detail; max 2

(c) (i) all (6) genes switched on in infested leaves;
compared with none in control;
switch on all bar one (5) genes in receiver leaves;
mites result in volatiles being emitted/AW; max 2

(ii) 4 (out of 6) genes switched on by wounding;
same effect for these as mite action;
only one gene switched on in receiver leaves;
wounding does not produce volatiles in same way as mites; max 2

(d) depends whether plants heterozygous;
advantageous in that effective alleles of all genes inherited together;
maximum protection for individuals inheriting these;
disadvantageous for individuals receiving ineffective alleles;
if plants homozygous then immaterial whether linked; max 3

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**3** (a) (i) (complete) dominance;
only one allele of heterozygote affects phenotype;
phenotype of heterozygote same as one homozygote;
recessive allele must be homozygous to appear in phenotype;
example/symbols;

codominance;
both alleles of heterozygote affect, the phenotype/functional protein;
example/symbols;

multiple alleles;
dominance hierarchy;
example/symbols; max 6

(ii) involuntary muscle movement/chorea;
mental deterioration;
brain cells lost;
ventricles enlarge;
(commonly) onsets in middle age; [*max 4*]

<u>dominant allele</u>;
autosomal/chromosome 4;
most sufferers heterozygotes;
1 in 2 chance of passing on condition;
<u>stutter</u>;
CAG (triplet) repeat;
sufferers have > 37/37 - 100, repeats;
more repeats earlier onset;
increased number with each generation;
inheritance from male and female different;
not truly Mendelian; [*max 6*] max 8

(iii) *advantages*
know have allele before having children;
take steps not to pass on allele/gene/condition;
test embryo and terminate if positive/test IVF embryo and do not implant if positive;
appropriate, AI/donor oocyte/donor embryo;
activity/physiotherapy to delay onset; [*max 4*]

*disadvantages*
know will suffer from incurable disease in time;
positive test on offspring means untested parent knows must have allele;
positive test on parent means any offspring knows has 1 in 2 chance of having allele;
max 6

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**3** (b) (i)

| *continuous variation* | *discontinuous variation* |
|---|---|
| no discrete classes .. | discrete classes; [1 mark] |
| vary between, limits/extremes; | no intermediates; |
| quantitative; | qualitative; |
| can be plotted as normal distribution curve; | can be plotted as bar chart; |
| example 1; | example 1; |
| example 2; | example 2; |

max 8

(ii)

| *continuous variation* | *discontinuous variation* |
|---|---|
| > 3 genes/many genes; | v. one/few, gene(s); |
| polygenes; | |
| many alleles; | v. few alleles; |
| different alleles have small effects on character | v. different alleles have large effects on character; |
| different genes have same effect on character | v. different genes have different effects on character; |
| additive effect; | different genes may interact; |
| large environmental effect | v. small environmental effect; |

max 6

(iii) organism 1 + phenotypic character;
environmental effect;
detail;

organism 2 + phenotypic character;
environmental effect;
detail; 6

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