

Our ref: MH/TH

23 August 2004

To:  
The Person Responsible for Biology  
SQA Co-ordinators  
Directors of Education  
Biology Assessment Panel Members  
Customer Accounts Managers

Action by Recipient	
	Response required
✓	Note and pass on
	None – update/information only

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Dear Colleague

### **National Qualifications Update – Biology**

This letter is intended to provide centres with an update on National Qualifications and should be passed to the member of staff responsible for Biology.

#### **1 AH Biology – Summary of Changes made to Arrangements document**

The Fifth edition of the Arrangements document was published in March 2004 and is effective from session 2004-2005. The 2005 examination will be in the new format.

This edition of the Arrangements document has been issued to centres on CD-ROM and is available on the NQ Biology section of the non-secure part of the SQA website.

A summary of the amendments to the Advanced Higher Arrangements is attached as Appendix A.

A specimen paper illustrating the new examination is now available on the same section of the SQA website.

#### **2 Advanced Higher Biology Investigation Guidance**

An updated copy of this guidance is attached to this letter.

The only change to the guide relates to the detail of submission date for the Investigation Report ie *“The submission date for the Investigation Report in Biology will be around the end of April. The actual date of submission will be notified to centres via the Operational Guide; Appendix 2: National Qualifications – Calendar of key dates and Appendix 3: Subject-specific submission deadlines.”*

I hope the contents of this letter are helpful to you. Please do not hesitate to contact me if you need further clarification.

Yours faithfully

A handwritten signature in black ink that reads "Mary Hoey". The signature is written in a cursive style with a large, looping 'M' and 'H'.

Mary Hoey  
Qualifications Manager  
NQ Maths, Science and Language Team

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**Biology Subject Update Letter (August 2004)**

**ADVANCED HIGHER BIOLOGY (FIFTH EDITION PUBLISHED MARCH 2004)**

**Summary of Changes to Arrangements Documents**

The changes made to the Arrangements document are indicated by the text underlined below.

**Course Details**

**Cell and Molecular Biology**

“Plasmids” added to the notes for a i Prokaryotes.

a ii Mitosis: the M phase – notes changed to read “Role of spindle fibres in the movement of chromosomes, alignment of chromosomes on a metaphase plate, separation of sister chromatids and formation of daughter nuclei.

a ii Control of the cell cycle – notes changed to read “Position and purpose of checkpoints... Mitosis promoting factor (MPF): protein complex controlling the entry of cells into mitosis.”

a ii Abnormal cell division: cancer cells. Notes amended to read “Mutations cause excessive cell growth characteristic of cancer resulting in tumour formation. Normal proliferation genes are known as proto-oncogenes which may give rise to mutation to dominant oncogenes. **(Please note error in document – should be oncogenes not allogenes).**

Antiproliferation genes (tumour-suppressor genes) help to restrict cell division at cell checkpoints. Mutations are recessive and when both copies mutate control of cell division is lost – due to loss of inhibition.

a iii Differentiation of cells into tissues and organs – notes updated to read “Cellular differentiation depends on changes in gene expression resulting in genes being switched on and off (similar depth of treatment to Higher Biology. The ability of the stem cells to differentiate, unlike specialised cells. The lac operon in E.coli – Repressor molecule, regulator gene, inducer, operator and structural gene (as in Higher Biology).”

a iv Mammalian cell culture – notes altered to read: “Requirement of aseptic conditions, solid surface, growth factors and nutrients in complex growth media. The addition of animal serum such as fetal bovine serum (FBS) to promote cell proliferation and antibiotics to prevent bacterial growth. Use of proteolytic enzymes to release cells from source tissue.”

a iv Bacterial and fungal cultures – notes altered to read “The advantages of the simpler growth media requirements and the culture conditions for bacteria and fungi compared to mammalian cells.

a v Plant tissue culture – notes altered to read “Techniques used (including requirement for aseptic conditions and suitable growth medium). Growth of explants on suitable media to produce a callus. The use of growth regulators such as auxins and cytokinins to cause tissue differentiation. Production of pathogen free plantlets and plants, generation...”

b i Polysaccharide structure. Notes altered to read “Comparison of polysaccharide structures of starch (amylose and amylopectin), cellulose and glycogen in relation to linkage of glucose monomers and degree of branching.”

## **Environmental Biology**

a ii Nutrient cycling – content statements amended to read “The nitrogen cycle” and “The phosphorus cycle”.

The nitrogen cycle – notes amended to read “Chemical transformations in the nitrogen cycle: nitrogen fixation in free living cyanobacteria and mutualistic Rhizobium in root nodules in legumes, functions of nitrogenase and leghaemoglobin, decomposition of proteins to produce ammonium (ammonification), roles of nitrifying bacteria *Nitrosomonas* and *Nitrobacter* in nitrification to produce available nitrate, assimilation of nitrate and ammonia into proteins and nucleic acids, loss by leaching and free-living denitrifying bacteria including Pseudomonas...”

The phosphorus cycle – notes amended to read “Only in relation to low ... ecosystems.”

c i Changes in complexity. Last paragraph in notes column amended to read “Loss of complexity through human activity as illustrated by monoculture, eutrophication (algal bloom and its consequences), toxic pollution, and habitat destruction.”

c ii Effects of intensive food production. Last sentence of notes changed to read “Environmental impact of increased use of pesticides and chemical fertilisers in relation to species diversity and loss of stability.”

c iv Pollution. Notes in second sentence, second paragraph altered to read “Consequences of biological magnification of food chains. Biotransformation. Toxicity and persistent/non biodegradable nature of DDT.

## **Biotechnology**

a 1i Growing microbes. Notes updated to read ... “The need for growth conditions and their control in laboratory culture and fermenters. Factors taken into account in scaling up from Petri dish to full scale production. Product formation and recovery.”

a 1ii Stages of growth. Notes updated to read ... “Measurement of growth using cell counts, dilution plating and turbidometric methods using haemocytometers, and colorimeters to obtain direct, indirect, total and viable counts.”

a 1iii Diauxic growth. Notes updated to read (second sentence) “The terms repressor molecule, regulator gene, inducer, operator and structural gene should be known. Negative control by the lac suppressor and positive control by CAP.”

## a 2 Industrial production of enzymes

Content statement added “Use of micro-organisms”. Notes inserted “Sources of cellulases, pectinases and amylases from naturally occurring micro-organisms. Manipulation of micro-organisms as exemplified by chymosin as an alternative to traditional sources of rennet.”

Content statement added “Production of enzymes”. Notes inserted “Fermentation conditions to include sterility, nutrients, oxygen, pH, temperature, anti-foaming agents, time and the need to control these.”

Content statement added “Product recovery”. Notes inserted “Production of primary and secondary metabolites. Separation by flocculation, filtration and centrifugation. Concentration by ultrafiltration and vacuum evaporation; purification by chromatography.”

a 3ii Plant cell culture. Notes amended to read... “Protoplast isolation using cellulases and pectinases. Osmotic sensitivity of protoplasts. Hybridisation to form the new varieties of plants by fusion of protoplasts from sexually incompatible species using polyethylene glycol (PEG). Characteristics of both parents such as high yield and disease resistance displayed in hybrid.”

Use of tissue culture in plant propagation. The need to control light, temperature and humidity to produce plantlets.

b 1i Silage production. Notes amended to read “Silage production in silos by inoculating bacteria and enzymes. Reasons for using *Enterococcus* and *Lactobacillus*. Pectinases and cellulases and their functions...”

b1ii Enhancing nitrogen fixing. Notes amended to read “Mutualistic relationship of *Rhizobium* species of bacteria in root nodules in legumes. Function of nitrogenase and leghaemoglobin. The need for anaerobic conditions. *Rhizobium* specificity due to plasmids.”

The mechanism of nitrogen fixing including (*Nif*) genes. The effect of high nitrogen concentrations on nitrogen fixing. Gene expression and plasmid transfer in improved *Rhizobium* strains.”

b 2 1 Fermented dairy products. Content statement “Traditional products” added. Notes added “Naturally occurring bacteria in milk as a source of inocula and effect of pasteurisation. Two stage fermentation process; first involving production of lactic acid, second gives product type.”

Content statement “Novel products (probiotics)” added. Notes added “Functional foods provide health benefits beyond basic nutrition. Role as nutraceuticals. Nature and effects of probiotics in competing with pathogens, anti-cancer activity, reducing blood cholesterol and improving lactose intolerance.”

Notes “Traditional... functional foods” deleted.

b 2ii Yeast extracts. Notes amended to read “Autolysis of yeast by enzymes to produce a number of flavours dependent on enzyme present, stage of life cycle or age of culture during degradation.”

b 2iii Fruit products. Notes amended to read “Reasons for problems associated with production of fruit juice drinks including viscosity, clarity, low yield, haze and extraction. Sources and use of cellulases, arabanase, pectinases and amylases to overcome these problems.”

New content statement added “Genetic modification of *flavr savr* tomato”. Notes amended to read “Gene for polygalacturonase (a pectinase which softens fruit) is cloned to produce RNA complementary to mRNA for the enzyme. Prevents gene being expressed. Production of fruit with less bruising and increased shelf life. Social and economic issues related to safety, production and use of GM foods.”

b 3i Antibiotic production. Notes amended to read “Type of organism used, growth conditions, control measures, secondary metabolites in microbial fermentation. Made from cheap feedstock, waste materials, starch and plant oils. Product recovery by downstream processing including extraction, recovery, separation and purification of product.”

Mode of action of antibiotics on bacteria – bacteriostatic/bacteriocidal. Named examples of antibiotics to include penicillin, streptomycin and erythromycin.”

b 3ii Content statement amended to read “Nature and production of monoclonal antibodies”

Notes amended to read “Protein nature of antibodies produced in response to specific antigens by B lymphocytes. Site and production of B lymphocytes.

Preparation of polyclonal sera and its disadvantages.

Monoclonals produced from a single B line secreting one specific antibody.

Nature of myeloma cells and their hybridisation with lymphocytes using polyethylene glycol (PEG) to produce hybridomas. Use of selective media and screening. Hybridomas only produce one particular monoclonal. Batch culture of secreting hybridomas in fermenters and extraction of pure antibody.”

Content statement added “Uses of monoclonal antibodies”.

Notes amended to read “Use of monoclonal antibodies in diagnosis and detection of disease. Use of immunoassay (Elisa) techniques involving monoclonal antibodies joined to enzyme; coloured product used to quantify presence of antigen specific to pathogen eg AIDS, meningitis. Treatment of disease: tumour-specific antibodies joined to toxins, combines with tumour cells and kill them.”

## **Animal Behaviour**

b 1 Innate and learned behaviour. Notes amended to read “Nature versus nurture. Development of behaviour depends on interaction between genetic and environmental influences. Innate behaviour: genetically determined, stereotypical response and its adaptive significance.”

Learning as modification of behaviour by experience. Ability to learn genetically determined and environmentally influenced. Variability of response within a species.

The role of both innate and learned behaviour in examples of vertebrates and invertebrates as exemplified by foraging in honey bees and bird song development.”

b 1i Content statement amended to read “The influence of parental care on learned behaviour.”

Notes amended to read “Compare short life span of many adult invertebrates with long life span of primates and relate to time to learn new behaviour.”

b 1ii Imprinting. Notes added to read “Irreversible learning process with environmental component. Critical time period of attachment after hatching. Object of attachment followed to exclusion of others. Adaptive significance in relation to protection of young and sexual behaviour.”

b 1iii Sign stimuli and fixed action patterns. Notes amended to read “Sign stimuli (releasers) elicit stereotyped responses called fixed action patterns which are species-specific. Feeding of young by parent birds.”

Fixed action patterns under genetic control, once initiated go to completion, resistant to change by experience, some variability between individuals and can produce complex behaviour patterns as exemplified by stickleback behaviour.

b 2i Natural selection of behaviour patterns. Notes amended to read “Behaviour patterns show variation and are inherited ie determined by genes. Some behaviours have greater reproductive success resulting in favourable adaptations accumulating in populations...”

b 2ii Single gene effect on behaviour. Notes amended to read “As illustrated by *Drosophila* period (*per*) gene. This gene controls a 24 hour cycle of activity and inactivity. Different forms of the gene alter production of protein which alters the period of hours taken to complete the daily cycle.”

b 2iii Behavioural adaptation to human influence. Notes amended to read “Human activity results in rapid environmental change. Some species are intrinsically adaptable and can change diet, foraging behaviour and habitat preference. As illustrated by foxes and herring gulls.”

c 1i Predation strategies. Notes amended to read “Comparison of solitary and co-operative hunting.”

c 1ii Foraging behaviour. Notes amended to read “Modification of behaviour to optimise gain and minimise energy expenditure. Significant aspects to include encounter rate and handling time of prey by predator and energy content of prey. As illustrated by optimum mussel size for a foraging crab. Optimal territory size in robin and humming bird: more resources within larger territory set against increased cost of defence.”

c 2i Male and female investment. Notes amended to read “Comparison of sperm and egg production in relation to number and energy store. External and internal fertilisation, parental investment. Cost of parental investment; compared to increased probability of production and survival of young. Greater investment by females; sexual dimorphism as product of sexual selection. Generally females inconspicuous.”

c 2ii Courtship and display. Notes amended to read “Male-male rivalry: increased access to female through fighting.”

Female choice: males have more conspicuous markings, structures, and behaviours to attract females.

c 2iii Avoidance of inbreeding. Notes amended to read “High levels of homozygosity alleles in inbred populations. Heterozygosity in outbred populations. Inbreeding increases expression of disadvantageous or lethal recessive genes resulting in lower fitness and reduced breeding success. Benefits of polygamy and male dispersal in social mammals. Monogamy, male territoriality and female dispersal in birds.”

c 3i Agonistic and appeasement behavior. Notes amended to read “Ritualised display and appeasement as a means of reducing risk of injury and energy expenditure.”

c 3ii Selfish and altruistic behaviour.

Content statement added “The concept of the ‘selfish’ gene.” Notes added “‘Selfish’ gene combinations are self-preserving; assist survival and pass on more copies to next generation resulting in increased frequency. Genes survive through natural selection.”

Content statement added “Kin selection.” Notes added “Natural selection that favours behaviour which helps relatives. Close relatives share larger proportion of genes. Coefficient of relatedness and Hamilton’s rule.”

Content statement added “Altruism”. Notes added “Altruism has costs since it improves survival chance of others while decreasing own chances. Benefits of mutual self-interest outweigh costs. Reciprocal altruism involves providing help to another and being repaid later. Co-operators leave more offspring.”

c 3iii Social organisation. Notes amended “Social organisation in primates. Establishment of social hierarchy by threat and display. Dominance hierarchy as system of social ranking. Rank determines access to food, shelter and mates. Social interaction, communication and behaviour of dominant individuals and subordinates. Grooming to reinforce close relationships, and lower dominance threat. Sexual presentation as appeasement gesture. Benefits to group related to survival due to increased protection, co-operative hunting, and division of labour. Best adapted contribute more to gene pool.”

## **Physiology, Health and Exercise**

aiii The ‘athlete heart’. Notes amended to read “Cardiac hypertrophy as a fundamental adaptation to increased workload imposed by exercise training. Endurance training increases left ventricle mass. A significantly larger stroke volume allows an endurance athlete to pump more blood from the heart than an untrained individual. Improves maximal heart rate and cardiac output. Reduces heart rate at rest and recovery time.”

bii Effect of exercise on body composition and weight control. Notes amended to read “The place of exercise in increased energy expenditure as part of weight-control programmes. Exercise increases energy output relative to input, increases fat loss, preserves lean tissue and helps prevent obesity. The effect of frequency, intensity, duration and type of exercise. The impact of exercise on body composition decreases as fat decreases.”

biii Osteoporosis and bone growth. Notes amended to read “Bone density increases from late adolescence and peaks at age 30 then decreases with age. Osteoporosis is caused by...”

biii Effects of exercise. First sentence of notes amended to read “Regular weight-bearing exercise of moderate intensity can maintain bone mass and increase bone strength.” Extra sentence added at end of notes “Women should maximise bone density before age related loss.”

b iv Content statement amended to read “Diabetes mellitus”.

Control of blood glucose levels. Notes added “Role of pancreas. Effect of changes in blood glucose levels. “

Content statement amended to read “Effect of exercise on diabetes mellitus.” Second paragraph of notes added “Exercise increases blood flow to skeletal muscle and an increase in enzyme activity associated with glucose storage.”

**Details of the Instruments for External Assessment: the structure of the examination has been changed.**

### **Examination**

The examination will contribute 80% of the total marks. The paper will carry 100 marks in total and will consist of three sections:

#### **Section A**

This section will contain 25 multiple choice questions based on the two mandatory units. Of these 8-10 will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Section A will have an allocation of 25 marks. Candidates will be expected to answer all questions.

#### **Section B**

This section will contain structured questions, data handling questions and extended response questions based on the two mandatory units with an allocation of 55 marks. Between 13-16 marks will test problem solving and/or practical abilities, the remainder will test knowledge and understanding. Candidates will be expected to answer all questions.

#### **Section C**

Amended to read “This section will contain structured questions, extended response questions and data handling questions based on each of the optional units with an allocation of 20 marks. Candidates will be expected to answer questions on one of the optional units. For each unit 4-6 marks will test problem solving and/or practical abilities, the remainder will test knowledge and understanding.”