SCOTTISH QUALIFICATIONS AUTHORITY

2003 Biology

Advanced Higher

Finalised Marking Instructions

2003 Biology Higher

Marking Scheme

Section A

1.	A	11.	A	21.	C
2.	C	12.	D	22.	A
3.	B	13.	A	23.	D
4.	B	14.	C	24.	B
5.	B	15.	D	25.	B
6.	D	16.	A		
7.	C	17.	B		
8.	C	18.	D		
9.	A	19.	A		
10.	C	20.	D		

Section B

Question 1

				NOTES
(a)		additional/ring/circular piece of DNA/genetic information in bacteria/prokaryote	**1**	Negate: - nucleus - found in animal/plant cell
(b)		Any two from receptors, enzymes, channels, carriers, attachment, junctions, recognition, transport antigen, cell adhesion, control passage of substances		Not cell signalling/strengthen membrane/allow diffusion
(c)	(i)	restriction (enzymes)/endonucleases	**1**	Not nuclease; not restrictive enzyme
	(ii)	electrophoresis	**1**	
	(iii)	Polymerase chain reaction/PCR	**1**	letters must be in correct order
(d)		no plasmids added/not given Ti plasmid (= wild type plants) no FRE1/no FRE2/no KA gene/no BI gene no <u>additional</u> iron uptake no toxin/KA/BI resistance given plasmids lacking FRE genes not exposed to Agrobacterium	**1**	Not: no alteration to DNA/DNA unchanged no genes inserted
(e)	(i)	(probes indicate that) KA plants have (yeast) FRE1 (probes indicate that) BI plants have (yeast) FRE2 control plants do not have the FRE (gene)	**any 2**	Negate – reference to KA or BI as disease resistant
	(ii)	<u>Probes</u> for FRE1 and FRE2 show that both genes are present in the same plant OR (DNA from the) cross-bred/KA+BI plants reacts with both <u>probes</u>	**1**	

Section B Question 1 (cont)

(f) (i) addition of FRE genes increases iron uptake
OR statement about uptake relative to control
(eg absorption is higher than control if FRE 1is present)
OR treatments relative to each other
(eg absorption is higher with FRE2 inserted than if FRE 1is present) **1**

(ii) correct quantification (for answer (i))
(eg FRE1 at 0.32 units and control 0.16 units/0.16 >control)
(eg FRE2 at 0.39 units and FRE1 at 0.32 units /FRE2 > FRE1 by 0.07
eg FRE1+2 at 0.72 is 0.33>FRE2 alone or 0.40>FRE1 alone) **1**

(g) (i) 72.868 / 72.87 / 72.9 / 73 (94/129 = 72.87) **1**

(ii) FRE2 gives greater (percentage) improvement in low iron

High 199 – 129 = 70 70/129 x 100 = 54.26%
Low 43 – 26 = 17 17/26 x 100 = 65.4% **1**

(h) the iron content of leaves of genetically modified tobacco in low iron
is much less than the unaltered plants /control (129 units) when iron is easy to absorb
OR
growing control/normal tobacco in high iron gives (about three times) more iron in leaves
than the best achieved by modified plants in low iron
mark for correct observation; quantification not required **1**

NOTES

Not: KA + BI resistance – must refer to **plants**
reference to disease

Can score part (i) in part (ii) answer

Correct units nmol mg^{-1} h^{-1} must appear at least once
Can accept no units if statement refers to absorption being
4x that of the control

Not 72.86 or 72.00

Comparison of two controls is not enough

129/31 OR 129/43 OR 129/41 are OK but not reference to
154 or 199 or 223

Section B

Question 2

(a) (i) chemicals do not have any effect on the herbivore/sawfly + attract another organism that does
OR plant does not kill/harm insect + attracts another organism to do this **1**

(ii) the plant suffers less grazing/<u>feeding</u> from sawfly/damage from herbivore
the parasitoid locates prey/host more easily
OR the parasitoid locates somewhere to lay its eggs/reproduce more easily **2**

(b) three trophic levels are involved + [producer + primary consumer + sec. consumer]
OR three trophic levels are involved + food chain showing the 3 organisms
OR three levels of a food chain/web are involved
OR three feeding levels are involved **1**

(c) (i) females lay eggs (inside host eggs) **1**

(ii) to allow plant (metabolism time) to produce volatiles/synomones/odour/smell/chemicals **1**
to allow synomones to be released

(iii) ensure insects cannot be influenced by movement of observer
randomise the Test bottle position/rotate apparatus to eliminate bias
control abiotic factors **<u>+ eg</u>** provide even illumination around the apparatus or constant temperature etc.
correct reference to odour from controls
same mass of twigs//odour source
flush out air chamber between tests
Any one point **1**

NOTES

Organism = predator = parasitoid

Not: only females attracted to chemicals

Not: time for eggs to hatch
time for chamber to saturate

Section B Question 2 (cont)

NOTES

(d) (i) the bars only indicate the duration of walking
OR the insects have not been walking all the time **1**

(ii) more time spent in test field when eggs are present (than when absent) **1**

Quantification replaces 'more'

when eggs are absent time spent in each field is <u>not significantly</u> different
OR when eggs present time spent in test field is <u>significantly</u> greater than controls **1**

(e) treatment X/slitting by itself does not produce synomomes
and
treatment Y/slitting + covering secretion does not produce synomomes **1**

treatment Z/slitting + oviduct secretion produces synomomes **1**

(f) (i) effect on host is lethal
OR only part of the life-cycle is parasitic **1**

(ii) parasitoid/wasp only ever eats one egg
<u>adult</u> wasp does not eat/kill/derive energy benefit from eggs
only uses sawfly to host larvae (not egg) **1**

NOT evolution alone

(g) co-evolution/evolutionary adaptation **1**

Section C Cell and Molecular Biology

Question 1A

Discuss the cell cycle under the following headings:

(i) the sequence of events in the cell cycle; **5**
(ii) how the cycle is controlled; **6**
(iii) how abnormal cell division can arise. **4** **15**

(i)

1 *interphase* is the stage between cell divisions OR interphase is G1, S, G2
2 G1 is growth stage OR in G1 cell gets bigger/grows
3 (followed by) S phase is when DNA replication occurs
4 (followed by) G2 is second period of cell growth/preparation for mitosis/describe detail
5 (followed by) mitosis is the division of the nucleus
6 cytokinesis divides the cytoplasm/results in two daughter cells
7 sequence correct ie G1 S G2 M
8 all phases of mitosis mentioned (PMAT) **any 5 from 8**

(ii)

9 checkpoint near/before the end of G1assesses size
10 ensures sufficient (mass) to form two daughter cells/to allow cell division/for cycle to proceed
11 checkpoint during G2 controls entry to mitosis
12 DNA replication assessed
13 so each daughter cell receives complete genome/copy of DNA
14 mitosis promoting factor (MPF) necessary for entry into mitosis
15 MPF is a protein (complex)
16 checkpoint during metaphase (of mitosis) controls entry to anaphase/cytokinesis/end of mitosis
17 M checkpoint checks chromosome alignment/ensures each daughter cell receives one chromatid from each chromosome **any 6 from 9**

(iii)

18 proliferation genes/proto-oncogenes stimulate the cell cycle/cell division
19 can mutate to form oncogenes
20 (then) cell cycle over-stimulated/excessive cell division occurs/can result in cancer/tumour
21 antiproliferation genes/tumour suppressor genes inhibit cell division
22 mutation can result in loss of inhibition
23 (antiproliferation genes) are recessive/both genes must mutate **any 4 from 6**

NOTES

Points 1 and 7 can be on diagram

Point 5 may be on diagram

9 Not *at* the end of/*during* G1

11 Not 'leading to ' mitosis

Cell and Molecular Biology

Question 1B

Compare the methods used to grow mammalian cells and plant tissue in culture. **15**

1 aseptic techniques required – award only once

Plant

2 suitable medium + named eg (M+S)
OR + **two** components – C source, mineral salts, water, vitamins
3 growth regulators/hormones used + one example – auxin or cytokinin
4 cause differentiation/growth of roots/shoots
5 source of plant cells is an explant
6 formation of callus/mass of undifferentiated cells
7 (initially) plantlets form
8 plant cells/tissues have long life span
9 plant cells are totipotent or explanation = capable of differentiation
10 reference to (growth of) protoplasts

Animal

11 mammalian cells need growth factors (provided in)
12 complex growth medium OR serum added to medium
13 any 2 components from salts, amino acids, vitamins, glucose, water
14 normal cells divide a certain number of times then die
15 tumour/mutated cells used because they are 'immortal'/give unlimited division
16 cells grow as a monolayer
17 normal cells need surface to adhere to/need anchorage
(accept converse for tumour cells)
18 cells spread/flatten out (then)
19 mitosis/divide until growth is confluent
20 single cells isolated and cultured to give clones/cell lines (to release cells)
21 use of proteolytic enzyme to release cells from source tissue
22 mammalian cells do not usually differentiate/stem cells can

NOTES

1 Not 'prevents contamination'

3 Not gibberellin

Environmental Biology

Question 2A
Discuss the circulation of nutrients in ecosystems under the following headings:

(i) decomposition of organic matter; **5**
(ii) the role of bacteria in chemical transformations in the nitrogen cycle. **10**

(i)

1 breakdown of organic matter to release (inorganic) nutrients/minerals
2 which are available for uptake by plants/primary producers
3 eg (organic matter) - animal waste/droppings/dead remains of plants/animals/microbes etc.
4 eg (organic molecule) - cellulose/chitin/protein/urea etc.
5 decomposers/saprotrophs are bacteria and fungi
6 detritivores are invertebrates/named example such as woodlice, earthworm, millipede
7 decomposers carry out breakdown by external (enzymatic) digestion OR detritivores digest internally
8 detritivores fragment detritus to produce humus
9 gives increased surface area for decomposers to work on

Maximum 5

(ii)

10 nitrogen fixation is nitrogen → ammonia/ammonium
11 nitrogenase required
12 anaerobic conditions necessary/inhibited by oxygen
13 leghaemoglobin (produced due to plant and bacterial genes) absorbs/removes/ binds excess oxygen (within Rhizobium cell)
14 oxygen released slowly for aerobic respiration
15 provides large amount of energy/ATP required by nitrogenase
16 carried out by free-living cyanobacteria /photosynthetic bacteria/Nostoc/ Azotobacter
17 or by symbiotic bacteria/Rhizobium in root nodules/legumes
18 nitrification is ammonia/ammonium → nitrate
19 ammonium → nitrite by Nitrosomonas/Nitrococcus
20 nitrite → nitrate by Nitrobacter
21 denitrification is nitrate → nitrogen gas
22 by Pseudomonas OR denitrifiers are free-living
23 anaerobic conditions required
24 ammonification/decomposition by bacteria releases ammonia from dead organisms/animal waste

Maximum 10

NOTES

6 Not carnivores in decomposer food chains eg centipedes/earwigs/false scorpions

10 ammonia = ammonium

19 and 20 Named bacterium must be correctly linked to stage

Environmental Biology

Question 2B

Discuss the effects of intensive food production on ecosystems. **15**

1. monoculture is cultivation of single species
2. large area is more economical/suitable for mechanisation
3. hedgerows cleared/habitats destroyed (to increase in field size)
4. (monoculture) leads to reduction in species diversity
5. (monoculture) leads to loss of stability/change in populations/increase in pest numbers or species
6. (monoculture) adversely affects soil structure/soil condition/crumb structure/organic content
7. erosion more likely
8. pesticides (any type) reduce species diversity
9. substances used may be toxic/polluting
10. may be persistent/non-degradable/may accumulate
11. concentration increased with each trophic transfer is biomagnification
12. consequence of (biomagnification) eg populations of top predator birds decreased
13. due to high concentrations being lethal OR causing loss of eggs due to shell-thinning
14. use of chemical fertilisers (to increase yield/promote growth)
15. loss of nutrients through leaching/cropping
16. nitrates/phosphate leak into aquatic ecosystems (in run-off)
17. nutrient enrichment/eutrophication occurs
18. leads to large populations of algae/algal bloom
19. sunlight blocked out and aquatic plants die
20. death of algae/plants leads to large bacterial population
21. high BOD/low levels of oxygen/oxygen depletion
22. aquatic animals/fish die

any 15

NOTES

14 chemical = artificial = inorganic

NOTES

Section D

Biotechnology

Question 1

Recent developments in biotechnology have increased the variety of fermented dairy products and yeast-based foods.
Discuss this statement under the following headings:

(i) traditional fermented dairy products; **5**
(ii) novel fermented dairy products and their benefits; **7**
(iii) yeast extracts and their uses. **3**

(i)

1. traditional products two egs – cheese, butter, soured cream, yoghurt, curds and whey
2. (traditional products) use bacteria present (naturally) in milk
3. pasteurisation kills these bacteria
4. so need for inoculum/introduced bacteria
5. gives control over type/quality of final product
6. fermentation produces lactic acid/lowers pH
7. uses lactose/sugars (in milk)
8. second fermentation gives the product type/flavour
9. improvements to traditional products from newly developed strains/bacteria/ enzymes

any 5 from 9

Section D Question 1 (cont)

(ii)

10. functional foods provide health benefits/ used as nutraceuticals
11. probiotics are fermented products
12. they contain (live) bacteria
13. – 15. (probiotic) bacteria control pathogens in the gut
    restore gut flora/ fauna after illness
    production of vitamins
    reduces duration of diarrhoea
    compete (with pathogens) leaving them less nutrients
    inactivate toxins (produced by gut pathogens)
    produce inhibitors (of growth of gut pathogens)
    any 3 of above for up to 3 marks
16. may help in cancer protection
17. may help to lower cholesterol
18. can improve lactose intolerance/improves lactase deficiency
19. by providing the enzymes that digest lactose

any 7 from 10

(iii)

20. provide hydrolysed extracts/marmite/vegimite
21. provides vitamins
22. provides flavourings
23. yeasts are able to autolyse/undergo autolysis
24. enzymes degrade the cells
25. flavour released depends on enzyme present/stage of life cycle/age of culture (during degradation) /degree of autolysis/temperature

any 3 from 6

NOTES

Question 2

Describe **three** different methods that can be used to measure the number of bacteria in a culture **and** describe a method of calculating the growth rate of a bacterial culture

1. direct count of cells using microscope
2. use of haemocytometer/description of grid on slide
3. fixed volume of culture
4. calculate number per unit volume
5. dead and live cells not distinguished/are included in count
6. low density is unreliable

max 5

7. dilution plating (plate/colony count)
8. serial dilution (of bacteria)/dilute by known factor
9. known volume (of a dilution) plated
10. incubation of plates
11. (each) viable cell forms colony
12. calculation of number of bacteria explained (dilution factor, colony count, vol used)
13. small errors amplified (by dilution factor)
14. delay for results

max 5

15. bacteria in liquid culture make the liquid turbid/cloudy
16. the more bacteria/greater turbidity the less light passes through
    OR turbidometry/absorbance v. number of bacteria
17. named device for absorbance/transmission measure (colorimeter, spectrophotometer, nephelometer)
18. non-viable cells contribute to turbidity
19. instrument may need to be calibrated for each species

max 5

20. growth rate constant/k can be calculated
21. measures how quickly culture is growing in exponential phase
22. use formula k = ln 2/g
23. g = time in hours for population to double

max 3

NOTES

22 NOTE ln 2 = 0.693

Animal Behaviour

Question 3

Discuss the following aspects of behaviour:

(i) imprinting; **7**

(ii) sign stimuli and fixed action patterns. **8**

Use examples of named species to illustrate your answer.

(i)

1. define as (rapid) identification/attachment with another individual
2. during narrow time period/in critical period
3. occurs after birth/hatching
4. results in following one individual to the exclusion of others
5. is a learning process/not innate/has environmental component
6. difficult to reverse/irreversible
7. example - named animal
8. example - description of behaviour
9. adaptive significance/benefit in terms of protection of young/finding food
10. adaptive significance/benefit in terms of sexual behaviour/idea of cross-fostering **max 7**

(ii)

11. sign stimuli (releasers) are signals which elicit <u>specific</u> response
12. response/FAP is automatic/stereotyped/preset
13. and species specific
14. example - named species
15. description of sign stimulus
16. description of stereotyped response/FAP
    (exemplar of 14 - herring gull
    of 15 - chick pecks red spot on adult beak
    of 16 - parent regurgitates food)
17. FAPs resistant to change by experience/learning
18. may exhibit some variability between individuals/occasions
19. series of releaser-FAP events can produce complex behaviour pattern
20. example; eg stickleback courtship or nest-building in lovebirds
21. once initiated FAPs go on to completion
22. sign stimuli/FAPs largely under genetic control **max 8**

NOTES

Animal Behaviour

Question 4

Discuss the effects of social behaviour on survival under the following headings:

(i) "selfish" genes; **5**

(ii) altruism; **5**

(iii) kin selection. **5**

(i)

1. selfish gene concept defined eg successful gene combinations are self preserving
2. genetic variation exists in populations
3. some variants compete more successfully/idea of natural selection
4. genes (not individuals) survive
5. selfish genes assist survival/reproduction of the individuals carrying them
6. selfish genes pass on more copies to the next generation (than unselfish genes)
7. selfish genes spread/prosper/increase frequency **max 5**

(ii)

8. altruistic behaviour has costs (eg time/energy/increased risk)
9. improving survival chances of other **and** decreasing own chances
10. benefits (of mutual self-interest) outweigh the costs
11. reciprocal altruism
12. involves providing help to another and being repaid later
13. co-operators leave more offspring than non-co-operators
14. example of behaviour
15. example of benefit

(exemplar of 14 - blood meal sharing by vampire bats
of 15 - bats are more likely to feed others who have fed them previously) **max 5**

(iii)

16. kin selection defined (eg natural selection that favours) behaviour which helps relatives
17. close relatives share larger proportion of their genes
18. coefficient of relatedness example, eg sibs 0.5/relatedness can be measured
19. spread of these (shared) genes increases
20. Hamilton's rule – genes will spread if net benefit minus cost is greater than zero
21. example of behaviour
22. example of benefit

(exemplar of 21- naked mole rats/worker bees do not breed/are sterile
of 22 - (helping close relatives to survive) helps copies of own genes to survive
max 5

NOTES

10 balance = outweigh

Physiology, Health and Exercise

Question 5

Outline the role of hormones in the control of blood glucose levels.
Discuss the effects of exercise on diabetes. **15**

Hormones in control of blood glucose

1. (blood) glucose level (BGL) must be kept within (narrow) limits
2. pancreas detects BGL
3. insulin and glucagon secreted by pancreas/islets of Langerhans
4. insulin and glucagon work on the liver
5. BGL (increase) causes increase in insulin (and decrease in glucagon secretion)
6. excess glucose converted to/stored as glycogen
7. corrective effect on BGL of insulin or glucagon
8. use/uptake of glucose in muscle/fat cells reduces BGL
9. BGL (decrease) causes increased glucagon (and decreased insulin secretion)
10. glucagon causes (increased) breakdown of glycogen to glucose

max 7

Exercise on diabetes

11. diabetes (mellitus) may be non-insulin dependent/NIDDM or insulin dependent/IDDM
12. NIDDM mainly in overweight/obese individuals
13. (in NIDDM) cells fail to respond to insulin/develop insulin resistance
14. (plasma) insulin levels are normal
15. target/skeletal muscle/fat cells are deficient in insulin receptors
16. glucose uptake (from blood) into cells is reduced
17. glucose uptake greater in individuals who exercise/are physically fit
18. increase in number of active insulin receptors
19. increase in sensitivity of receptors/decrease in insulin resistance
20. increases capillary network/blood flow to skeletal muscle
    OR increase in enzymes associated with glucose storage
21. onset of NIDDM prevented/obesity less likely with regular exercise
22. exercise is not helpful in IDDM

max 8

NOTES

3 Islets of langerhans = pancreas

Reference to alpha and beta cells must be correct if used

Physiology, Health and Exercise

Question 6

Discuss the effects of exercise on weight control and on bone composition.

Exercise in weight control

1. exercise increases energy deficit/difference between intake and expenditure per day/ increases output relative to input energy
2. exercise increases fat loss and preserves lean tissue/increases body mass index/helps prevent obesity
3. low energy/reduced food intake causes fall in BMR
4. (drop in BMR) prevented by exercise/exercise increases BMR
5. impact on weight loss decreases as fat decreases
6. aerobic exercise is more effective
7. two eg of aerobic exercise - brisk walking, jogging, swimming, cycling. etc
8. (exercise should be of) moderate intensity
9. long duration/done frequently/cumulative

max 6

Bone composition

10. bone density increases from late adolescence and peaks about age 30
11. density decreases with age
12. minerals/calcium loss from bones
13. occurs earlier/faster in females than males
14. lack of exercise is a risk factor for osteoporosis
15. osteoporosis is progressive loss of minerals leading to porous/brittle bones/fractures
16. physically fit/active individuals have greater bone mass
17. bone strength increased by weight-bearing/resistance exercise/mechanical stress
18. any one eg of such activity
19. women should maximise bone density in 20s/30s (before age-related loss)
20. young elite/endurance athletes can develop osteoporosis

max 9

NOTES

2 lean tissue = muscle

15 calcium = minerals

No mark for oestrogen effect since the question is about exercise

[END OF MARKING INSTRUCTIONS]