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ABSTRACT

The Committee for General and Technical Education of the Council of Europe has initiated several projects to study, compare and evaluate curriculum materials used in the member nations. This publication, a result of such attempts, was prepared after making a survey of the status of biology teaching at the upper secondary school level in 19 member countries--Belgium, Cyprus, Denmark, France, Federal Republic of Germany, Iceland, Ireland, Italy, Luxembourg, Norway, Spain, Scotland, Sweden, Switzerland, Turkey, United Kingdom, Netherlands, Austria, and Malta. The study was concerned with the aims and objectives, program content, teaching methods, evaluation and assessment, and future trends in the development of curricula for the gifted at the upper academic secondary level. Questionnaires were designed on these aspects of biology teaching and completed by each member country. The report, with a number of tables and appendices, is divided into five separate chapters. General conclusions and recommendations are included in a separate section. In almost all countries, the status of biology is inferior to that of either physics or chemistry. With the recent changes in syllabi in these countries for more emphasis on genetics, cytology, ecology, developing skills and modes of thought for scientific study, the position of biology is improving gradually. (PS)

Council of Europe

COUNCIL
FOR
CULTURAL
CO-OPERATION

EUROPEAN CURRICULUM STUDIES

No. 3 : BIOLOGY

1972

EUROPEAN CURRICULUM STUDIES
(In the Academic Secondary School)

B I O L O G Y

by

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Council for Cultural Co-operation
Council of Europe
Strasbourg
1972

The Council for Cultural Co-operation was set up by the Committee of Ministers of the Council of Europe on 1 January 1962 to draw up proposals for the cultural policy of the Council of Europe, to co-ordinate and give effect to the overall cultural programme of the organisation and to allocate the resources of the Cultural Fund. It is assisted by three permanent committees of senior officials : for higher education and research, for general and technical education and for out-of-school education. All the member governments of the Council of Europe, together with Greece, Finland, Spain and the Holy See are represented on these bodies [1].

In educational matters, the aim of the Council for Cultural Co-operation (CCC) is to help to create conditions in which the right educational opportunities are available to young Europeans whatever their background or level of academic accomplishment, and to facilitate their adjustment to changing political and social conditions. This entails in particular a greater rationalisation of the complex educational process. Attention is paid to all influences bearing on the acquisition of knowledge, from home television to advanced research ; from the organisation of youth centres to the improvement ot teacher training. The countries concerned will thereby be able to benefit from the experience of their neighbours in the planning and reform of structures, curricula and methods in all branches of education.

Since 1963 the CCC has been publishing, in English and French, a series of works of general interest entitled "Education in Europe", which record the results of expert studies and intergovernmental investigations conducted within the framework of its programme. A list of these publications will be found at the end of the volume.

Some of the volumes in this series have been published in French by Armand Colin of Paris and in English by Harraps of London.

These works are being supplemented by a series of "companion volumes" of a more specialised nature to which the present study belongs.

General Editor :

The Director of Education and of Cultural and Scientific Affairs, Council of Europe, Strasbourg (France)

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1. For complete list, see back of cover.

FOREWORD

The Council of Europe, working through the Committee for General and Technical Education of the Council for Cultural Cooperation, has in recent years become increasingly interested in the field of curriculum development. One manifestation of this interest is the continuing support it has given to what has become known as the OCESCE Study (Oxford/Council of Europe Study for the Evaluation of the Curriculum and Examinations) of which this present study of biology forms part. Thus several publications of the results of the Study, in mathematics, Latin and modern languages have already been published either under the auspices of the Council for Cultural Cooperation or commercially (1). The OCESCE Study, which is also partially financed through the generosity of the Gulbenkian Foundation, of course represents no more than the opinions of those specialists engaged in it : any judgements made are theirs, and do not commit the responsibility of the Council of Europe in any way. At the same time, as the one appointed to direct the Study, I should like to express gratitude to the Council of Europe for the help and encouragement it continues, through its Secretariat, to give us.

The OCESCE Study, which is carried out at Oxford in the University Department of Educational Studies, aims at being European rather than national-oriented, and is concerned with the aims and objectives, the programme content, teaching methods, evaluation and assessment and future trends in the development of curricula for the gifted at the upper academic secondary level. Through a study of the official and semi-official publications of the member countries of the Council of Europe it has arrived at an overall evaluation which represents the state of a number of subjects about the beginning of the new decade. There is a tendency towards increasing riguour in the delimitation of curriculum goals, the subject matter taught and in the use of assessment techniques.

From the Study is emerging valuable data concerning curriculum theory in the member countries, which should be useful in arriving at pedagogical agreements on equivalences between the various European countries. To some extent this is a function of what might be termed the congruence problem : How far do terminal school courses in one country "fit" with initial courses in higher education in another ?

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(1) W.D. Halls and D. Humphreys, European Curriculum Studies
N° 1 : Mathematics, Council for Cultural Cooperation, Strasbourg, 1968

P. Story, European Curriculum Studies
N° 2 : Latin, Council for Cultural Cooperation, Strasbourg 1969

W.D. Halls, Modern Languages and Education in Western Europe, George Harrap, London, 1970

What the Study seeks to provide is the raw material upon which pedagogical decisions made by educational experts at international conferences could be based.

The present publication on biology exemplifies the wide diversity that still exists in teaching programmes in this subject at the upper secondary level. On the other hand, current trends towards the harmonising, if not the unification, of programmes can be discerned. There is considerable concern, for example, about the preservation of the natural and human environment in which we live. There is common concern also regarding the problems of human biology posed in the latter half of the twentieth century. Such questions give rise to moral dilemmas and ethical issues which it is right and proper should be discussed in school.

Further studies which are in the press include those on physics and chemistry. One on the teaching of economics is in preparation. The series will be completed by comparative studies of the mother tongue, civic and social education, history and geography. It is hoped that by 1972 the main subjects of the academic secondary curriculum will have been covered in this way. A synthesis of the whole series of subject studies will then be made in relation to such questions as the overall balance of the curriculum, the various alternatives to traditional examinations that are emerging and the increasingly blurred distinction between general and vocational education, as well as other related issues.

Comparative Education Centre W.D. HALLS

INTRODUCTION

This study was initiated by the Council of Europe with the purpose of making a survey of biology teaching in the upper academic secondary school in Europe, with particular reference to the most specialised courses in this subject, indicating those areas which might prove worthy of more detailed study. The work follows on, in part, from the discussions and recommendations of the OECD conferences held at Vevey in 1962 and at Helleback in 1964, to which frequent references will be made. At the outset of the study, four major areas of research were defined : the justification for teaching biology, the subject matter taught, the methods of teaching and the means of assessment used. From the preliminary documentation received, questionnaires were designed, and distributed to the official representatives of each member country. The first of these questionnaires dealt with the organisational aspects of teaching biology and methods of instruction and evaluation, the second was a list of possible teaching aims, while the third consisted of a list of biological topics classified according to an adapted version of the Dewey Decimal classification. Further information on the teaching of biology at this level was gathered at the working party held at Strasbourg in December 1968, and on a study tour of Europe made the following year.

A preliminary report was written, and formed the basis for discussion for a second working party held in Stockholm in January 1970. Discussion at this meeting centred on the teaching of environmental biology and on the operational definition of teaching aims. Suggestions made by the delegates to this meeting have, as far as possible, been incorporated into this final report.

This report completes the Council of Europe study of the teaching of science in the upper secondary school, and it is immediately apparent that the academic status of biology is inferior to that of either physics or chemistry. Biology suffers from the legacy of the past, where it was equated with "nature study" ; indeed, an underlying separation into botany and zoology may still be observed in some countries. On account of the proportion of descriptive material contained in the syllabuses and the continuing emphasis on the storing of fact at the expense of understanding, biology tends to be regarded as the "easy science". However, with the stress on systematics and morphology gradually declining, and the increasing importance given to such areas as genetics, cytology and ecology, to the more heuristic forms of practical exercise, and to the acquisition of the skills and modes of thought appropriate for scientific study, the position of biology in the academic secondary school is slowly improving.

It would seem that biology, with its relevance to contemporary human and social problems, coupled with its concern with concrete objects and direct observation is in a unique position to provide a scientific training that would appeal to all young people, whatever their academic orientation, and might form a useful bridge between the social sciences and the pure sciences. The problems of pollution, conservation and population are now of pressing importance for modern society and study of them should form part of the education of all men. Study in these areas should make the moral implications of sciences and of technological progress more immediately apparent. At the same time biology can play an important part in pupils' intellectual development. While its role is not that of a 'key' subject, like mathematics, or languages, the contribution it makes to the development of logical thought and the experimental approach, and to a deepened understanding of the natural world, should, nevertheless, assure it of an important position in an academic education.

I would like to record my grateful thanks for the help given me by the delegates to the Council of Europe conferences of biology teaching. Their names are listed below.

BELGIUM	Mlle De Ridder	Inspectrice de chimie et de biologie de l'enseignement moyen et normal, Dilbeek
CYPRUS	M. Renos Kyriakides	Teacher of Biology in the Pancyprian Gymnasium
DENMARK	M. Mogens Lange	Senior Master, Birkerød Gymnasium, and Inspector
FRANCE	M. Campan	Inspecteur Général
FEDERAL REPUBLIC OF GERMANY	Oberschulrätin Kreuzer	Hamburg
ICELAND	M. Oernolfur Thorlacius	Biology Teacher, Hamrahlid Grammar School, Reykjavik
IRELAND	M. M. Langan	Inspector, Department of Education, Dublin
ITALY	M. Arturo Sergio Beer	Inspecteur Central auprès de la Direction Générale de l'Instruction Classique et Scientifique, Ministère de l'Instruction Publique, Rome
LUXEMBOURG	M. Joseph Hoffmann	Professeur au Cours Universitaires, Lycée de Garçons, Luxembourg
NORWAY	Lektor Knut Gaarder	Gymnasrådet, Oslo
SPAIN	M. Joseph Amengual	Inspecteur de l'Enseignement Secondaire, Barcelona

SWEDEN	M. Stig Fred	Educational Adviser, National Board of Education, Stockholm
SWITZERLAND	M. Pierre-André Tschumi	Professeur à l'Université de Berne
UNITED KINGDOM	M. P.R. Booth	Her Majesty's Inspector, Upper Basildon

Information for the Netherlands was received mainly from Dr. G.P. Hekstra, Secretary of the Biological Council of the Royal Netherlands Academy of Sciences and Letters, Amsterdam.

CHAPTER I

THE AIMS OF TEACHING BIOLOGY

Although most countries set out in detail their objectives for teaching biology and discuss those skills which study of the subject should develop, there is, apart from one or two isolated instances (i.e. experimental courses such as that devised by the Nuffield Foundation) little evidence of any attempt to make these often rather loosely phrased aims operational in a structured course. The low status of biology in the academic secondary school is reflected in the somewhat limited thinking that has been done as yet on the contribution that this subject might make to a general education.

This is somewhat discouraging, for it would appear that recent advances in biological research and methods might make this subject of particular interest to the pupil at this level, and might prove an academic discipline combining rigorous training in scientific methods with the opportunity to discuss moral and social questions not raised by the other sciences. Research in biology has thrown light on the nature of living phenomena, and in particular on the nature of Man, his heredity, his physical nature, and his relationship with his environment. Study of the findings of research in these areas should surely form a vital part of the education of all young people.

Yet biology is the least often studied of the natural sciences and is usually the first to be excluded from an overcrowded timetable. It is disturbing to note how few countries lay any real emphasis on contemporary problems and leave study of these topics to the discretion of the individual teacher.

The objectives to be achieved should be determined primarily by the degree of specialisation desired. Where highly specialised study of biology is to be undertaken, academic consideration of the subject itself will be an influencing factor and pupils will be expected to assimilate a fairly large corpus of knowledge. Where biology is seen primarily as a component of a general education and the degree of specialisation is less, the emphasis will tend to be more on the contribution this subject can make to the pupils' intellectual development.

In the Federal Republic of Germany, where an academic education consists of study of a wide range of academic subjects, study of biological phenomena is seen as a means of developing skills, and of furthering the pupils' intellectual and moral development. As it would not be possible in the time available to gain a detailed knowledge of all aspects of biology, certain problem areas are studied and related to a broad conceptual framework. Particular emphasis is laid on pupils gaining an overall picture of the subject area of biology and the interrelationship of all the parts. They should be led to grasp the scientific approach to problems through a study of the findings of research and of the lines along which research is conducted. The ultimate aim of the course is to develop in pupils "wissenschaftliches Bewusstsein", a scientific awareness of the world, and to cultivate in them a sense of social responsibility through understanding of and respect for life.

In France also, the study of life is considered to make an important contribution to both intellectual and moral development. The living world with man at the centre is to form the subject of study and unity to be shown by seeking out the general characteristics of all living things and by analysing their interaction. Both France and the Federal Republic of Germany stress the importance of seeing each facet of biological knowledge in the perspective of the whole subject area.

Sweden lays more emphasis than other countries on the dynamic equilibrium of Nature and on important practical considerations, such as supply of food and conservation of resources. Moral and social problems of great interest to pupils at this stage, such as population dynamics, phylogeny and sex education are discussed in special seminars.

In the United Kingdom, the degree of specialisation required at this stage may militate against the acquisition of scientific study techniques, and overcrowded syllabuses may reduce the amount of experimental practical work that can be undertaken. Lack of official control of syllabuses means that there is no one set of aims which may be said to apply to biology teaching throughout the United Kingdom. The report of the Science Masters' Association (Biology for Grammar Schools) which may be considered as fairly representative of current opinion stresses the importance of biology as a science of life and expresses the hope that it will come to make a greater contribution towards general and humane education, while continuing to provide an opportunity for specialist education.

The results of the questionnaire circulated on the aims of teaching biology (Table 1) show a fair degree of agreement between the respondent countries on the objectives for this subject at this level. The number of countries supplying complete information here was unfortunately very small. The aims listed can be very loosely grouped into four main categories :

1. Pratical utility

2-5. Acquisition of knowledge relevant to subject

6-11. Development of intellectual skills and attitudes

12-18. Aims concerned with wider implications of subject.

All seven respondent countries agree that a biology course should aim at preparing the pupil for higher education and for a career, should develop his knowledge and understanding of biological laws and phenomena, should provide him with a training in methods of experiment and observation, and should develop his understanding of the nature of science and the scientific method. There is a measure of agreement then in each of the four

Table 1 - The aims of teaching biology

	AU	BG	FR	FRG	NE	SD	UK
1. Preparation for further education and/ or a career	x	x	x	x	x	x	x
2. Development of knowledge and understanding of biological laws and phenomena	x	x	x	x	x	x	x
3. Introduction to the practical and technological applications of biology	x			x	x	x	x
4. Contribution to health and to sex education	x		x	x		x	x
5. Study of the history of biology							
6. Intellectual training developing reasoning ability	x		x	x	x		x
7. Development of critical faculties		x		x	x		x
8. Development of clear expression	x	x		x			
9. Development of aesthetic appreciation of Nature	x			x			
10 Training in methods of experiment and observation	x	x	x	x	x	x	x
11 Development of experimental approach		x	x	x			x
12 Development of understanding of nature and respect for life	x			x	x		x
13 Understanding of man's role in nature	x		x	x	x	x	x
14 Study of philosophical, moral, social and political problems related to applied biology	x	x	x	x	x		x
15 Appreciation of the limitations of biology		x		x			
16 Interrelationship of biology with the other sciences	x	x	x	x	x		x
17 Development of understanding of nature of science and scientific method	x	x	x	x	x	x	x
18 To assist pupils' moral development		x	x	x			

categories of aims. Some differences in emphasis may be noted however : where France tends to stress the more precisely measurable skills and modes of thought, such as development of the reasoning ability and of the experimental approach to the subject, the Federal Republic of Germany and Austria claim also to develop the powers of expression and the aesthetic appreciation. Sweden on the other hand, stresses the practical aims, such as preparation for a career and training in scientific methods of study.

There are one or two discrepancies in this table. Although all countries aims at giving training in methods of experiment and observation, Austria, the Netherlands and Sweden do not, apparently, seek to foster the experimental approach to problems. Yet these two aims (10 and 11 on the table) seem to bear a close relation one to the other. Then Sweden appears to be the only country to omit the study of the philosophical, moral, social and political problems related to biology. Yet in the section on the aims for teaching of biology in the official handbook for the gymnasium (Läroplan för gymnasiet) it is stated that contemporary social problems should form an important part of the course. Again, it seems strange that Belgium does not consider that an understanding of man's role in nature forms an essential part of a course in biology.

This type of study can obviously not bear too rigid an interpretation, but may be useful as a preliminary exercise, serving to indicate trends and tendencies. The degree of overlap between the member countries shows that it might be possible to agree on a common core of aims. Some work was done on this by the delegates to the Stockholm working party held in January 1970 and a provisional list of aims drawn up. These aims were grouped into three main categories, for which it was not possible in the time available to attempt a precise definition. These were :

Category I

Long-term objectives, not measurable precisely, and not necessarily specific to biology. It was felt that many of the intentions published in official directives fell into this category.

Category II

More immediately attainable aims, which must be achieved in order to reach those objectives falling into category I. Category II aims should be precisely definable and measurable.

Category III

Short-term aims, which are measurable and specific to biology. Ultimately, each aim listed in Category II would have a corresponding list of aims in Cateory III. In the time available it was possible only to work out details of category III aims corresponding to one category II aim. Further discussion should produce a complete and carefully structured system.

The suggestions made for each category are as follows :

Category I

1. To prepare students for further education, for employment, and for leisure.
2. To develop the various intellectual abilities (both cognitive and affective) as fully as possible for each student.
3. To make students aware of the social, economic and moral significance of biology (this will, of course, include local, national and international implications).
4. To encourage a respect for living organisms and nature and an appreciation of the aesthetic value of biology.

Category II

1. To acquire a knowledge of living organisms including man, the cycles of energy and material in the environment, the equilibrium of nature, and man's effect on it.
2. To acquire some competence in and understanding of the techniques of biology.
3. To make observations and to design and carry out experiments, to analyse the data so obtained, and to synthesize these into hypotheses.
4. To apply scientific knowledge and methods to unfamiliar situations.
5. To comprehend biological information and to communicate it intelligibly.

Category III (for item number 2 of Category II)

It is intended that ultimately there will be given, for each Category III aim, an example to illustrate precisely what is meant. Although discussed, these examples were insufficiently finalised to be included in the report. The techniques of biology were finally described as follows :

(i) Investigation of problems concerning organisms in their environment, by methods appropriate to these problems. It is understood that these investigations will take place mostly in the field.

(ii) Physiological techniques

(iii) Ethological techniques

(iv) Biochemical techniques

(v) Microbiological techniques

(vi) Dissection

(vii) Histological and cytological techniques

(viii) Use of mathematical methods

(ix) Use of radioactive tracers

(x) Techniques of identification and classification

Representatives from each country were requested to list in order of priority those skills which were intented to be developed by a biology course at this level. The results are shown in Table 2.

The priority seems to be given in most European countries to the intellectual skills and habits associated with biology, storing of fact and comprehension, where the 'tools' of the subject, biological drawings and diagrams come low on the list. Only the United Kingdom and France give high priority to the ability to investigate unknown specimens and to design simple experiments. The lack of emphasis given to these skills reflects the small amount of heuristic practical work done in most countries. This point will be discussed further in Chapter III.

It would seem that in spite of the interest shown in the modern aspects of biology teaching, little of the new thinking has yet been incorporated into actual biology programmes, which are still of a traditional nature. Agreement was reached, however, among delegates to the Strasbourg working party on some of the principles which should govern the design of biology courses. These were as follows :

1. The delegates of the European countries are unanimous in considering that biology should above all familiarise pupils with the ecological aspects of life, namely the relationship between living creatures and their environment.

2. This will make it possible, inter alia, to throw light on and ensure a better understanding of current problems connected with the population explosion, pollution, sex and so on. The primary aim of such teaching would thus be to engender a new attitude towards nature and methods of investigation, rather than to inculcate knowledge of innumerable facts. While pupils are preparing for examinations and university studies, the knowledge they acquire of biology will at the same time prepare them for life.

3. This evolution of biology towards a humanistic function does not dispense with the need for a sound basis of fundamental knowledge. The nature of this knowledge will clearly depend on the new aims.

4. Although the delegates unanimously agree on the aim of biology teaching, some of them consider that such teaching should retain its national character, deriving from specific national aims, and from the characteristics of the population, the territory and the flora and fauna of each country.

Table 2 - Relative importance of skills to be developed by a biology course (numbered according to order of priority)

	BG	CY	DK	FR	FRG	IR	NE	NO	SD	SW	UK
1. Knowledge of biological facts	1	3	1	3-4	1	1	1	1	3	3	1
2. Ability to make biological drawing	3	1	4-5	1	2	3	3	-	-	2-3	2
3. Ability to make biological diagram	-	1	5	3-4	3	3	2	3	4	3	2
4. Ability to describe and investigate unknown specimen	3	-	4	3-4	3	4	5	2	4	4	1
5. Ability to design simple experiment	3	-	5	1	2	3	3-4	-	2	3	2
6. Comprehension of biological prose	-	1	2	1	2	5	4-5	-	-	-	4
7. Ability to understand and to interpret biological data	-	1	1	1	1	4	3	3	3	3	3
8. Ability to compare biological situations or specimens	3	1	3-4	1	2	3	2-3	3	3	3	3
9. Ability to deduce the implications of biological situations	-	1	3-4	1	2	3	2-3	3	3	3	3

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CHAPTER II

STRUCTURE AND CONTENT OF THE SYLLABUS

The problem of finding out what is taught in biology throughout Europe can be approached at two levels, the qualitative and the quantitative.. For the purposes of this survey, an attempt was made to find out the depth in which each biological item is taught in each country, by asking for a subjective estimate according to a three point scale. In order to introduce a greater degree of objectivity, the approximate time given to each sub-section of the syllabus was asked for, and an estimate of the amount and nature of the practical work done. The complete results of this syllabus analysis appear in Appendix II. The estimates of time and of depth of study are, of necessity, approximations, and individual variations within each country may be very great. The results obtained give, however, general indications as to the emphasis laid on the different areas of biology.

The original analysis, consisting of over fifteen hundred items was designed to find out exactly what biological topics were studied in Europe. This list was then abbreviated and all topics studied by less than 44 per cent of the respondent companies removed. A list of rare topics appears in Appendix IIA.

As thought processes in biology form a network, rather than a series of simple branches, the number of possible ways for designing a syllabus analysis is infinite. The various topics included may be correlated in a large number of different ways, depending upon whichever aspect of the subject the teacher wishes to emphasise. It was consequently difficult to allot topics to any definitive area. The analysis was designed therefore so that, as far as possible, the classification of facts into groups did not reflect any one teaching approach.

The following major sections were defined

1. Biochemistry and biophysics
2. Physiology
3. Anatomy
4. Morphology
5. General principles related to biology
6. Bio-sociological problems
7. Ecology
8. Earth sciences
9. Embryology

10. Histology
11. Cytology
12. Evolution
13. Genetics
14. Representative plant types
15. Representative animal types

The percentages of the total syllabus analysis represented by each major section are given in Table 3A.

Table 3 A - Percentage of total syllabus analysis represented by each major section.

1.	Representative types of animal	33,5 %
2.	Physiology	29 %
3.	Representative types of plant	7 %
4.	Ecology and ethology	7 %
5.	Biophysics and biochemistry	5,5 %
6.	Histology	5 %
7.	Genetics	3,5 %
8.	Anatomy	3 %
9.	Cytology	3 %
10.	Evolution	2,5 %
11.	Morphology	2 %
12.	General principles related to biology	1,5 %
13.	Earth sciences	1 %
14.	Embryology	1 %

By way of comparison, Table 3B gives for each respondent country, the proportion of all biological items taught represented by each major section.

Table 3 B - Proportion of time spent on each major section of the syllabus.

BELGIUM	
1. Physiology	32 %
2. Representative plant types	17,5 %
Representative animal types	15 %
3. Genetics	17 %
4. Evolution	7 %
5. Cytology	4,5 %
6. Histology	4 %
7. Anatomy	3,5 %
8. Ecology	3 %
9. Morphology	3 %
10. Biophysics and biochemistry	2 %
11. Biosociological problems	2 %
12. General principles	1 %
13. Embryology	1 %
14. Earth sciences	0 %
DENMARK	
1. Physiology	22 %
2. Representative animal types	21 %
3. Biophysics and biochemistry	7,5 %
4. Histology	7 %
5. Anatomy	7 %
6. Biosociological problems	6,5 %
7. Ecology	6 %
8. Evolution	6 %
9. Cytology	4 %
10. Representative plant types	3,5 %
11. Genetics	3 %
12. Embryology	2 %
13. General principles	2 %
14. Morphology	1,5 %
15. Earth sciences	1 %

FRANCE	
1. Ecology	18 %
2. Physiology	18 %
3. Representative animal types	12 %
4. Earth sciences	11,5 %
5. Evolution	8 %
6. Cytology	6 %
7. Representative plant types	6 %
8. Anatomy	5 %
9. Biosociological problems	4 %
10. Genetics	3,5 %
11. Histology	2,5 %
12. General principles	2 %
13. Biophysics and biochemistry	1,5 %
14. Morphology	1 %
15. Embryology	0 %
GERMANY	
1. Physiology	31 %
2. Genetics	14 %
3. Evolution	12 %
4. Ecology	8 %
5. General principles	7 %
6. Anatomy	5 %
7. Cytology	4 %
8. Embryology	3,5 %
9. Histology	3,5 %
10. Biosociological problems	3 %
11. Biophysics and biochemistry	2 %
12. Representative animal types	1,5 %
13. Representative plant types	5 %
14. Morphology	5 %
15. Earth sciences	0 %

ICELAND	
1. Earth sciences	32 %
2. Physiology	18 %
3. Representative animal types	16 %
4. Biosociological problems	5 %
5. Cytology	4,5 %
6. Evolution	4,5 %
7. Representative plant types	4 %
8. Biophysics and biochemistry	4 %
9. Histology	4 %
10. Ecology	3,5 %
11. Anatomy	2 %
12. Embryology	1,5 %
13. Morphology	1 %
14. General principles	1 %
15. Genetics	0 %
IRELAND	
1. Physiology	23 %
2. Representative animal types	15 %
3. Ecology	14 %
4. Representative plant types	13 %
5. Genetics	5,5 %
6. Cytology	4 %
7. Biophysics and biochemistry	3,5 %
8. Morphology	3,5 %
9. Anatomy	3,5 %
10. Histology	3 %
11. Earth sciences	2 %
12. Evolution	2 %
13. General principles	1,5 %
14. Biosociological problems	1,5 %
15. Embryology	1,5 %

NETHERLANDS	
1. Physiology	37 %
2. Representative animal types	18 %
3. Anatomy	8,5 %
4. Genetics	6 %
5. Histology	5 %
6. Biophysics and biochemistry	5 %
7. Biosociological problems	3 %
8. Cytology	3 %
9. Representative plant types	3 %
10. Evolution	3 %
11. Embryology	2,5 %
12. Ecology	2,5 %
13. General principles	1 %
14. Earth sciences	1 %
15. Morphology	5 %
NORWAY	
1. Representative animal types	32 %
2. Physiology	20 %
3. Genetics	8 %
4. Evolution	8 %
5. Representative plant types	7 %
6. Biosociological problems	5 %
7. Embryology	4 %
8. Histology	4 %
9. Anatomy	3 %
10. Cytology	3 %
11. Biophysics and biochemistry	2,5 %
12. Ecology	1 %
13. Earth sciences	1 %
14. Morphology	1 %
15. General principles	0 %

SWEDEN	
1. Ecology	29 %
2. Physiology	15 %
3. Representative animal types	10 %
4. Biophysics and biochemistry	9 %
5. Genetics	8 %
6. Representative plant types	7,5 %
7. Biosociological problems	5,5 %
8. Cytology	4 %
9. Evolution	3 %
10. General principles	1 %
11. Histology	0,5 %
12. Anatomy	0,5 %
13. Morphology	0,5 %
14. Embryology	0,5 %
15. Earth sciences	0 %
SWITZERLAND	
1. Physiology	20 %
2. Representative types of animal	20 %
3. Earth sciences	15 %
4. Representative plant types	6 %
5. Anatomy	6 %
6. Genetics	5 %
7. Embryology	3,5 %
8. Cytology	3,5 %
9. Evolution	3,5 %
10. Biophysics and biochemistry	2,5 %
11. Ecology	2,5 %
12. General principles	2,5 %
13. Biosociological problems	2,5 %
14. Histology	2,5 %
15. Morphology	0 %

UNITED KINGDOM	
1. Representative animal types	25 %
2. Physiology	25 %
3. Representative plant types	6 %
4. Anatomy	5 %
5. Histology	5 %
6. Biophysics and biochemistry	5 %
7. Genetics	4,5 %
8 Ecology	4,5 %
9. Biosociological problems	4 %
10. Evolution	3 %
11. Morphology	2,5 %
12. Cytology	2,5 %
13. General principles	2 %
14. Earth sciences	2 %
15. Embryology	1 %

A tremendous variation between the emphasis placed on each area can be noted. Physiology is still the most important area of study in the majority of countries. It has been superseded by ecology, however,in both France and Sweden. Most other countries spend less than 5 per cent of the time available on this aspect. One surprising feature is the prominence of the study of earth sciences in Iceland, but this may probably be attributed to the inclusion of a large amount of geology in the biology course. The study of plants and animals still occupies more than a third of the time in Belgium, Norway and the United Kingdom ; however, the newer disciplines of genetics and cytology now take more time between them than the once dominant ones of anatomy and morphology. The Federal Republic of Germany in particular seems to have moved away from the traditional approach, placing emphasis on the study of man, his origins and his environment and giving particular importance to the philosophical background of the subject. The somewhat heterogeneous section, general principles, involving the study of social, moral and philosophical problems related to biology, is regarded as particulary important in Germany. The delegates to the Strasbourg conference stress this aspect of biology, and it may be that these topics are discussed within the framework of the biology lesson in most countries, although no definite time is allotted for studying them.

A certain amount of overlap may be noted between topics taught in chemistry and biology. In France, there is a tendency to link the various sciences in a cognate subject which forms the core discipline of the two science sections of the lycée : Section C, sciences physiques (physics and chemistry) and Section D, sciences naturelles (a natural science course involving elements of both geology and biology). This means that although the programme is primarily oriented towards ecology, there is also a strong emphasis on the study of evolution and earth sciences. From the list of representative animal types, each teacher must choose four for detailed study, of which one must be aquatic and the others terrestrial.

The degree of autonomy possessed by the individual teacher in the Federal Republic of Germany makes detailed answers to this type of syllabus analysis difficult. As with the other academic subjects, the teacher is issued with an outline plan for which he fills in the details according to his own capacities and the pupils' interests. The designs of these outline plans do not differ substantially throughout the country. In most of the Länder there is freedom of choice between the following main areas :

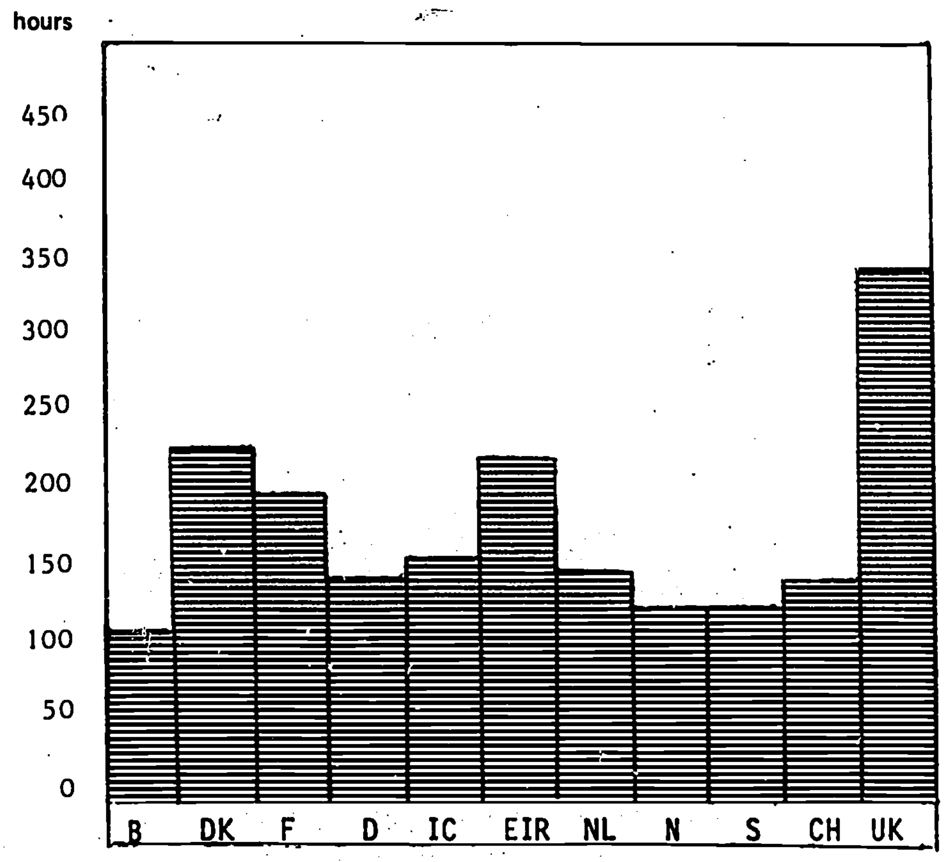
1. Physiology and biochemistry
2. Molecular genetics
3. Evolution
4. Biocybernetics (biological regulation)
5. Human genetics
6. Embryology and development
7. Ecological interactions

Three of these subjects are obligatory and are usually treated at a high level. The three subjects most commonly selected for study tend to be physiology, biochemistry and evolution.

Although there is evidence of new material being incorporated into programmes, and of courses being redesigned in some countries to include a greater proportion of ecology, genetics and cytology, and to give more time to the discussion of socially relevant problems, the courses in most cases are still strongly traditional, dominated by study of representative animal types, anatomy and morphology. It seems that the recommendations made by the delegates to the Strasbourg conference (see Chapter I) are still remote from present reality. It may be that they were looking too far ahead for their suggestions to be of any practical use at present. Further discussion might indicate how the reforms they suggest might best be incorporated into biology programmes.

After comparing the major areas of study, more detailed comparisons can be made as to the depth of study, and the amount of practical work done in connection with each item. Some differences may be observed in the amount of time available for teaching biology at this level but in general, apart from the United Kingdom, where biology is one of three or four specialist subjects studied during the last two years of academic secondary education, the time allowance is not very generous.

Table 4 - Hours devoted to biology in the upper academic secondary school



In making use of available time, two trends may be observed : either a wide range of topics may be covered superficially, or a few topics covered in depth. Only the United Kingdom, with its generous time allowance can afford to cover a wide syllabus in a fair amount of depth.

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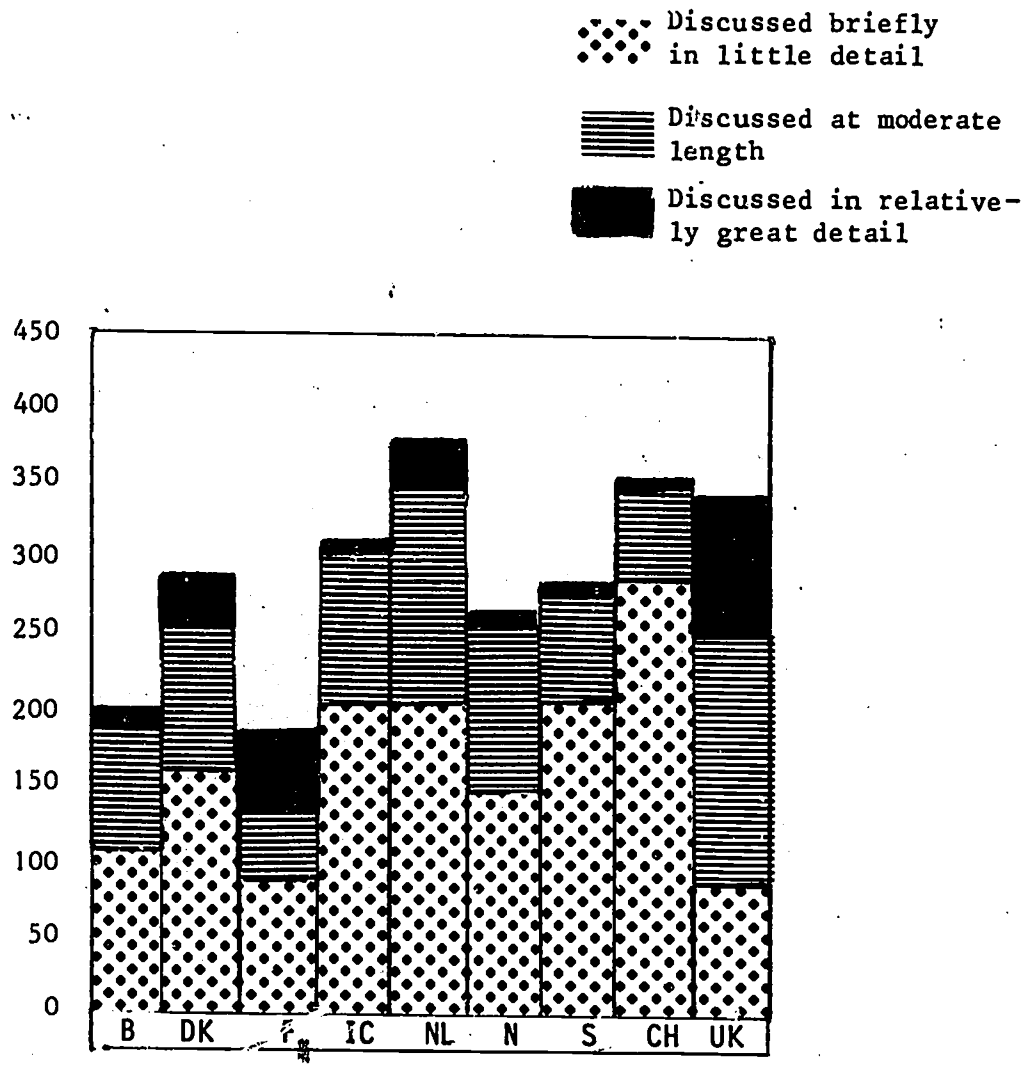
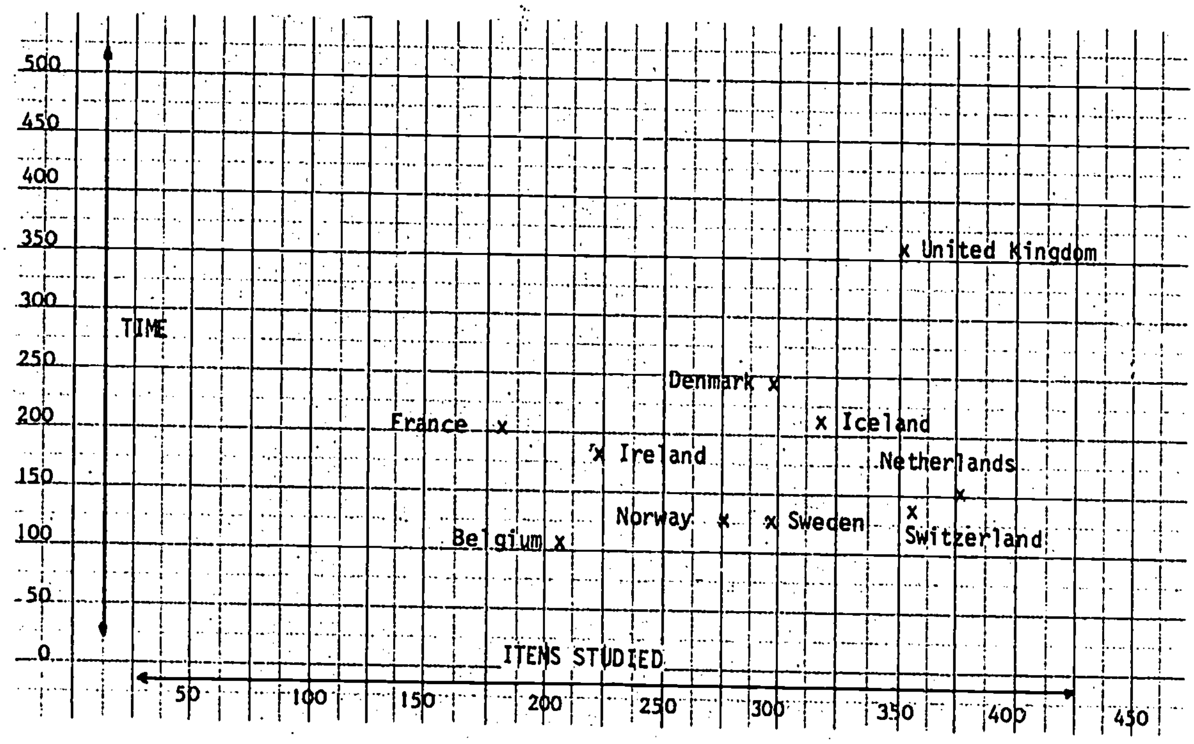
Table 5 - Number of items studied in each category of depth



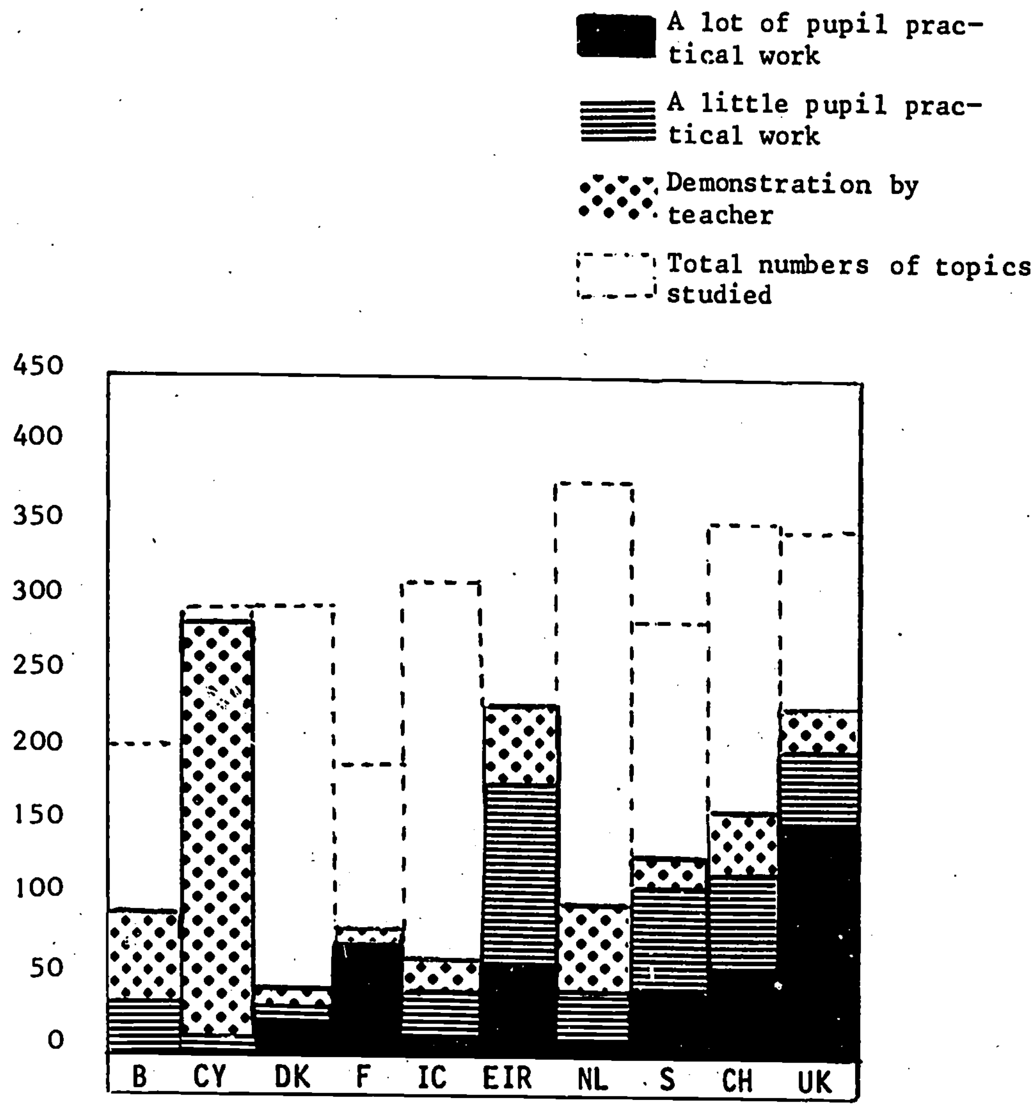
A direct comparison of the number of items studied with the amount of time available indicates that France and Ireland cover a fairly limited amount of ground with a fairly generous time allowance, where at the other end of the scale, Switzerland and the Netherlands cover a wide range of material in a fairly short time.

Table 6 - Number of items studied in relation to hours allotted to study of biology



Determining factors in the depth at which each topics is studied are the material facilities available for practical work, the proportion of time which can be spent in a laboratory, and the type of practical work which is undertaken.(This point is discussed in greater detail in Chapter III).

Table 7 - Numbers of items accompanied by various types of practical work



More detailed information on the practical work done is given in Table 8. Most practical exercises are done in connection with the study of physiology, and representative animal types, which still account for the major part of programmes in most countries. A fair proportion of practical work is done also on ecology in France, Sweden and Ireland. In general, however, both Tables 7 and 8 indicate that limited practical work is done in most countries as yet, and that demonstration by the teacher is still more common than exercises performed by pupils themselves. In France alone is demonstration by the teacher rare, and pupil exercises always of a detailed nature.

NUMBER OF ITEMS IN CONNECTION WITH WHICH PRACTICAL WORK PERFORMED

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Earth sciences	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	-	-	2	-	-	-	2	-	-	-	-	-	-	-	2	-	2	1	1
Physiology	-	14	19	-	4	70	10	5	4	20	-	-	5	-	1	-	4	19	9	16	28	-	8	18	-	7	-	15	11	2	4	13	22	31	20	13
Biophysics and biochemistry	-	-	2	-	-	5	8	2	1	5	-	-	-	-	3	1	6	-	5	3	3	-	6	4	-	6	-	8	3	-	-	3	1	9	1	1
Embryology	-	-	-	-	-	3	-	1	-				-	-	-	-	-	-	-	1	1	-	-	1	-	2	-	-	1	-	-	2	2	2	-	-
Morphology	-	-	-	-	-	6	-	-	-	1	-	-	-	-	-	-	-	-	7	-	-	-	1	1	-	-	-	-	2	-				4	1	-
Anatomy	-	3	5	-	-	-	5	-	3	3	-	-	1	-	-	5	5	-	-	7	2	4	-	2	-	3	-	2	1	-	4	4	-	11	-	1
Ecology + Ethology	-	-	-	-	-	28	-	-	-	12	-	-		not known		-	-	-	17	16	1	-	1	3	-	-	-	4	13	-	-	6	1	9	4	1
Histology	-	2	6	-	-	11	3	-	-	4	-	-		not known		4	5	-	8	3	2	-	6	2	-	-	-				4	-	-	5	-	-
Cytology	-	4	2	-	-	4	-	-	-	4	-	-		not known		1	4	-	-	1	6	-	1	1	-	5	-	1	3	-	2	1	-	11	2	-
Evolution	-	-	6	-	-	8		not known		4	-	-		not known			not known		-	4	1	-	-	-				2	5	-	2	3	-	7	-	2
Genetics	-	4	4	-	-	9		not known		4	-	-		not known			not known		-	5	2	1	2	-				-	-	-	1	-	4	-	-	3
General principles related to biology	-	-	1	-	-	3		not known						not known			not known		-	1	-	-	-	-				2	3	-	2	2	-	2	3	1
Representative types of plants	-	6	5	-	-	17		not known		1	-	-		not known		1	-	-	8	9	2	-	2	3	-	1	-	4	4	-	10	8	-	13	2	-
Representative types of animals	1	1	1	-	21	34		not known		17	-	-		not known			not known		11	36	7	6	3	21	-	25	-	12	22	1	27	29	10	45	19	1
Biosociological problems	-	-	-	-	-	15		not known		1	-	-		not known			not known		-	4	-	-	-	-				-	-	-	-	4	-	1	2	-

A : Much pupil practical
B : A little pupil practical
C : Demonstration by teacher

The widely differing emphasis placed on the different sections of the biology programme indicate a considerable degree of variation between the various European countries in their choice of subject matter. It was hoped that a list made of items studied by at least 90 per cent of countries might form the basis of a limited agreement as to some common ground. This list (given in Appendix IIb) contains, however, only seventy items, amounting to 11.3 per cent of the total syllabus analysis. This is surely far too slender a basis for compiling any nucleus of common ground to be agreed as a basis for all syllabuses, even allowing for some items to have been studied earlier in the course.

The major areas where there is agreement include certain aspects of blood, respiration, vitamin and mineral requirements, photosynthesis, cell division, evolution and genetics. There are in addition one or two taxonomic groups, such as fungi, studied by over 90 per cent of countries.

A second list (given in Appendix IIb) was made of items studied by fewer than 44 per cent of countries. This contains 27.2 per cent of the items listed, which usually have particular relevance for one country. In three of the four countries studying diatoms, for example, fishing is a major industry. Giberellius and Kinetin are studied only in schools in Ireland and the United Kingdom, where a great deal of the early work on them was done : and Cyprus is one of only two countries which begin their study of the history of biology with the early Greeks.

The constant advances of biological research mean that syllabuses for this subject, as for all the other natural sciences must frequently be revised and up-dated. Ideally, there should be in addition a means whereby new syllabuses can be evaluted. The ease with which new elements can be introduced will depend on the degree of centralisation of the educational system. It is more likely, however, that where the individual teacher has considerable autonomy new elements will be incorporated spontaneously into biology programmes without awaiting the approval of the central authorities.

In the majority of countries, reforms are initiated from a high level, although pressures for change probably come from the teachers themselves, and more particularly, through their professional associations. In the United Kingdom alone, a tightly interlocking system of control means that changes stem from the national examining bodies rather than from the central authorities, who are not responsible for devising new curricula.

Details of the methods used for changing syllabuses appear below in Table 9.

Table 9 - Mechanisms for Syllabus Change

AUSTRIA	Ministerial conferences
BELGIUM	Changes made as a result of proposals made by school inspectors or by the Minister of Education
CYPRUS	Changes made by Inspectorate
DENMARK	Ministry of Education. Teachers may also try out their own schemes
FRANCE	Conseil supérieur de l'Education Nationale
ICELAND	Formerly gymnasium teachers. The newly founded Department for School Research may help in this respect
IRELAND	Syllabus revised every five years by a committee of school, Ministry and university representatives
LUXEMBOURG	Commission Nationale
NETHERLANDS	A national committee for biological curriculum development is to be nominated soon
SWEDEN	The National Education Board has syllabuses under revision continually and may change them every seventh year
SWITZERLAND	Usually teachers' initiative
TURKEY	Board of Education after testing in pilot schools
UNITED KINGDOM	Syllabuses issued by regional examining boards. Changes initiated by subject committees, composed of university and school teachers

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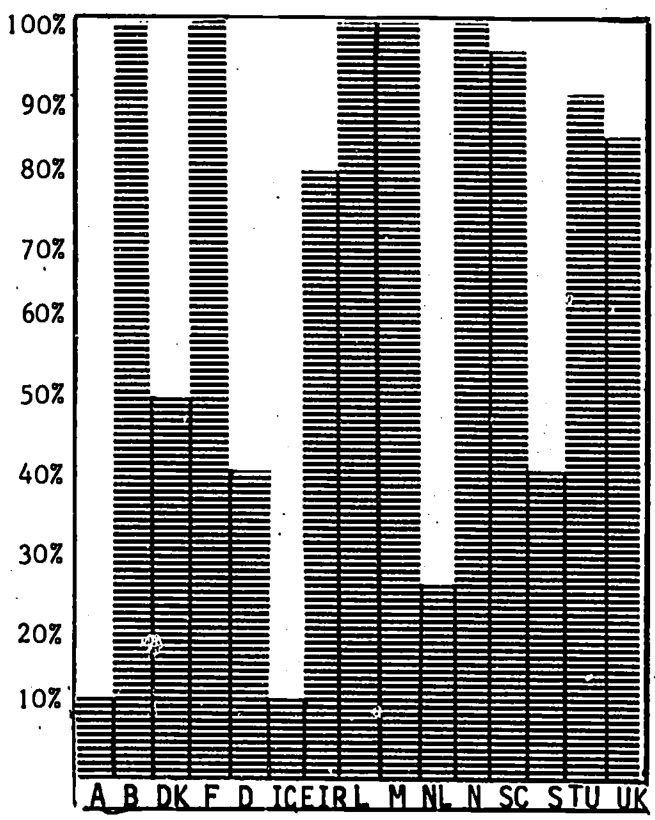
CHAPTER III

TEACHING METHODS AND RESOURCES

The facilities available are a prime factor influencing the choice of teaching method. With the current movement towards more experimental work in biology lessons, provision of laboratories and the equipment in them is of obvious importance. The ratio of laboratories available in most countries is for one to be supplied for biology for every two hundred to two hundred and fifty pupils. In spite of this, the actual teaching time which may be spent in a laboratory at this level may vary very considerably, as is shown in Table 10.

Table 10 - Proportion of Biology Teaching in a well equipped laboratory



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Lack of facilities, combined with large classes might make the introduction of practical work difficult in some countries. In the Federal Republic of Germany and also in Denmark and Sweden, a solution is found to the problem of limited laboratory time by alternating theoretical and practical work in the lecture theatre and in the laboratory.

Policies regarding the setting up and maintaining of laboratories tend to follow one of two patterns ; either a large capital outlay is made and a complete new laboratory built, and little money spent subsequently, or a small outlay is made initially and the laboratory built up gradually. There are obvious disadvantages to both schemes. In the first type of laboratory equipment may quickly grow out ot date, where in the second, although the latest equipment may be bought it may be some time before this type of laboratory becomes fully operational. There was no evidence in any country of any official directives regarding the setting up and maintenance of laboratories, nor is there any sum of money allocated annually to be spent on equipment. Provision of apparatus in the laboratory seems to be left entirely to the individual teacher's initiative, and to the funds he can raise from the educational authorities.

Table 11 shows the provision of laboratory equipment and the extent to which audio-visual aids are used. Although provision of microscopes and microprojectors is apparently generous in most European countries, centrifuges and quick-weighing balances are available in only a few countries, and even so are found only occasionally except in Sweden. On the other hand, a wide range of audio-visual aids is available in most countries, in particular films and slides, and in many cases, radio and TV programmes. There are indications, however, that full use is not always made of these ancillary aids. Only in five or six countries is there a government operated scheme supplying schools with laboratory apparatus.

Table 11 - Provision of apparatus and facilities (in the upper academic secondary school)

	Austria	Belgium	Cyprus	Denmark	France	Germany	Iceland	Ireland	Italy	Luxembourg	Malta	Netherlands	Norway	Scotland	Spain	Sweden	Switzerland	Turkey	U. K.
Numbers of pupils to one microscope		2	40	1	1-3	HE-3 B25-1	2-10	2	4	1	1	2	2	2	10	1-2	1		1
Frequency of occurrence of apparatus : Binocular microscopes		f		f	a							o	f	f	a	a	f		f
Microprojector - availability	-	f	-	a	o	f	o	a	a	a	a	f	o	f	f	a	f	a	a
- usage	-	f	-	f	o	f/o	-	f		f	o		o	f	o	f/o	f	o	f
Aquaria				f	a	f						f	a	a	f	a	a		a
Refrigerator				a	a	a						o	a	f	o	a	f		f
Incubator				a	f	a						o	a	f	o	a	o		f
Centrifuge				o	o	o						f	o	o	o	a			f
Quick weighing balance				a	-	f						o	a	f	f	a	o		o f
Audio-visual aids : (A = availability B = usage)																			
Epidiascope A				-	o	-						f	o	-	f		-		o
Television A	a	o	a	-	a	-	-	a	a	a	a	o	-	o	f	a	-	-	a
(use) B	-	f	o	-	o	-	-	o	f	-/o	o		-	o	-/f	f/o	-	-	-
Radio A	a	o	-	-	a	o	-	a	a	o	-	-	a	o	f	a		o	a
(use) B	o	f	-	-	o		-	-		-/o	-		o	o	-/o	f/o	f	f	-
Films (moving) A	a	f	a	a	a	a	a	a	a	a	a	f	a	f	f	a		a	a
(use) B	f	f	o	f	f	f	o	-		f	o		o-f	[illegible]	f	f/o	f	o	o
Film loops A	a	f	-	-	a	o	a	a	a	a	-	o	o	f	o	a	-	a	a
(use) B	f	f	-	-	f	f	o	-		f	-		o	f	o	f/o	-	o	o
Slides or filmstrips A	a	a	a	f	a	a	a	a	a	a	a	f	a	f	a	a	o	a	a
(use) B	f	f	o	f	f	f	f	o		f	o	o	f-o	f	f	f/o	f	o	f
Overhead projector A	-	o	-	-	o	-	a	a	a	a	a	o	a	f	o	a	o	a	a
(use) B	-	f	-	-	o	-	f	-		f	o	f	o+f	f	o	f/o	f	o	f

Key
o : occasional
f : frequent
a : always or nearly always
1/10 = under 10 % 1/5 = 10-25 %
1/3 = 25-50 % 2/3 = 50-75 %

One of the major problems in biology teaching is the supply in sufficient number of specimens for experiment. The solutions adopted to this problem are varied. It is, of course, possible to gather specimens from the environment of the school, but sole use of this source of supply may eventually deplete the resources. Alternative sources in many countries are university departments, and special biological supply agencies. In the United Kingdom, for example, local education authorities run supply banks for specimens.

Another solution to the problem of supplying specimens is for each school to provide its own facilities, gardens, greenhouses, animal rooms or ponds. Although school gardens are encouraged in some countries, notably in France and in Denmark, Table 12 indicates that provision of these facilities is still very sparse.

Table 12 - Approximate proportion of schools possessing

	B	CY	DK	F	D	EIR	NL	N	S	CH	UK
A - animal rooms	1/10-	0	0	2/3?	1/10-	1/10-	0	-	1/10-	1/10-	1/5
B - green houses or equivalent	1/10-	0	1/10-	1/10-?	1/10-	1/10-	1/10-	1/2	1/10-	1/10-	1/3
C - school gardens	1/10-	some	1/10-	1/10-?	1/3	1/3	1/10-?	1/10-	2/3	1/3	1/5
D - school pools	1/10-	0	1/10-	1/10-?	1/10-	1/10-	?0	-	1/10	1/3	1/5

Provision of gardens might fill a number of useful functions, supplying fresh specimens and forming a basis for the study of certain aspects of ecology and methods of cultivation. Miniature habitats might also be created so that pupils might study these at first hand. Much would depend here on the individual teacher's initiative and the amount of assistance available.

The numbers of laboratory assistants found in European schools, whether qualified or not, are, however, very small. This may well explain why there is evidence of facilities not being used to their full capacity and also the lack of greenhouses, animal rooms and other facilities of this type. Details appear in Table 13 of the provision of laboratory assistants in the countries from which information was forthcoming.

Table 13

1. Are laboratory assistants employed in the academic secondary school ? 2. If so, what qualifications are necessary ?	
BELGIUM	1. Occasionally 2. Untrained
FRANCE	1. One laboratory assistant for each 50 hours of instruction : i.e. one assistant for two teachers 2. Brevet de technicien in large schools. Untrained in smaller schools
FEDERAL REPUBLIC OF GERMANY	1. Occasionally 2. Untrained
ITALY	1. All classes over a certain size must have laboratory assistant 2. Diploma from Industrial and Technical Institute
LUXEMBOURG	1. One full-time technician for each biology laboratory 2. Diploma from school of Mechanics
MALTA	1. One assistant shared by two departments 2. Some have City and Guilds Laboratory Technicians certificate
NETHERLANDS	1. 25/30 % of schools have laboratory assistants: two for every three science teachers 2. Training in physics, chemistry and simple biology
SWEDEN	1. One assistant for all sciences in each gymnasium 2. Usually unqualified
UNITED KINGDOM	1. About one assistant for three science teachers 2. Usually untrained

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It is obvious that the importance of didactic teaching far outweighs that of any other method in the majority of countries. This predominance of didactic teaching is not by any means peculiar to biology. Research into the teaching of other subjects, economics, for example, at this level shows that in this subject also, lecturing by the teacher is the customary mode of instruction. It is disturbing to note also the amount of time taken up by confirmatory rather than exploratory practical work, except in France, where the former is not allowed. It would seem that only in Denmark, France, Sweden and the Federal Republic of Germany, and to a certain extent in the United Kingdom, are there any signs of biology teachers breaking away from the hierarchy of formal teaching methods, although the degree of overlap between the estimates of time given in some countries suggests a great deal of individual variation.

A similar predominance of traditional methods of instruction can be observed when the relative importance of each pupil activity is studied. (See Table 15) The taking of notes still receives the greatest emphasis, and surprisingly enough, in almost half the respondent countries, these notes are still being dictated by the teacher, even at this senior level in the school. Only France and the Federal Republic of Germany seem to have reduced note taking by any significant amount. In view of the age of pupils at this level in some countries, where the terminal classes in some countries are almost equivalent to the first year of university in others it would seem appropriate for the emphasis to be on independent work, on the part of the pupil. With the stress laid on use of reference books and self instruction in the United Kingdom and the Federal Republic of Germany, it would seem that in these countries a fair amount of opportunity is given to the pupil to acquire study methods suitable to the subject. The importance given to project work is disappointingly small, in view of the current interest shown in this type of exercise. In the case of Sweden, however, the figures given may be misleading, as the pupil is expected to spend from thirty to forty hours of his spare time during the terminal year working on a biology project. As this is an extra-curricular activity, no indication of its importance is given on this table.

Five possible teaching methods were defined as follows :

A - Didactic method : (exposition or lecture by teacher, with or without experimental demonstration)

B - Socratic method : (questioning and discussion with the pupils to eli.ci: their knowledge and ideas)

C - Practical work done by pupils after A or B, as confirmation of something they have already been told

D - Heuristic method (practical work done by pupils in response to the setting of a problem to which they do not know the answer)

E - Project method

Each country was then asked to estimate what proportion of its teaching time was taken up by each type of instruction. The results appear in Table 14.

Table 14 - Teaching Methods Used

Figures given indicate approximate percentages of teaching time

	CY	DK	F	D	EIR	NL	N	S	CH	UK
A - Didactic	50-75%	0-10%	0-10%	15-25%	75-100%	75-100%	15-20%	25-50%	50-75%	25-50%
B - Socratic	25-50%	25-50%	0-20%	10-25%	0-5%	5-20%	15-45%	25-40%	0%	10-25%
C - Confirmatory practical	-	25-40%	0%	15-25%	0-10%	0-5%	0-5%	10-20%	10-20%	25-50%
D - Heuristic	-	10-25%	c.80%	15-25%	-	-	15-25%	10-25%	10-25%	25-50%
E - Project work	-	c.5%	c.5%	10-15%	-	-	-	10-25%	0-10%	10-25%

Table 15 - Pupil activities

(rated in descending order according to the importance attributed to each activity)

	B	CY	DK	F	D	EIR	NL	N	S	CH	UK
A. (i) Note-taking, dictated by teacher	-	2	1	-	-	1	1	-	-	1	1
(ii) Note-taking, précis of teacher	1	2	1	2	2	(-)	1	1	1	1	1
B. Note-taking from text-book	3	-	-	-	-	2	4	-	2	3-5	3
C. Use of other reference books	-	-	3	3	2	4	6	3	4	5	4
D. Self-instruction on limited topic	-	-	(7)	-	3	-	-	-	-	5	7
E. Composing and giving short lecture	2	2	6	5	2	-	3	3	4	5	7
F. Long project (1 term-1 year)	-	2	5	6	-	-	-	-	-	5	6
G. Discussion	-	3	2	1	1	-	2	1	2	5	4
H. Radio or TV at this level	-	1	-	7	-	3	-	-	4	-	-
I. Essays	-	-	3	(4)	3	5	4	-	7	-	1
J. Programmed learning	-	2	-	-	-	-	-	-	-	-	-

More detailed study of the skills to be developed by practical work (see Table 16) show clearly the lack of importance attributed in the majority of countries, with the possible exception of the United Kingdom and France, to the more heuristic forms of practical work, such as experimental design or investigation of an unknown specimen, although nearly all countries claim to spend up to 25 per cent of their time on exploratory practical work.

Table 16 - Laboratory skills

Laboratory skills degree of importance

A : Essential
B : Very important
C : Moderately important
D : Worth some attention
E : Unimportant
※ : already given in Table 2

	B	CY	DK	F	D	EIR	NL	N	S	CH	UK
Dissection	A	-	D	C	C	C	D-E	A	A	C	A
Use of ordinary microscope	A	A	B	A	A	B	B	A	A	C	A
Use of phase contrast illumination	-	-	D	-	-	E	E	-	D	D	D
Use of dark ground illumination	-	-	(D-E)	-	-	E	E	-	-	(E)	D
Maceration of material	-	-	-	D-E	E	C	E	-	C	D	D
Cutting sections of botanical material	C	A	B	C	C	C	C	C	D	C	C
Use of hand microtome	B	-	(D-E)	D	-	E	E	-	D	D	-
※ Description/investigation of unknown specimen	C	-	D	C-D	C	D	E	B(D)	D	D	A
※ Ability to make a good biological drawing	C	A	D-E	A	B	C	C	-	-	B-C	B
※ Ability to make a good biological diagram	-	A	E	(C-D)	C	C	B	C	D	C	B
※ Ability to design (+ execute) a simple experiment	C	-	E	A	B	C	D(-C)	-	B	C	B

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The only skill regarded by nearly all as essential is use of the ordinary microscope, which, it will be remembered, is the only one of the few pieces of biological equipment to be provided in sufficient quantity in all countries. The newer and more sophisticated microscope techniques, such as phase contrast and dark ground illumintation receive little attention in schools in any country and only Belgium rated the use of the hand microtome as higher than 'worth some attention'.

It would seem from the differing emphasis placed on various sections of the syllabus (see Chapter II) that general conceptions of biology held by each country must diverge significantly. In an attempt to find out exactly how each country conceived the subject eight possible lines of approach were distinguished:

1. Molecular - biochemical
2. Cytological - genetic
3. Taxonomic - ecological
4. Taxonomic - evolutionary
5. Physiological
6. Physiological - ecological
7. Pre-medical - anatomical
8. Applied biology

Each country was requested to list in descending order of priority the importance given to each of these lines of approach. The results appear in Table 17.

Table 17 - General approach to biology teaching

	B	CY	DK	F	D	EIR	L	MA	NL	N	SC	E	S	CH	UK
Molecular/ biochemical	6		1		1	8	3	7	4	-	6	1	3=	5	5
Cytological/ genetic	5	1	2=	1=	2	6	2	2	5	2	3	2	3=	3	4
Taxonomic/ ecological	1=	2?	5	1=	5	2	1	6	-	-	4	5	1=	1	6
Taxonomic/evo-lutionary	1=	3?	3	1=	6	7	-	8	2=	1	5	4	5=	4	2
Physiological	4	4?	2=	1=	3	3	4	1	1	3=	1	3	3=	2	1
Physiological/ ecological	1=	5?	4		4	1	-	4	2=	-	2	6	1=	-	3
Pre-medical/ anatomical	7		-		7	5	5	3	6	3=	8	7	5=	-	7
Applied biolo-gy (e.g."rural science")	-		-		8	4	-	5	7	-	7	8	5=	-	8

In spite of the differences noted in Chapter II in the importance attached to each part of the syllabus, Table 17 shows that the approach is primarily biological in most countries, particularly in the treatment of physiology. In one or two countries, Norway and Sweden for example, the approach appears to be initially twofold, both botanical and zoological. In the United Kingdom, this underlying separation into botany and zoology seems to run through the whole biology course.

In most countries the physiological approach is still pre-eminent although the cytological/genetic approach now comes in second place, where the systematic/evolutionary approach, for so long predominant has gone to fifth or sixth place. The ecological approach ranks fairly high, although it has not yet reached the position of importance given to it by the delegates to the Strasbourg conference (see Chapter I).

Courses in most countries include some study of socially relevant questions although France and Sweden, with their emphasis on ecology are the only countries to treat this aspect of biology in any great amount of detail. Aspects of conservation and the pollution problem receive most attention, closely followed by the world food problem and the world population problem. Public health receives surprisingly little attention in most countries, but may well be discussed at an earlier level. Only in Cyprus and Ireland are schools not expected to play a part in sex education. In all other countries, this is usually given by the biology teacher, with some help from others. As this is an area of study influenced by the dominant religion of some countries, it might be difficult to make any recommendations here on an international plane.

The considerable variation in the amount of ecology studied has already been noted. In recent years, development of this area and improvement of ecological methods mean that this subject is now capable of forming a most valuable basis to all biological studies in school. In his report for the Council of Europe, 'Environmental Education and its social relevance in North-West Europe', T. Pritchard comments, "The present undoubted problems in conservation... are due basically to insufficient public awareness of the relationships between man and his environment... all sections of the population, at all ages from the primary school upwards must have their eyes opened to the importance of the environment".

A major obstacle to the introduction of an increased proportion of ecology into the biology programmes at this level is in the lack of teachers who are really knowledgeable about this subject. (This point will be discussed further in Chapter V).

Study of the type of work undertaken in connection with ecology revealed that detailed qualitative description and measurement of physical and biotic factors are the most frequently used methods. The more experimental methods, such as using statistical methods, and follow-ups in the laboratory or in the field are used far less frequently. This is disappointing for this type of exercise can provide the most useful scientific training. Until the teaching of this subject is remodelled it will be difficult to provide the environmental knowledge that is so urgently needed.

The state of ecology teaching might be improved by the provision of more facilities for undertaking field-work. Field centres already exist in Norway and the United Kingdom, and camps may also be organised in Sweden and Denmark. Lack of funds and of teachers trained in ecology mean that little opportunity exists for carrying out field work in other countries.

It is obvious tha [illegible] the general lack of material facilities, the dominance of traditional teaching methods, the emphasis on confirmatory practical work and teacher demonstration, the work done by research into biology and teaching methods for this subject has still not yet penetrated to the classroom. Although great interest is currently shown in remodelling biology courses so that ecology and molecular biology take on a more important role than the traditional areas of systematics, morphology and anatomy, much of the new thinking has yet to be translated into reality. Factors militating against swift modernisation of programmes are the material problem of providing resources, and the relatively low status of biology in the academic secondary school.

Table 18, indicating future trends in the teaching of this subject shows that in many countries biology is to be given a larger time allowance, more active teaching methods are to be used, and the proportion of genetics, cytology and molecular biology is to increase. One somewhat surprising feature is that the reforms outlined in this table are apparently not accompanied by any wide-scale increase in in-service training or material facilities.

Table 18 - Future trends in the Methodology of teaching biology

BELGIUM	New syllabus to be drafted in 1970 will move away from systematics and place more emphasis on ecology and molecular biology
CYPRUS	Attempt to move towards more active methods, with the possible introduction of the Nuffield Foundation biological programmes
DENMARK	Introduction of more practical work, possibly on lines of American BSCS
FRANCE	The new syllabus devised in 1966 with a predominantly ecological bias is still being evaluted
ICELAND	Increased emphasis on ecology and on laboratory work. Teaching approach will be molecular/biochemical
IRELAND	Biology was introduced as an option for the leaving certificate in 1969 for the first time
ITALY	In general, there is a move towards an expansion of courses and a biology course is to be introduced for the first time into the terminal class. In the lower secondaryschool, more pupil participation in biology lessons is recommended and it is probable that this trend will extend to the upper secondary school also Pilot schemes are at present being conducted in 62 schools on the lines of the BSCS
LUXEMBOURG	A major transformation of curricula, giving more time to biology began in 1968

NETHERLANDS	The Biological Council of the Royal Dutch Academy of Sciences is assisting in the organisation of in-service courses, the object of which is to introduce an increasing proportion of experimental work into the schools. In future the syllabus will stress molecular biology and ecology
NORWAY	The emphasis in the syllabus will, in future shift from morphology, anatomy, systematics and evolution to genetics, cytology and physiology
SCOTLAND	New Scottish Certificate of Education syllabus will be introduced in 1974, combining the approaches of the Nuffield Foundation course in biology and the BSCS
SPAIN	As a result of the OECD conference held in 1962, pilot schemes were started in the pre-university classes. These were based on the American BSCS books. These trials are now complete, and the trend in biology teaching will in future be towards an increasing amount of observation in the laboratory and less emphasis on the teaching of theory and systematics.
SWITZERLAND	In future emphasis in the syllabus will shift from botany and zoology towards more general biology, including ecology, genetics, molecular biology, evolution, anthropology and demography
UNITED KINGDOM	The teaching approach of the Nuffield Foundation courses is having a profound and far-reaching effect on biology teaching. Emphasis on factual knowledge is decreasing and growing importance is given to critical enquiry as a means of approaching scientific problems

CHAPTER IV

THE TERMINAL EXAMINATION

A major factor determining the form and standard of the terminal examination is the role attributed to it as a selector for careers and for higher education. Much depends here on the purpose of the terminal class of the academic secondary school, whether it leads on directly to higher education, or whether it combines academic study with a vocational orientation. In France, for example, pupils taking up employment on leaving the lycée are regarded as 'accidents', who should have been diverted into another type of school at an earlier date. In Sweden, on the other hand, some of the lines of the gymnasium are designed to ease the pressure on higher education by providing a combined academic and vocational training preparing pupils for taking up employment on leaving school.

Table 19 indicates that in the majority of countries, the final assessment serves both as a qualification and as a basis for competitive selection.

Table 19 - Purpose of terminal examination

	B	CY	DK	D	EIR	NL	N	S	CH	UK
1. Incentive	-	-	-	x	-	x	x	-	x	-
2. Vocational guidance (for pupil)	-	-	-	x	x	(x)	-	-	x	-
3. Vocational selection (for employers)	x	-	-	-	x	x	-	x	x	x
4. Competitive selection	x	x	-	x	x	-	x	x	-	x
5. Qualification for higher education	-	x	x	-	x	x	x	x	-	x

It is only necessary to use the terminal examination for the purpose of selection in those countries where a 'numerus clausus' operates with regard to university places. Among countries represented here, only Denmark and the Netherlands would appear to regard successful completion of the academic secondary course as a sufficient qualification for higher education. Other countries require a good mark in the terminal examination, although only in a handful of countries, the United Kingdom, Ireland, Cyprus and Turkey, is the supply of places so limited that for some universities an additional competitive examination is necessary. The shortage of places on university biology courses appears to be almost universal in Council of Europe countries, only Denmark and Malta reporting sufficient supply.

The degree of centralisation controlling examination standards is very varied, some countries allowing the teacher almost complete freedom to set and mark his own examinations, others setting only one paper for pupils throughout the country and maintaining standards by operating detailed marking schemes and by exercising careful statistical control. Where the examination is used for competitive selection it is obviously of great importance that a fair degree of control is exercised to ensure parity of standards. Table 20 shows that the United Kingdom and France both use marking schemes and maintain standards from year to year by statistical control. In both countries, the terminal examination is designed to serve as a selector for higher education, and control is strongly centralised. In the United Kingdom, where examinations are set and marked by nine different regional examining boards, the maintaining of parity of standards is particularly important. Denmark, however, allows the teacher far greater freedom, and examinations are set and marked internally with a certain amount of supervision from inspectors. At the same time, Denmark is one of the few countries where there is sufficient provision of places on university biology courses.

It would appear however, that in spite of the shortage of places for higher education and the need to use the terminal examination for competitive purposes, in most countries, the majority still rely on impression marking and on subjective methods of controlling standards from year to year.

Table 20

	B	CY	DK	F	D	IC	L	MA	NL	N	SC	E	S	CH	TU	UK
A. <u>Use of marking schemes</u>																
1. Impression marking	x	-	x	-	x	(x)	x	-	x	x	-	-	NA	x	x	-
2. General marking schemes	-	-	-	x	-	(x)	-	-	-	-	-	x	NA	-	-	-
3. Detailed marking schemes	-	x	-	-	-	-	-	x	-	-	x	-	NA	-	-	x
B. <u>Standards maintained from year to year</u>																
1. By memory and experience	-	-	x	-	x	x	-	-	x	x	-	x	NA	x	x	-
2. Statistically maintained	-	x	-	x	(x)	-	-	x	-	-	x	-	NA	-	-	x

From the amount of examination time given to biology, (see Table 21) it seems that this is regarded by many countries as a 'fringe' subject. A large proportion of countries examine biology orally and not in writing as compared with such key subjects as mathematics and modern languages, for which there are written examinations for all sections of the academic secondary school in almost all countries.

Table 21 - Nature of the terminal examination

	A	B	CY	DK	F	D	IC	EIR	L	MA	NL	N	SC	E	S	CH	TU	UK
A. Number of written papers	-	-	1	2	1	-	-	1	1	2	-	-	2	1	-	-	1	2
B. Length of oral test (in minutes)	30 45	15 20	-	30	20	15 30	20	-	30	-	20 30	30	-	-	-	15 30	-	-
C. Length of practical examination (in hours)	-	-	-	-	-	-	-	-	-	3	-	1/2 1	-	(x)	-	-	-	3
D. Work done during the course taken into account in the final assessment	-	-	x	-	-	-	-	-	-	-	(x)	x	(x)	x	x	x	-	-

Biology still plays a less important role in the terminal examination than the better established sciences, physics and chemistry, for which subjects there is usually some kind of written examination for science specialists. In Sweden, biology is one of the subjects for which there is no central test in the new system of continuous assessment. The teacher's estimate alone counts for biology in the final grade. Only in the United Kingdom and Malta does biology rank as a major subject in the final assessment, but here there is a subject rather than a certificate examination, and pupils specialise in only three to four academic subjects, for intending biologists, nearly always sciences or mathematics during the last two years of secondary education.

In spite of the increasing importance attributed to practical work, only the United Kingdom and Norway include a practical test in the terminal examination, and in the latter, this test is used only as a control to check the class teacher's assessment, and consists more or less of an exact repetition of one of 45 regulation experiments done during the course, such as the identification of a microscope slide, or food tests. These examinations test the standard of a class and do not serve as a qualification for individual pupils.

In the United Kingdom, the important role of practical exercises in biology instruction is reflected in the weight given to the practical examination, which forms an integral part of the final test. Examples of the type of exercise demanded of pupils appear in Appendix III. One of the major problems of setting practical examinations is the provision of an adequate supply of specimens. In the United Kingdom, these must be found for fifteen to twenty thousand candidates, and for this purpose, supplies are retained from year to year by the examining boards, and teachers given warning in advance of what they will be required to provide themselves.

Although no specific practical tests are given in the majority of countries, candidates may be asked to identify and comment on specimens during the oral examination.

In addition, in a few countries, project work carried out during the course may count in the final assessment. In the Federal Republic of Germany, a small proportion of pupils submit a dissertation based on one year's research for a project. In the United Kingdom also, it is possible to submit a project, which may give extra marks to outstanding pupils, but which will not prejudice the results of others. The final mark for those taking examinations based on the Nuffield biology course consists of half for examination work and half for course work.

The types of question set at this level tend to be essays and problems although there is still evidence of some emphasis being given to questions demanding reproduction of fact. Examples of examination questions from several countries appear in Appendix III.

A comparison of the skills tested in the terminal examination (see Table 22) confirm the evidence found in the studies of teaching objectives and methods, that emphasis is still laid primarily on the acquisition of knowledge, at the expense of the acquisition of the 'tools' of the subject, such as the ability to make biological drawings and diagrams. Again the number of countries giving any importance to those skills demanding independent thinking on the part of the pupil, the investigation of unknown specimens and experimental design, is disappointingly small. Among the intellectual skills demanded, the ability to reproduce fact and to compare specimens rate as more important than the ability to evaluate and to interpret biological data. The only practical skill considered of importance is the use of the microscope.

Table 22 - Pupil skills examined in terminal examination

	B	CY	DK	F	D	EIR	NL	UK
Knowledge of biological facts	x	x	x	x	x	x	x	x
Comprehension of biological prose		x		x			(x)	
Comprehension and interpretation of biological data		x		x	x		(x)	x
Deduction of implications of a biological situation		x		x	x		x	x
Comparison of biological situations or specimens		x		x	x	x	x	x
Ability to evaluate validity of statement or experiment				x	x	x	(x)	x
Ability to communicate biological information in writing	x		x			x		x
Ability to design simple experiment				x	x	x	(x)	x
Description and investigation of unknown specimen			(x)	(x)			x	x
Ability to make good biological drawing			(x)	x		x		x
Ability to make good biological diagram			(x)	(x)		x		x
Dissection				(x)				x
Use of microscope			x	x	x			x
Maceration of material				(x)				
Cutting of sections of botanical material			x	(x)				(x)

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It is evident that in spite of the interest shown in new methods of instruction and in the recent developments of research, the pattern of the terminal examination in biology remains strongly traditional and the lack of importance given to this subject in the final assessment in many countries reflects its low academic prestige. Although a considerable amount of attention is being given to the development of experimental skills and to the academic "up-grading" of the subject, the skill demanded in the majority of countries in the final examination is principally the ability to store and to reproduce facts.

Until those skills tested by the terminal examination have come nearer to those the course aims to develop, the final assessment cannot be considered a true estimate of biological ability - and yet this is the test which for most countries serves as a predictor of the ability to study biology at a higher level.

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CHAPTER V

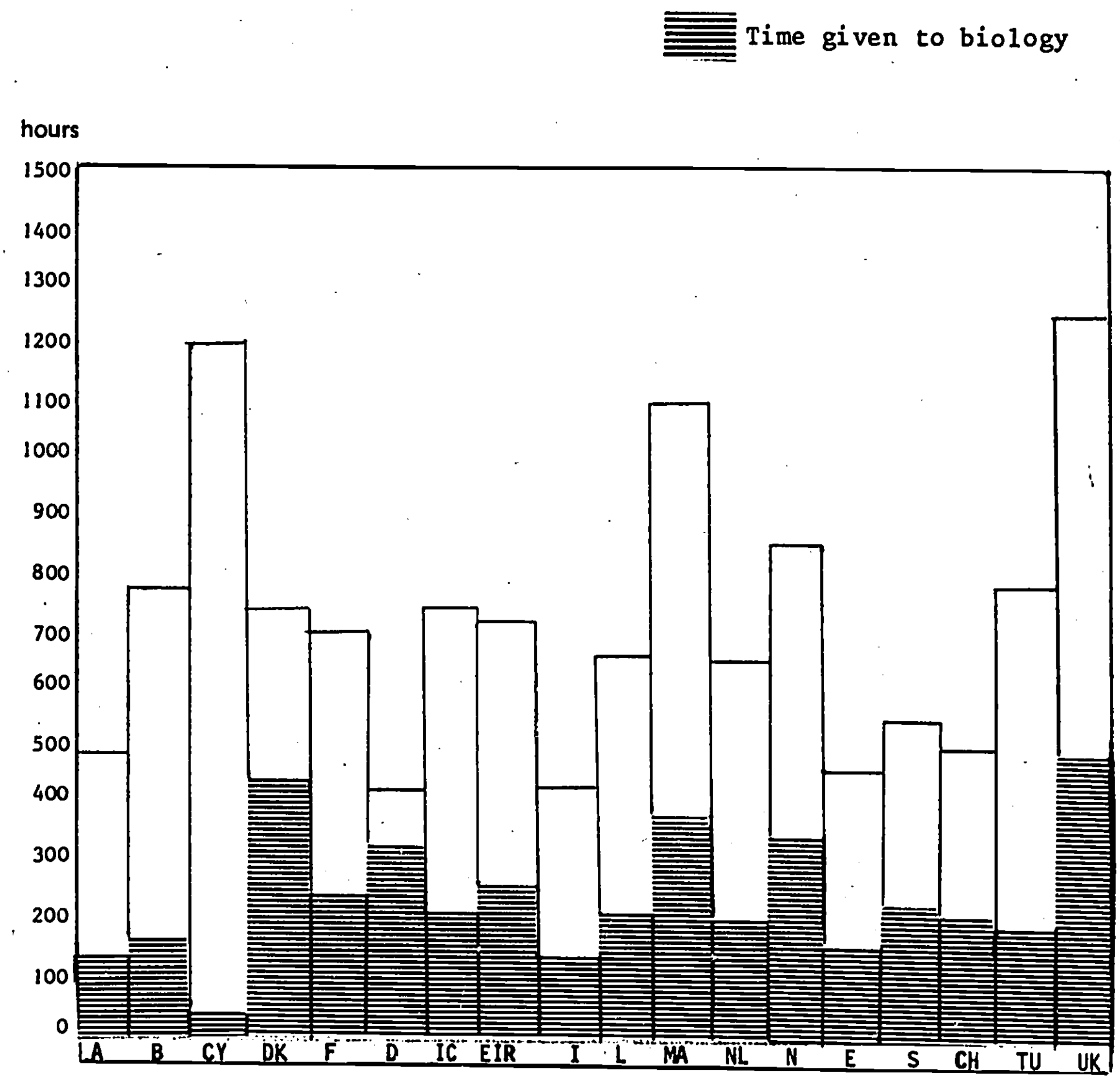
GENERAL ORGANISATION OF THE BIOLOGY COURSES WITHIN THE ACADEMIC SECONDARY SCHOOL

The problem of providing biology courses for pupils at this level must vary considerably in size from country to country, with the overall population varying from a quarter of a million in Iceland to close on sixty million in the Federal Republic of Germany. Another consideration influencing planners is the percentage of the age group entering this type of education. Sufficient statistical detail was unfortunately not available here, otherwise a study might have been made comparing the size of each country and the number following biology courses at upper secondary level with the provision of material facilities such as laboratories and apparatus. It may be the case that the smaller countries are not equipped to undertake research projects of the scope of the Nuffield or BSCS projects, and that innovations may tend to come from the larger countries. On the other hand, it might be easier to introduce new methods into the smaller countries with a homogenous educational system.

In spite of considerable variation in the general organisation of secondary education, in particular in the number of years given to it, ranging from nine in Austria and the Federal Republic of Germany to five in Norway, progressive selection, both internal and external operates within all systems. In all countries, some degree of specialisation can be observed, and previous knowledge of the subject is required for entrants to university biology courses in all countries except Ireland and Belgium. A physics/mathematics line or section is well established in the academic secondary school throughout Europe ; natural science lines are comparatively new in many countries, and distribution is not yet even between the different options at this level. In Norway, for example, it is not yet possible to study biology at all gymnasia, and in France, girls tend to choose the natural science option, while boys prefer mathematics and physics.

Table 23 shows that the proportion of time given to biology as compared with the other sciences is still small in most countries.

Table 23 - Total hours available for science in final three years of Academic Secondary School (times given for most specialised sections)



The information given in this table is for the most specialised sections of the academic secondary school, and the proportion of time given to biology in other science sections is considerably smaller. Biology courses for non-scientists are usually very limited, and tend to be either a more superficial treatment of the same material as the specialist courses, study of a smaller range of topics, or discussion of general themes, such as genetics, or the role of man in nature.

Although biology might seem to offer a simple way of approaching scientific thinking to the student of the humanities, it is, in fact, physics and sometimes chemistry that are more usually included in non-specialist science courses.

A comparison of the proportions of time given to the major areas of the curriculum (see Table 24) shows the importance given in all countries to mathematics, and in all, save the United Kingdom, to the study of languages.

Table 24 - Percentage of time given to science and other major areas of the curriculum for the last three years of course

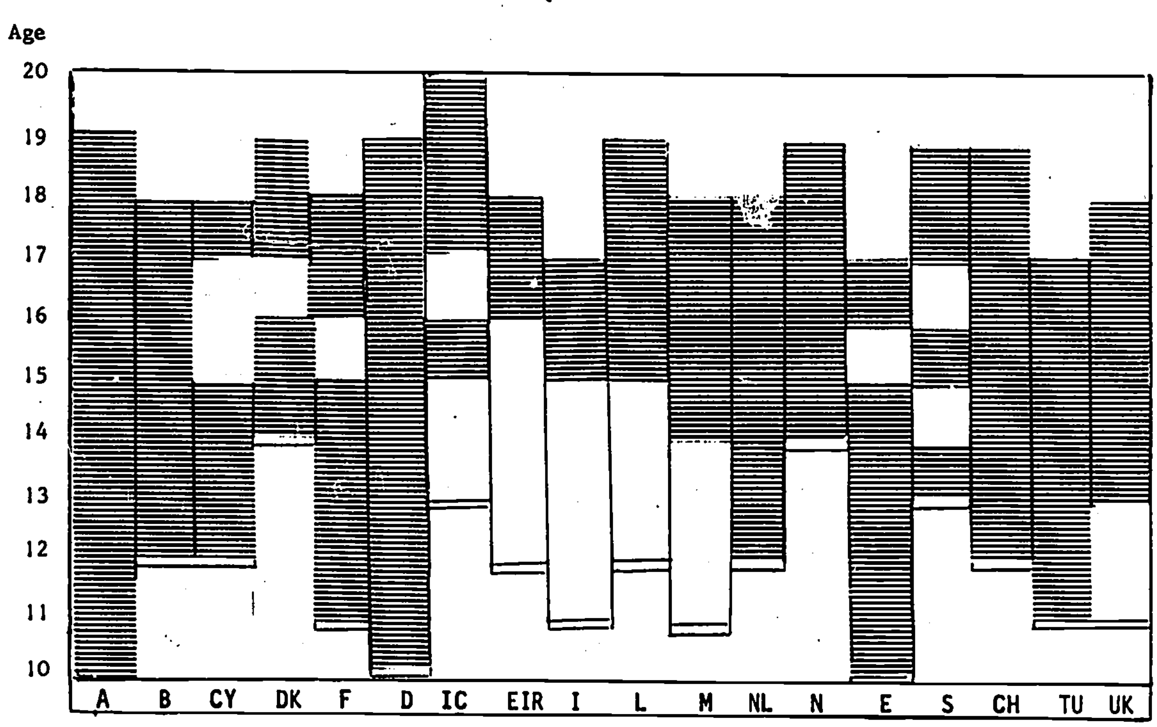
	Biology	Chemis-try	Physics	Maths	Langua-ges	Other
Austria	5 %	7 %	5 %	11 %	30 %	42 %
Belgium	4 %	3 %	7 %	15 %	34 %	38 %
Cyprus	1 %	10 %	15 %	5 %	20 %	49 %
Denmark	10 %	6 %	7 %	11 %	23 %	43 %
France	6 %	5 %	8 %	15 %	28 %	38 %
Germany	8 %	8 %	10 %	12 %	18 %	44 %
Iceland	7 %	7 %	8 %	17 %	not known	not known
Italy	4 %	3 %	4 %	10 %	35 %	44 %
Luxembourg	3 %	4 %	6 %	15 %	35 %	37 %
Malta	10 %	10 %	10 %	15 %	25 %	30 %
Netherlands	3 %	9 %	10 %	13 %	27 %	38 %
Norway	6 %	9 %	10 %	11 %	26 %	38 %
Spain	9 %	9 %	9 %	18 %	13 %	42 %
Sweden	4 %	7 %	11 %	14 %	29 %	35 %
Switzerland	5 %	5 %	5 %	10 %	25-35 %	40-50 %
Turkey	6 %	8 %	9 %	17 %	not known	not known
United Kingdom	20-25 %	20-25 %	20-25 %	20-25%	--	0-35%

Research into the teaching of other subjects has shown that mathematics, the mother tongue and modern languages are the only 'core' subjects of the academic secondary school in Europe, being studied by all pupils in all sections or lines, with the exception of the United Kingdom and Ireland. In the latter, however, the amount of marks allotted to mathematics in the Leaving Certificate is greater than those allowed for all other subjects, save Irish, and study of this subject is therefore regarded as higly desirable. It is possible only in the United Kingdom to study subject combinations containing neither mathematics nor science, and similary it is possible, indeed customary, for scientists to study no languages. The degree of specialisation here, however, is reflected in the generous time allowance for biology at this level.

Biology clearly does not rank as one of the basic subjects in an academic education, nor is it yet considered as on a par with the other sciences. It is surprising to note the lack of continuity in teaching this subject in many European countries (see Table 25).

Table 25 - Duration of course in biology

Start of secondary course



In five countries, there is one year in the final three, when no biology is taught. In Italy, furthermore, no biology as such is taught at all in the last two years.

In most countries, it will be observed that biology instruction is not given from the outset of secondary education, although considerable interest was shown by the delegates at the Strasbourg conference in the effects of teaching integrated science in the lower secondary school on the attitudes of pupils at senior level. Although six countries teach general science, the introduction of integrated science is, as yet, only being discussed in one or two. The physical sciences course recently introduced at upper secondary level in France represents an attempt to coordinate the study of topics which are becoming increasingly difficult to separate into two hard and fast categories, but apart from the inclusion of elements of geology in some courses, there is little evidence of any effort to combine study of biology with the other related sciences.

Provision of biology teachers

At the OECD conference on the teaching of biology (Vevey, 1962) the following statement was made :

" First we need enough well-trained and educated biology teachers... When we ... have that, then the time is ripe for changing curricula and programmes ".

There are two parts to the problem of providing teachers for biology, the first is the initial training, both academic and pedagogic, of a sufficient supply of teachers to fulfil current needs, the second, the maintaining of the present teaching force in contact with new developments.

The majority of countries report an actual, or incipient, shortage of biology teachers. In particular, the numbers entering this branch of teaching seem to be declining. In the Federal Republic of Germany, this shortage will become particularly acute in three or four years time, as a large proportion of biology teachers are now close to retiring age. Where 17 per cent of teachers in the 60-65 age group are biologists, only 1 per cent of those now entering teaching are qualified in this subject. In other countries, where there is a shortage of teachers - Denmark and Switzerland for example - the proportion of men biology teachers considerably exceeds that of women. It might be possible here to counteract deficiencies if more women were attracted to the profession.

The major reason given for the almost universal shortage of teachers is the low status of teaching as a profession, and more particularly, of biology as an academic subject. Although research work appears to be more attractive, the majority of graduates in biology still enter teaching in all countries except the United Kingdom. Poor salaries are cited as a further disincentive by half the countries. Coupled with this is the expense of training, and the number of years, in some cases as many as seven, before the first salary is received. Lengthy training would not necessarily deter students, if the subsequent salaries were good, but this is often not the case. In the Federal Republic of Germany, for example, the probationer teacher must at present teach for two years, while receiving a very small salary, although measures are now being taken to reduce both the length of pedagogic training, and of probationary teaching.

Once an adequate teaching force is ensured, the problem arises of retraining and of keeping teachers in constant touch with recent developments, or else the situation may arise where although there is no actual shortage in numbers, the quality of the teachers themselves may be under standard. In science subjects, the problem of keeping up to date with the new developments of the subject is particularly acute. It has been suggested that the small proprotion of ecology included in syllabuses is a reflection of the fact that only recently qualified teachers have undertaken any detailed study of this area.

In-service training courses in biology are of two main types : the first aims at keeping teachers informed of the findings of research and of the expansion of the subject itself, while the second are disigned to familiarise them with new teaching methods. In all countries the considerable interest shown in the teaching of biology is reflected in the existence and activities of teachers' associations, and the high attendance at courses. Although in only a few countries attendance at courses leads to increased salary or promotion, between 20-50 per cent of biology teachers attend them. Sweden has achieved nearly 100 per cent attendance rate at in-service training courses.

Details of in-service training courses and teachers' associations appear in Appendix IV.

CONCLUSIONS AND RECOMMENDATIONS

There is a remarkable similarity between the recommendations made in 1962 and 1964 OECD conferences on the teaching of biology and those made at the meetings organised by the Council of Europe. Table 26 shows those recommendations which are directly comparable.

Some steps have been taken to implement these recommendations, but as yet only a few reforms have been made. In the area of curriculum development, few countries, other than France and Sweden, lay any emphasis on ecology and although the biology of man is now becoming increasingly important, there are still one or two countries who do not study this area. However new courses, moving away from traditional study of biology, have been introduced in seven countries. The recommendation that biology should be a basic subject in the curriculum for all pupils is still far from being implemented - only the United Kingdom and Sweden appear to have special courses for non-scientists. This may be because the status of biology as an academic subject remains low.

As far as teaching methods are concerned, lip-service is generally paid to the importance of understanding principles rather than the learningof fact. But in practice, it seems that learning of facts still receives greater emphasis - particularly in the terminal examination. Laboratory work is on the increase, but there are still a few countries able to do virtually none - due to lack of facilities and teachers and laboratory assistance. In the majority of countries, however, practical work remains primarily confirmatory in nature. Gardens and greenhouses are provided in only 10 % of schools, libraries are limited and field study centres are known only in 4 countries. Audio-visual materials are in far more plentiful supply. One encouraging feature is the development of pilot experiments and research into biology teaching methods.

As far as the teachers of biology themselves are concerned, inadequate supply was reported in most countries, but only a few are taking steps to improve the situation. Investigation into the nature of teacher training is beginning in some countries. Co-operation between school and university teachers is still very limited.

It appears that the effects of recommendations made at the earlier conferences have had only a limited success and the situation remains essentially unchanged. It may be that recommendations remain unimplemented because of lack of money, or lack of interest and knowledge in the right quarters. Bernhard Rensch commented at Vevey in 1962, "Satisfactory reform of biology education will be possible in many countries only when educational experts, administrative authorities and members of parliament are themselves better instructed about biological discoveries and their meaning". Further reasons why reform is slow to take place may be that the recommendations made at these conferences fail to reach the appropriate authorities or that many of the recommendations apply to internal organisation and attitudes which international organisations have no power to influence.

It would seem appropriate to conclude this report by outlining the fields of action in which an international organisation might operate :

1. All three conferences have called for the formation of an international committee concerned with one or more aspects of biology teaching. After settling some organisational and policy problems, it should be possible to put this suggestion into practice. This is why the suggestion of the delegates at the Stockholm conference that a steering committee be set up to work towards the formation of a full "European" biology group, may have a better chance of success than its predecessors.

2. The delegates at Stockholm further recommended that this steering committee should :

   a) Arrange to have a coordinating secretary during its brief existence before being replaced by the permanent group. The function of secretary might possibly be taken by members of the steering committee in turn.

   b) Hold its first meeting as soon as possible.

3. The steering committee should be recommended to further :

   a) The organisation of the exchange of information. In this connection attention is again drawn to the recommendation made at Strasbourg in December 1968 that the Secretariat should act as a clearing house for information on the teaching of biology. The need now is for circulation of articles on specific topics. Articles should be as detailed as possible, and should describe methods of teaching at present in use and those to be desired in future in each country. A suitable first topic might be ecology and nature conservation, provided that this is treated in a precise and scientific manner.

   b) A continuation of the discussion on the definition of the aims of biology teaching, initiated in Stockholm in the hope that some agreement might be reached on a few aims common to all countries.

   c) Education in biology at earlier levels. It was felt that a comparative study (similar to the present one) could be of interest and use.

Additional recommendations

Further comments on the recommendations made at Strasbourg suggest that some of the following could also usefully be considered by either the steering committee or the Permanent Biology Group.

1. The biology group should meet to try to unify the requirements for final examinations and university entrance. For this the following steps would need to be taken :

   a) The identification of a minimum amount of factual content which might be included in the syllabuses of all countries.

   b) The identification of the abilities and techniques which pupils might be expected to acquire.

   c) Agreement on the standards of the final assessment.

2. The Council of Europe will be the third organisation to sponsor a conference which recommends some sort of international action in connection with biology teaching. The previous two appear to have had only limited effect. The biology group should consider whether their effectiveness would be increased if they cooperated with the people involved in the previous biology conferences, and in the production of the UNESCO book "New Trends in Biology Teaching".

3. If the previous suggestion were adopted, the biology group should be in a strong position to facilitate exchange of information on the reforms being carried out in the various countries and also to provide information and advice on new developments in curriculum and in teaching methods.

Table 26 - Recommendations made at four international meetings

Vevey, 1962 (OECD)	Helleback, 1964 (OECD)	Strasbourg & Stockholm 1968 & 1970 (Council of Europe)
A. On the curriculum 1. "... that all pupils between the ages of 11 and 18 years be provided with an integrated and continuous natural science curriculum in which broad, up to date, and well taught biology takes its place as an essential component in general education".	"... that the education of all children throughout the whole of their school lives be permeated by the subject matter, principles, methods and spirit of biology".	In view of the new objectives and achievements in the teaching of biology ... it is (now) indispensable and a basic requirement for general education. (It) should therefore be taught to all pupils at all levels.
2. "... general biology must be assigned an importance at least as great as that given to any other natural science".	"Among the sciences, biology has a special claim to the attention of educators... In one direction it is closely connected with the other natural sciences, in another direction it merges with the social sciences".	
3. "Only through a study of organisms can man understand himself, also an organism, and thereby approach wisely the task of improving his life".	"Human biology and the relation of biology to human affairs should hold a central place".	"... (Biology should) ensure a better understanding of current problems with which mankind has to content (e.g.) over-population...".
4. "Biology... provides essential knowledge for the protection and wise long-term optimal utilisation of man's natural resources".	"No one can live a really full life without an understanding of (man's)... place in the whole ecology of the world".	"... biology should above all familiarise pupils with the ecological aspects of life, namely the relationship between living creatures and their environment". (Strasbourg)
5. "In view of the different needs and situations in different countries we do not recommend a particular curriculum. A number of promising courses and textbooks are available in some countries and we recommend their study for possible adaptation to each country's circumstances".	"(Courses) should be adapted to the local conditions of the country".	"(Biology) teaching should (nevertheless) retain its nation character, deriving from specific national aims and from the characteristics of the population, the territory and the flora and fauna of each country". (Strasbourg)

Vevey, 1962 (OECD)	Helleback, 1964 (OECD)	Strasbourg & Stockholm 1968 & 1970 (Council of Europe)
B. On teaching methods 1. "... Teaching (should aim) at understanding of general principles e.g. evolution".	The topics (in a biology syllabus) should lead "to an understanding of important biological ideas and principles".	"There is a need for a sound basis of fundamental knowledge".
2. "... Laboratory and field work are therefore essential".	That "well equipped laboratories and other facilities (gardens, greenhouses, audio-visual materials, libraries etc.)... be provided in all secondary schools... and stations for field studies... in suitable areas".	
3. "Pilot experiments to assess the value of new courses and textbooks should be encouraged".	(That research be done to develop) "suitable methods and materials for the teaching of modern biology".	
C. Possible fields for international action 1. An international coordinating committee on biological education, composed of representatives of national committees, should be established to ensure coordination...	"... than an international committee be set up".	"that a steering committee be constituted which will work towards the establishment of a permanent biology group within the frame work of the Council of Europe".
2. ...and distribution of information"Make known to teaching circles in each country both the BSCS materials and those of European countries (exchange of textbooks and teaching brochures, in certain cases after translation).	... to advise on school biology books, to produce annually a selected list of books available... (and to distribute these lists) to central educational authorities for subsequent distribution to schools	"The Council of Europe is asked to (make) possible an exchange of information on the reforms being undertaken in the various countries. Articles should be as detailed as possible and should describe methods of teaching at present in use and those to be desired in the future in each country".

Vevey, 1962 (OECD)	Helleback, 1964 (OECD)	Strasbourg & Stockholm 1968 & 1970 (Council of Europe)
3. "It would be useful to have an internatio-nal centre wich would regularly distribute skilfully written reports on biological problems and on important new results of research to all leading newspapers and popular journals".		
4. "Some source of initial support should be sought to get the work of the national and international committees started". "To organise at times seminars on the reform of school biology curricula".		The Council of Europe is asked to faci-litate the continuance of work of the (biology discussion) group.
5. (An international agency could) "solve the practical problems of the acqui-sition by European schools of audio-visual and experimental materials from abroad".		
6. (An international agency could help in) "the search for finance to aid the establishment of facilities for pilot projects and refresher courses". "To arrange visits between the national committees for exchange of information and experience and to establish closer contact etc."	"That adequate funds be made available (for research)".	"The Council of Europe is asked to (make) possible attendance at practical courses and training organised by the governments of the various member states, if necessary by the allocation of grants".

APPENDIX I

GENERAL REFERENCES AND THE MAIN NATIONAL PUBLICATIONS

A. General

Organisation for Economic Co-operation and Development

- i New Thinking in School Biology, 1962
- ii Biology today - its role in Education, 1964

Council for Cultural Co-operation - Education in Europe Series

- i School Systems, a guide
- ii How to qualify as a "biologist" in the Universities of Europe

UNESCO

- i Statistical Year Book 1967
- ii New trends in Biology Teaching, Vol. 1, 1966

Council of Europe

Environmental Education - its social relevance in N.W. Europe (by T. Pritchard) Whittakers Almanack 1969

B. Aims

Austria :

Erziehung und Unterricht, Stadtschulrat für Wien

BERGER, Walter, Professor Dr., M.A. (London), Die österreichischen und englischen Lehrpläne an allgemeinbildenden Mittelschulen (höheren Schulen). Eine vergleichende Studie mit einer Darstellung der Struktur der englischen Grammar School ("Schulwissenschaftliche Reihe des Bundesministeriums für Unterricht, Band I"), Wien, Bundesministerium für Unterricht.

Belgium :

Preface of the brochures and syllabuses (c.f. Section C)

Cyprus :

Stated in the official syllabus

Denmark :

Guidance on the Curriculum in the Gymnasium, 1961

MINISTRY OF EDUCATION OF DENMARK, Regulations concerning the Curriculum in the Gymnasium, 1961

France :

Official Texts in the Official 'Bulletins' of national education

Germany :

Included in the curricula of the separate Länder as follows :

FRANZ, Wilhelm, Oberstudienrat, Die äusseren Voraussetzungen des Wahlpflichtfaches im naturwissenschaftlichen Unterricht, ("Das Wahlpflichtfach im Unterricht der Gymnasien - Beiträge zu seiner praktischen Gestaltung"; 1. Heft), Heidelberg, Quelle und Meyer Verlag, 1964

Baden-Württemberg

KULTUSMINISTERIUM DES LANDES BADEN-WÜRTTEMBERG, Lehrpläne für die Gymnasien Baden-Württembergs, Villingen/Schwarzwald, Neckarverlag GmbH, 1957

KULTUSMINISTERIUM DES LANDES BADEN-WÜRTTEMBERG, Kultus und Unterricht, Amtsblatt des Kultusministeriums Baden-Württemberg, März 1958, Nummer 3

KULTUSMINISTERIUM DES LANDES BADEN-WÜRTTEMBERG, Kultus und Unterricht, Amtsblatt des Kultusministeriums Baden-Württemberg, April 1959, Nummer 4a

Schulordnung für die Gymnasien, hier: Stundentafeln und Lehrpläne, Erlass v. 8.XII.1961, Villingen/Schwarzwald, Neckarverlag GmbH, 1961

Bayern

STAATSMINISTERIUM FÜR UNTERRICHT UND KULTUS,
Amtsblatt Nr. 1 v. 24. Jan. 1964
Amtsblatt Nr. 16 v. 26. Aug. 1964
Amtsblatt Nr. 17 v. 16. Sept. 1964

Stundentafeln und Stoffpläne für die höheren Schulen in Bayern (München 1960)

Berlin

SENATOR FÜR VOLKSBILDUNG - ABT. II, Entwurf eines Bildungsplans für die Oberschule wissenschaftlichen Zweiges, Berlin, Dez. 1954

SENATOR FÜR VOLKSBILDUNG, Ordnung der Reifeprüfung an den Oberschulen wissenschaftlichen Zweiges (Gymnasien) im Lande Berlin, 8. Jan. 1959, Berlin, April 1959, Berlin

Hessen

DER HESSISCHE MINISTER FÜR ERZIEHUNG UND VOLKSBILDUNG, "Bildungspläne für die allgemeinbildenden Schulen im Lande Hessen. I: Einleitung, Stundentafeln und Erläuterungen", Amtsblatt des Hessischen Ministers für Erziehung und Volksbildung, Wiesbaden, März 1956, Sondernummer

DER HESSISCHE MINISTER FÜR ERZIEHUNG UND VOLKSBILDUNG, "Bildungspläne für allgemeinbildende Schulen - Neuordnung des naturwissenschaftlichen Unterrichts an den Gymnasien", Sonderdruck aus dem Amtsblatt des Hessischen Ministers für Erziehung und Volksbildung, Wiesbaden, Juni 1962, Nr. 6

DER HESSISCHE MINISTER FÜR ERZIEHUNG UND VOLKSBILDUNG, "Bildungspläne für die allgemeinbildenden Schulen im Lande Hessen. II: Das Bildungsgut, A: gemeinsame Bildungs- und Erziehungsaufgaben der allgemeinbildenden Schulen", Amtsblatt des Hessischen Ministers für Erziehung und Volksbildung, Wiesbaden, Januar 1957, Sondernummer 1

DER HESSISCHE MINISTER FÜR ERZIEHUNG UND VOLKSBILDUNG, "Der Vollzug der Lernmittelfreiheit 1963 an allgemeinbildenden Schulen", Amtsblatt des Hessischen Ministers für Erziehung und Volksbildung, Wiesbaden, Oktober 1962, Sondernummer

Niedersachsen

Allgemeine Richtlinien und Richtlinien für den Unterricht in den Fächern Physik, Chemie und Biologie, Herm. Schroedel-Verlag, 1966

Nordrhein-Westfalen

Richtlinien für den Unterricht in der Höheren Schule, Heft 8-r: Biologie

Nürnberger Lehrpläne des Deutschen Vereins zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts. In: Der Math. und Naturwiss. Unterricht 18. Band, Heft 1/2, Seite 1

Rheinland-Pfalz

Amtsblatt des Ministeriums für Unterricht und Kultus Erlass v. 1 Tgb. Nr. 802 1. v. 14. Jan. 1964

Saarland

DER MINISTER FÜR KULTUS, UNTERRICHT UND VOLKSBILDUNG, Richtlinien und Stoffpläne für das Fach: Biologie, Juli 1960

Iceland :

Programmes and official directives issued by Ministry of Education

Ireland :

"Rules and Programmes for Secondary Schools 1968-69". Government Publication Sales Office

Italy :

Ginnasio superiore, liceo classico, liceo scientifico - orari e programmi d'insegnamento esami di maturità classica e scientifica, (Programmi scolastica Pirola - 1083), Milano L. di G. Pirola, 1964

MINISTERO DELLA PUBLICA ISTRUZIONE, DIREZIONE GENERALE - ISTRUZIONE MEDI MEDIA, CLASSICA, SCIENTIFICA E MAGISTRALE, Programmi di insegnamento per la la scuola media, il liceo ginnasio, il liceo scientifico e l'istituto magistrale, 1944-45, Roma, Istituto Poligrafico dello Stato, 1959 (ristampa)

Luxembourg :

"Horaires et Programmes de l'enseignement secondaire et supérieur et de l'institut pédagogique, 1967-68". Published by "Ministère de l'Education Nationale du Grand Duché de Luxembourg", 12, rue du St. Esprit, Luxembourg

MINISTERE DE L'EDUCATION NATIONALE, Courrier de l'Education Nationale, Avril 1963, N°. 2

Malta :

Government Grammar Schools, Malta - Gozo : Syllabus for the Lyceum and the Girls' Grammar Schools, 1965

Netherlands :

Programme basis for the Modernisation of the Biology Curriculum (written by an Inspector)

MINISTERIE VAN ONDERWIJS EN WETENSCHAPPEN, Voorstel leerplan Rijksscholen, K. Biologie, Staatsuitgeverij te 'S-Gravenhage, 1968

Norway :

Undervisnings plan for Gymnaset

Tilrading om Reform av Gymnaset, 1967

Spain :

MINISTERIO DE EDUCATION NACIONAL, Plan de bachillerato de 1957 - decreto de 31 de mayo de 1957 y cuestionarios ("Cuadernos de orientación didactica"), Madrid, Publicaciones de la Dirección General de Enseñanza Media, 1959, Num. 69

MINISTERIO DE EDUCACION NACIONAL, Plan de bachillerato de 1957 - decreto de 31 de mayo de 1957 y cuestionarios ("Cuadernos de orientacion didactica"), Madrid, Publicaciones de la Direccion General de Enseñanza Media, 1963, Num. 69

MINISTERIO DE EDUCACION NACIONAL, Plan de bachillerato de 1957 - programas de quinto curso (con orientaciones metodológicas), ("Cuadernos de orientación didactica"), Madrid, Publicaciones de la Dirección General de Enseñanza Media, 1960, Num. 15

MINISTERIO DE EDUCACION NACIONAL, Plan de bachillerato de 1957 - programas de sexto curso (con orientaciones metodológicas), ("Cuadernos de orientación didactica"), Madrid, Publicaciones de la revista 'Enseñanza Media', 1958, Num. 49

Sweden :

"Läroplan för gymnasiet".

United Kingdom :

(Policy Statement of Association for Science Education : School Science and General Education)

Preface to Nuffield Foundation publications (strictlv applies only to schools teaching the Nuffield Scheme but in practice many of these aims are held by other schools also)

Scotland :

Various publications of the Department of Education and Science Biology Syllabus (1968 of S.C.E. Examination Board) "Science for General Education, Curriculum Paper 7 (Consultative Committee on the Curriculum)

C. Organisation (Svllabuses etc.)

Austria :

BUNDESMINISTERIUM FUR UNTERRICHT, "88. Verordnung: Lehrpläne der Gymnasien, Realgymnasien und Wirtschaftskundlichen Realgymnasien für Mädchen sowie des Bundesgymnasiums für Slowenen", in III. Sondernummer zum Verordnungsblatt für den Dienstbereich des Bundesministeriums für Unterricht, Wien, 1, Oktober 1967, Stück 10a

Belgium :

FEDERATION NATIONALE DE L'ENSEIGNEMENT MOYEN CATHOLIQUE, Programme et directives, sciences naturelles, Lierre 1961

MINISTERE DE L'INSTRUCTION PUBLIQUE, DIRECTION DE L'ENSEIGNEMENT MOYEN, Instructions concernant la réforme de l'enseignement moyen, physique - chimie - biologie, 1960

Cyprus :

Official Syllabus

Denmark :

See Section B

France :

Horaires et programmes de l'enseignement de second degré, Paris, Librairie Vuibert 1969

Instructions concernant la réforme de l'enseignement moyen, physique - chimie - biologie, 1960

Germany :

See Section B

Iceland :

See Section B

Italy :

Syllabuses from the Ministry

Special requirements circularised by Ministry

Luxembourg :

See Section B

Norway :

See Section B

Spain :

Decrees : 31-V-1957 ; 11-VII-1963 (1862/1963) ; 31-V-1967 (1106/1967)

Sweden :

See Section B

ORRING, Jonas : School in Sweden, Sö-Förlaget/Skolöverstyrelsen, Stockholm, 1967

Switzerland :

"Reglement für die eidgenössischen Maturitätsprüfungen" (1929, but in process of revision)

United Kingdom :

Royal Society - Institute of Biology, Biological Education Committee Survey Report (1962) on "Biological Sciences in Sixth Forms and at Universities in the U.K."

Syllabuses of the examining boards :

Associated Examining Board, Wellington House, Station Road, Aldershot, Hants.

Cambridge University Local Examinations Syndicate, 17 Harvey Road, Cambridge.

Welsh Joint Education Committee, 30 Cathedral Road, Cardiff.

North Universities Joint Matriculation Board, Manchester 15.

Oxford University Local Examinations Syndicate, Summertown, Oxford.

Oxford and Cambridge School Examination Board, 10 Trumpington St., Cambridge.

Southern Universities Joint Board, 22 Berkeley Square, Bristol 8.

University of London Examinations Board (University Entrance and School Examinations Council, Senate House, London, W.C.1.)

Scotland :

SCE Examination : Syllabus

Scottish Education Department : Science News Letter : Field Work in Biology

Scottish Schools Science Equipment Research Centre : Lists of Apparatus

Consultative Committee on the Curriculum : Curriculum Paper 7

D. Methodology

France :

See Section B

Luxembourg :

See See Section B

Norway :

See Section B

Spain :

Ministerial Orders 5-VI-1957 ; 8-VI-1957 ; 26-III-1958 ; 8-VIII-1963 ; 8-XI-1963 ; 4-IX-1967 ; 14-XI-1967 ; 20-II-1968

Sweden :

"Läroplan for gymnasiet"

3 other books help with planning

United Kingdom :

Association for Science Education - School Science Review

Association for Science Education - Education in Science

Nuffield Foundation Publications

Teachers' Guides published with textbooks (increasing tendency)

Various publications of the Department of Education and Science

Scotland :

S.E.D. : Memoranda

Colleges of Education : Aberdeen College publishes a "Biology Newsletter"

APPENDIX II

DETAILED SYLLABUS ANALYSIS

Column 1 : In column 1 the depth of treatment given to each item is marked on the following scale :

I Brief consideration

II An average amount of time

III Very thorough

Column 2 : In column 2 the type of practical done in connection with each item is indicated in accordance with the following scale :

A. A great deal of practical work done by pupils

B. A limited amount of practical work done by pupils

C. Item treated theoretically only

D. Demonstration done by the teacher

Column 3 : In column 3, the importance of each item for qualification for university is indicated according to the following scale :

E. Essential or very important

F. Important

G. Not very important

The figures at the top of each sub-section indicate the amount of time (in minutes) for which items in this section are studied.

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1.	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
551 <u>Earth Sciences and Related Matters</u>																																				
9 <u>Land and Soil</u>																																				
90 Soil formation and evolution										III	A					II	C	F				I	C/D	F							I			I	D	E
91 Quantative Studies of soil constituents										II	A											I	C/D	F							I			III	A	E
92 Soil structure										II						II	C	G		B/D	F	I	C/D	F							I			II	B	E
93 Soil profile																II	C	F				I	C/D	F							I	B	F			
94 Physical properties of soil																I	C	G		B	G	I	C/D	F							I	B	F	II	A	E
574 <u>Physiology</u>																																				
11 <u>Transport systems</u>	120-160							30			20			90			60			80		100-150				30			70			35			150	
111 <u>Sap circulation</u>																																				
1112 <u>Paths</u> through plants mechanisms	II	B/D	F		D	E	I			I			II			II			II		E	II	B/D	F	II			I	A		I	D	F	II	C	E
1115 Relevant Experiments					D			B/D		I										B/D	E	II	B/D	F				I	A		I	D	F	III	A	E
112 <u>Blood circulation</u>	240-120							40						180			110			160			510			45			45			30			190	
1121 Respiratory transport	II		E		D		I			I			II			II	C		II	C	E	II	C/D	E	I			I	A		I	C	G	II	B	E
1122 Saturation levels of haemoglobin	II	D	F		D		I						II			II	C	G	II	D	E	II	C/D	F	II			I	A		I	C	F	II	B	E
1123 Defence by clotting, by phagocytosis	II	C	F		D	F	I						II			II	C	F	II	C	E	II	C/D	F	I			I	A		I	C	E	III	C	E
1125 Defence by antibodies	III	C	E		B	F	I						II			II	C	F	II	C	E	II	C/D	F	I			I	A		I	C	E	II	C	E
113 <u>Lymphatic system</u> Structure and physiology	I				D	F	I						I			II	C	F	II	D	E	I	C	F	I			I			II			II	D	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
12 <u>Respiration</u> 121 <u>Gas exchange</u>		240									120			30									250-300						30			25			280	
1210 Experimental evidence (plants)	III	B/D	F		B	E		B		I	A	E	I	B	G				II	B/D	E	II	C/D	E	I	B		I	A		I	D	E	II	A	E
1211 Experimental evidence (animals)	III	B/D	F		B	E				II	A	E	I	B	G				II	B/D	E	II	C/D	E							I	D	E	II	A	E
1212 Diffusion paths in plants and animals	III	B/D	F		D	F							I	B	G					C	E	III	C	E	I			I	B/C					II	A	E
122 <u>Biochemical Aspects</u>		120						460			60			360									400-500						80			30			200	
1224 <u>Glycolysis</u>							III			I			III			I			I	C	G	II	C	F	I											
1225 Krebs cycle components	II		F		D	F	III			I			III			I			I	C	G	II	C	F				I	C		II	C	G	II	C	E
1226 Points of energy release	II	C	F		D	E	I			I			III			I			I	C	F	I	C	F	I			I	C		I	C	G	I	D	F
1227/8 Oxido-reduction chains-lactic acid					D	F	II						III			I				C	F/G	I	C	F				I	C		I	C	F/G	I	B	E
1229 Alcohol formation							I						III			II				D	E	II	C	F	I						I	D	F	II	A	E
13 <u>Nutrition</u> 131 <u>Digestion</u>		75						80			180			180			115						150-200			110			40			30			135	
1311 Of Starch and proteins	I	B/D	F		B	F	I	A		III	E	A	III	B		II	B	F	III	A/D	E	II	C/D	E	II			I	A		I	B	E	III	A	E
1312 of lactose	I	B/D	F		D	F														D	G	II	C/D	E	I			I	C		I	C	E			
1313 of maltose	I	B/D	F		D	F										I	B	F		C	G	II	C/D	E	I			I	C		I	C	E			
1314 of sucrose	I	B/D	F				II	A								I	B	F		D	G	II	C/D	E	I			I	C		I	B	E			
1316 of fats	II	B/D	F		[illegible]	[illegible]	II	A					III	B	F	II	B	F	III	A/D	E	II	C/D	E	I			I	C		I	B	E	II	B	F
132 <u>Assimilation and Absorption</u>		15						60									60						50-100			45			20			40			100	
(of glucose, amino-acids and fats) 133 <u>Egestion</u>	I	D.			D	F	II									II	C	F		C	E	II	C/D	F	II			I	C		I	C	E	II	C	E
134 <u>Vitamin Requirements</u>		15						60			30			60									100-150			80			40			60			120	
1341 Sources	I						II						II							C	E	II	C/D	F	II			I	B		I	C	F	I	C	E
1343 Effect of deficiency of																																				
A,B,C,D,E,K	I		E		D	E	II			I	E		II							C	F	II	C/D	F	II			I	C		I	C	E	II	D	E
1344 Effect of deficiency of others					D	G																II	C/D	F				I	C					I	D	G
1345 Role in metabolism					D	F				I		G								C	E	II	C/D	F				I	C		I	D	E	I	D	F

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
135 Mineral requirements		115						150			60			45			55						150-200			70			90			55			205	
1351 Sources and role in plants																																				
of nitrates, phosphates, sulphates, iron	I				D	G	II			I			I			I				D	E	II	C/D	E	II			I	B		I	B	F	II	C	E
1352 Role in plants of potassium magnesium	I				D	F																II	C/D	E												
1353 Role in plants of calcium																						II	C/D	E												
1354 Culture solution experiments	II									I	A		I	D								II	C/D	E		B/D		II	B		I	D	E	II	B	E
1355 Mode of entry to plants	I	B/D	E		D	G	I						I			I	C	F		D	E	II	C/D	E	I			I	C		I	C	E	II	B	E
1356 Role in animals of calcium phosphates and iron	I	D	F		D	F	II			I						I				D	E	II	C/D	E	II			I	C		I	C	E	II	D	E
1357 Role in animals of iodine, chlorine	II	D	F				II			I						I				D	E	II	C/D	E	II			I	C		I	C	E	I	C	F
1358 Role in animals of potassium, sodium					D	F	II			I						I				D	F	II	C/D	E	I			I	C		I	C	F	I	D	E
137 Parasitism		65						30			60			30			50						150 200			30						130			260	
1371 General principles	I	B/D	F		C		I						I			I	C	E		C	E	II	C	F	II						I	C	F	II	B	E
1372 Study of an animal and a plant parasite	II	D	F		C	E	I			II	A	E				I	C	F		A	E	II	C	F	II						III	D	F	III	A	E
138 Saprophytism		55						30			30			30			10						50-100									40			100	
1381 General principles	I	B/D	F				I						I			I	C	E		C	E	II	C/D	F	I						I			II	A	
1382 Study of named example	II	B/D	F		D	F	I			I	A		I							A	E	II	C/D	F							I	A	F	II	A	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
14 <u>Excretion</u>		20						120			60			30			110			180			100			30			25			55			230	
141 Deanimation							II						I	C	F	I	C	G		C	F	II	C	E	I			I	C		I	C	F	II	C	E
142 Ultra-filtration in glome-tulus	I	D	E				II						I			II	C	E		C	E	II	C	E	I			I	C		I	C	F	II	B	E
143 Selective re-absorption from tubule	I		E		D	F	II						I			II	C	E		C	F	II	C	E				I	C		I	C	F	II	B	E
144 Homeostasis							II			II		E	I							C	F	II	C	E				I	C		I	C	F	II	C	E
145 As related to temperature regulation					D	F	II						I			II	C	E		C	E	II	C	E							I	D	F	II	C	F
16 Reproduction																																				
161 <u>Asexual Reproduction</u>		35						60			90		40-80				55		140-280			150-200				25		15				50			200	
1611 Amitosis	I	C	E		D	F							I			I	C	E				I	C/D	F				I	C		I	C	F			
1612 Parthenogenesis	I	D	E		D	F	I						I			I	C			C	F	I	C/D	F				I	C		I	C	F	II	B	F
1613 Genetic and Adaptive implications					D	F	I			II		E	I			I	C	F		C	F	II	C/D	F				I	C		I	C	F	II	C	E
1614 By budding (animals)	I		E		D	F	I			I	A	E	I			I	C	F		D	G	I	C/D	F	I			I	C		I	A	F	II	A	E
1615 Principles of vegetative reproduction	I		E		D	F	I	B		I		G	I			I	C	F	III	A	E	II	C/D	F	I						I	A	F	III	A	E
162 <u>Alternation of generations</u>	I	C	E		D	F	I			I	A	E	I			I	C	F	II	B	E	I - II	C	F	II						III	A	F	II	B	E
163 <u>Sexual Reproduction</u>		30						40			180		40-80				65					100-150							15+			90			80	
1631 Gamete formation and fertilisation	I	B	E		D	F	II			III	A	E	II			II	C	E		B	E	II-B III	C/DE		I			I	B		II	C	F	II	A	E
164 <u>Hermaphroditism</u>	I	C	E		D	F	I									I	C	F		D	F	I	C	F				I	C		I	C	F	I	C	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
18 Response																																				
181 Irritability																	20						0-50						10			225			260	
1811 Physiology of animal sense organs					D	F																I	C	F												
1812 Plant Reception of stimuli					D	F																I	C													
182 Plant hormones		25						60						90			10						100-150						40			20			120	
1821 Experimental evidence for their existence	I															I				D	E	II	D/B	F				I	B					II	A	E
1823 Theories of mode of action	I						II									I				C	F	II	C	F				I	C					II	C	E
1825 Uses to Man	I				D	F	I	B								I				D	F	II	C	F				I	C					I	C	E
183 Plant Tropisms		60						30						80			20						100-150						40			20			120	
1831 Phototropism	I	D	E		D	F	I	B								I	C			D	E	II	B C/D	F		B		I	A		I	D	F	III	A	E
1832 Geotropism	I				C	F	I									I	C			D	E	II	C/D	F		B		I	C		I	D	F	III	A	E
184 Plant Nastic Responses								20						70			10						50-100									10			40	
1841 Light					C	F	I	D					II			I	C	G		D	F	I	C/D	F/G										II	D	F
1843 Touch					D	F	I	D					II			I	C	G		D	G	I	C/D	F/G										I	D	G
185 Taxes in Response to : light							I	A					II			I	C	G		D	F	I	C/D	F/G	II									II	B	F
186 Animal Hormones		120						180			240			90			250						200-250			45			70			85			230	
1861 Sources	I		E				I									I	C	F		C	E	II	C/D	E	I			I	C		I	C	E	I	B	E
1862 Metabolic role of adrenalin	II		E		D	F	II			III	A	E				II	C	E		C	F	II	C/D	E	I			I	D		I	C		III	B	E
thyroxin, pituitary and sexhormones																																				
1863 Role of insulin and digestive hormones	II		E		D	F	II			II		E				II	C	E		C	E	II	C/D	E	I			I	B		I	C	E	I	C	G
1864 Role of thymus gland	I		E		D	G	I													C	G	II	C/D	E	II			I	C		I	C	E	I	C	G
1865 Principles of feedback mechanism							I			I						I	C	F				II	C/D	E				I	C		I	C	E	II	C	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
187 <u>Nervous co-ordination</u>		120						180			150			360			175						300-400			60			160			70			250	
1871 Transmission of impulses reflex arc, autonomic system	I	C	F		D	F	II			II	A	E	III			II				C	E	III	C/D	F	II			II		B	I	C	F	II	B	F
1872 Response via cerebellum	I	C	F		D	F							II			I	C	F		C	F	III	C/D	F				I		C				II	D	F
1873 Response via cerebrum	I	C	F		D	F				I			II			II	C	E		C	E	III	C/D	F	I			I		C				II	C	F
188 <u>Muscle action</u>		35						180			180						60						150-200						40			65			150	
1881 Antagonistic pairs, joint structure					D	F	II									I				D	F	II	C/D	F	I			I	D		II	D	F	II	A	F
1882 Movement of joint	I				D	F										I				D	F	II	C/D	F				I	D		I	D	F	I	B	G
1883 Physiology of contraction	I				D	F	II			III	A	F				I				D	F	II	C/D	F				I	B		I	D	F	II	B	E
2 <u>Plant water relations</u> 21 <u>Absorption of water by roots</u>					D	F										I	C	F		B	E		100-150			60			35			12			100	
22 Transpiration, (stream excluded)		50															10					I	B C/D	F	I						I					
Experimental evidence	II						II						II									I	B C/D	E	I			I	A					II	A	E
Cooling effect					D	F										I	C	G		A	E	II	B C/D	F	II			I	C		I	D	F	II	A	E
Conditions effecting rate					D	F	II						II							B	E	I	B C/D	E	I			I	C		I	C		II	A	E
23 Plasmolysis & turgidi by in cells	II	B	F				I	A		I	A	E				I	C	G		B	E	II	B C/D	E	I						I	B	F	II	A	E
24 Stomatal action	I				D	F										I	C	G/F		B	E	I	B C/D	E	II			I	B		I	B	F	II	A	E
3 <u>PLANT SYNTHESES</u> 31 <u>Photo synthesis</u>		50						300			270			300			145			400			250-300			135			240			110			290	
310 Beginning & end products	II	D	E		D	F	II			III	A	E				II	C	E		A	E	II	B C/D	E	II	B		II	A		II	D	F	II	A	E
311 Experimental evidence					D	F	III	A		III	A	E	III			II	C	F	III	A	E	II	C	E	II	B		II	A		II	D	F	III	A	E
313 Structure of chlorophyll					D	F				II	A	E				II	C	G		B	E	II	C	E				II	A		I	C	F	I	C	F
314 Absorption spectrum of chlorophyll					D	F	I	D		II	A	E										II	C/D	E				I	C		I	C	F	I	C	E
315 Other photosynthetic pigments					D	F				I	A	E								C/D		II	C/D	E				I	A		I	D	F	I	D	E
316 Photolysis of water					D	F				I	A	E				II	C	F		B	F	II	C	E				II	A		I	D	F	I	D	E
317 Photosynthetic phosphorylation					D	F										I	C	F		D	E	II	C	E				II	B		I	C	F	II	D	E
318 Chemistry of carbon dioxide absorption					D	F										I	C	G		C	G	II	C	E				II	C		I	C	F	I	C	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
32 Chemosynthesis	II	C	E		D	F	I									I	C	F				I	C/D	F	I						I	C	F	II	C	E
33 Protein synthesis							II			I						I	C	G		C	G	I	C/D	F	I			I	C		I	B/C	F	II	C	E
35 Food storage	I	C	E		D	F				II						I	C	E		A	E	I	C/D	F	I			I	C		I	B	F	I	A	E
4 <u>GROWTH</u>														360									150-200			60										
40 Types of Seed	I	B/D	F		C/D	F				II	A	E								A	F	I	C/D	G										I	A	F
42 Conditions needed for germination	II	B/D	F		D	E		A								I	C	F		A	E	I	C	G							I	D	F	II	A	E
43 Mobilisation of food reserves	II	B/D	F		D	E		A								I	C	F		A	E	I	C	G		B					I	D	F	I	A	E
44 Vacuolation and elongation (plants)					D	F		A		I			I	C	F		D	F				II	C	F							I	C	F	II	A	E
45 Differentiation (plants)	II	C	F				I									I	C	E		D	E	II	C/D	F	I						I	B	F	II	A	E
46 Secondary thickening in stems	I	B	E		D	F	II	A		I						I	C			A	E	III	C/D	E	II						I	B	F	I	B	E
47 Secondary thickening in roots	I	B	E		D	F	I			I						I	C			B		III	C/D	E							I	B	F	I	B	E
48 Leaf fall and bud development	I	B	E		D	F	I			I						I	C			B		I	C/D	G							I	B	F	I	B	E
49 Changing body proportions (animals) and/or transplantation experiments					D	F	II									I	C	F				I	C	G							III	B	F	II	B	G
574.19 <u>BIOPHYSICS & BIOCHEMISTRY</u>																																				
190 Diffusion (with respect to organisms)	I				D	E	II	B					II	D	E					D	E	I	C/D	F	II			II	A		II			II	A	E
191 Buffering living cells							II	B						D	E	I	C	G				I	C/D	F				I	A		I			II	B	E
192 Osmosis and Osmotic pressure	II	D	F		D	E	II	A		II			II	D	E	II	C	F		B	E	I	C/D	F				II	A		II			III	A	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
193 <u>Organic chemistry</u> (in living cells)		170						330			105			220								350-450				100			350			75			425	
1935 <u>Lipids</u> 19351 Structure							I			II						I	C	F				II	C	F	I			I	C					II	C	E
19352 Metabolism in animals							I			I												II	C	F				I	C					I	C	F
1936 <u>Monosaccharides</u> (structure and test)								A		I	A	E				I	B	G		A	E	II	C	F	I	B		I			I			II	A	E
1937 Dissaccharides (Structure	I	C			C											I	B	G		C	G	II	C	F	I	B		I						I	C	E
1938Polysaccharides		25									40																		50			20			80	
19381 Starch : Structure & test	I	C					I	A		I	A	E				I	B	G		A	E	II	B	F	I	B		I	A		I	B	F	I	A	E
19382 Cellulose : Structure & test							I									I	B	G		C	G	II	B/D	F	I	B		I	C		I	C	F	I	C	E
19383 Glycogen Matabolism					D	F	I	A		II						I	B	F		C	E	II	B/D	F	II			I	C							
1939 <u>Proteins</u>		105						300			45			105															200			40			180	
19391 Peptide link	I			II	A	E	I	A	E	I	C	F		C	G		C	G				II	C	F				I	C					I	C	E
19392 Chemical propeties	I	C					II			I	A	E				I	C	F/G		B	G/F	II	C	F	I			I	A							
19393 Chemical tests				II			I	A	E							I	B	F		A	E	II	C	F	I			I	A		I	D		II	A	E
19395 Simple and conjugated							II									I						II	B/C	F	I			I	C							
19396 Nucleic Acids	II	C			D	E	II			I	E					II	C	E		C	F	III	C/D	F				III	C		I		E	I		E
195 <u>Chromatography in Biology</u>							II													D	G	I	B/D	F				I	B					II	A	E
196 <u>Colloid Chemistry</u>, with respect to protoplasm	II	D	E				II									II	C	F		D	F	I	B/D	F				I	C					II		
197 <u>Enzymes</u>		60						360			60						60						100 150			15			120			30			370	
1971 Hydrolases							II			II						II	A/B	F				II	B/C	F				II	B					II	A	E
1972 Oxidoreductases							II											F				II	B/C	F				II	B					II	A	E
1973 General properties							III	A												A	E	II	B/C	F	I	B		III	C					III	A	E
1974 Theories of mode of action					D	F	II									I	G			C	E	II	B/C	F				II	C	E				II	C	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
574.3 <u>EMBRYOLOGY</u>																																				
31 Of plants e.g. capsella		D	F														D	G														B	F		A	F
33 Of vertebrates		50						300						240-300			105			160-200			250-300			240			60			270			80	
331 Frog					D	F	II									II	C	F		B	F	III	C/D	F	II	B					II	B	F	II	A	E
332 Chick							II	B								I	C	F		B	F	III	C/D	F	II	B		I	D	F						
333 Man (or other Mammal)	II	F			D	F	III									I	C	G	I	C	E	II			III		G	I	B		III	D	F			
574.41 <u>MORPHOLOGY</u>		200									120			45			30			360			100						20						360	
411 Of plants		A	F								A	E																								
4111 Typical Mesophyte																				A	E	I	C/D	G				I	B					III	A	E
4112 Hydrophytes					D	F														A	G	I	C/D	G										II	B	F
4113 Xerophytes					D	F														A	G	I	C/D	G										II	A	E
4114 Wind pollinated flowers					D	F														A	F	I	C/D	G												
4115 Insect pollinated flowers					D	F														A	E	I	C/D	G				I	B					III	A	E
4118 For asexual Reproduction (see also section on ecology)					D	F				II										A	E	I	C/D	G										II		
412 Of animals					D	F										I	C/D	G	III	A	E	II	B C/D	G										III	A	E
574.42 <u>ANATOMY</u>																																				
421 <u>Dicotyledon</u> (mesophyte)		150						260			40			200			70						300-400			125			35			50			260	
4212 Stem	II	B/D	E				III	A					II			I	A/B	F		B	F	III	A/CE/F		II	B		I	A		II	A	F	III	A	E
4213 Root	II	B/D	F				I	A					II			I	A/B	F				III	A/CE/F		II	B		I	B		I	A	F	II	A	E
422 <u>Monocotyledon</u>		30						70						100			40						300-400									30			70	
4221 Leaf	I	D	F				I									I	B/C	F				III	A/C	F	I						I	B	G	I	A	F
4222 Stem	I	D	F				II	A								I	A/B					III	A/C	F	I						I	B	G	I	A	F
4223 Root	I	D	F				I									I	A/B	F				III	A/C	F							I	B	G	I	A	F

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
423 Preparation of temporary microscope slides, plant and animal tissues	I	B	F				III	A		III	A		I				A/B			B	F	III	A	E							III	A	F	III	A	E
424 Preparation of permanent microscope slides, plant and animal tissues	I	D	F							III	A	E																								
426 Animal Anatomy		110						180			120			180			160						200									110			130	
4261 Stomach, duodenum wall, artery : vein							II	D								II	A/B			B	F	II	C/D	F							I	C	F	II	A	E
4262 Capillary																II	A/B			B	F	II	C/D	F							II	C	F	II	D	F
4263 Testis and ovary							II	D		III	A	E				II	A/B			B	F	II	C/D	F							II	C	F	II	D	F
4264 Kidney							II	D								II	A/B			B	F	I	C/D	F							II	C	F	II	A	E
574.5 ECOLOGY & ETHOLOGY																																				
571 Experimental techniques (including measurement of physical &											630			240									150-200						240						350	
chemical factors in the environ-										III	A	E								A	E	I	C	G				II	A					II	A	F
ment, sampling techniques, simple										II	A	E								A	E	I	B/C	G				I	A					II	A	F
mapping & surveying & quantitative studies of behaviour)																																				
52 Autecology		70									720						175						50-100						560			160			400	
521 Physiological adaptations		50									360			60												10			160			30			60	
5211 of plants		II									III			II								I	C/D	G	I			III			I					
52112 Calcicole/calcifuge										II										A	E	II	C/D	G				II	B		I	B	F			
52113 Xerophytes & Hydrophyles					D	F				III										A	E	II	C/D	G				II	B		I	B	F			
52115 Halophytes					D	F											A	G				I	C	G				II	B							
52116 Deciduous trees					D	F											A	E				I	C	G				II	B		I	B	F			
5212 of animals (various methods)					D	F				III										B	E				I			II	C							
522 Morphological & anatomical adaptations					D	F				III	A	E								A	E	II	C	F				III	C							

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
23 <u>Reproductive adaptations</u>		20						120			60						105						25						180			90			340	
231 Aquatic & aerially dispersed spores					D	F				I		G								B	F	I	C	G										II	A	F
232 Wind & animal, cross & self pollination					D	F	I			I		G								A	E	I	C	G							I	B	F	III	A	E
233 Seed dispersal mechanisms					D	F				I		G								B	F	I	C	G							I	B	F	III	A	E
234 Fertilisation external, internal, place of development of young	I		F		D	F	I			I						II	C	F		D	E	I	C	G				I	C		I	B/D				
235 More selection					D	F	I			I						I	C	G		C	F	I	C	G				II	B							
236 Territorial behaviour					D	F	II			I						I	C	G		B	F	I	C	G				III	B		I	C		II	D	F
24 (Other) <u>Protective adaptations</u> e.g. migration		15						360									70						50						120			40				
241 Behaviour : hibernation defense					D	F	III			I						I	C	F		B	E	I	C/D	G				II	B		I	C	F			
242 Structural e.g. camouflage spires	I				D	F	II			I						I	C	F		B	F	I	C/D	G				I	C		I	D	F			
3 <u>Synecology</u> (e.g. in a named habitat)											300			240			45												360						300	
31 Species list, numbers, distribution					D	F				II	A	E								A	E							II	B					III	A	F
35 Influence of a species on its environment					D	F				III	A	E				II	C	F		A	E							III	C							
4 <u>Nutritional relationships</u>		30						150			180						55						50-100			10			330						220	
41 Food webs					D	F	II			III		E								A	E	I	C	F				III	B					III	A	F
42 Pyramid of numbers (in nature)							I			II		E				I	C	F		A	E	I	C	F				III	B					I	A	F
43 Carbon cycle	I	C	F				II			II						II	C	F		B	E	II	C	F	I			III	A					II	B	E
44 Nitrogen cycle (in nature)	I	C	F		D	F	III			II						I	C	F		B	E	II	C	F	I			III	C					III	B	F
5 <u>Larger communities</u>											180			60			70						50						200						60	
51 Major ecological units					D	F							III	A	E	II	C	F		B	E	II	C	G				III	C							
52 Succession communities					D	F							II	A	E	I	C	F		B	E	II	C	G				II	C					II	B	F
53 Climax communities													II	A	E					B	E	II	C	G				II	B							
54 Regulation of population level					D	F										I	C	G		C	E	II	C	G				II	C							

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
57 <u>Competition</u>								40			120			120			20						25						280						285	
571 Seed viability					D	F	II													B	F	I	C	G				II								
572 Colonisation					D	F														A	E	I	C	G				II	B					II	B	F
573 Interspecific & intraspecific competition in plants & animals					D	F				I	A					I				B	E	I	C	G				III	C					III	A	G
574 Ecological niche					D	F	I			I	A					I				B	E	I	C	G				III	B					I	B	F
574.82 <u>HISTOLOGY</u>																																				
821 <u>Plant Histology</u>		70						200			360			240									50-100			45						80			200	
8211 Formation of cell wall 1°x2°	I	C	F																	B	F	II	B/C	F							II	C	F	II	A	F
8212 Xylen & phloen cells sche-lerenchyma	I	B/D	F		D	F		A		III										A	E	II	B/C	F	II						II	A	F	III	A	E
8215 Fibres	I	B/D	F		D	F		A														II	B/C	F	I						I	A	F	I	A	E
8216 Parenchyma	I	B/D	F		D	F														A	E	II	B/C	F	I						I	A	F	III	A	E
8217 Collenchyma	I	B/D	F		D	F																II	B/C	F	I						I	A	F	II	A	E
822 <u>Animal Histology</u>		130						600			300						345						300			90			50			200			580	
8221 Skeletal Tissues (Bone & main types of cartilage)								A								I	A/B			A	E	I	C	F	I						I			II	A	E
8222 <u>Muscle</u>		(25)									(120)						(40)						(5o)			(15)						(30)			(100)	
82221 Heart muscle					D	F				III	A	E				I	A/B	F				II	B/C	F	I									I	A	E
82223 Unstriated muscle	I				D	F										I	A/B	F				II	B/C	F	I						I	C	F	II	A	E
82225 Striated muscle	I				D	F				III	A	E				I	A/B	F		A	E	II	B/C	F	II						II	B	E	II	A	E
8223 <u>Glandular Tissues</u>		(40)									(60)												(25)									(30)			(60)	
82231 Salivary, gastric, intestinal & liver					D	F										I	A/B	F		A	E	I	C/D	G	I											
82232 Pancreas					D	F				III	A	E				I	A/B	F		A	E	I	C/D	G							I	C	F	I	A	F
82233 Thyroid	I				D	F				III	A	E				I	A/B	F				I	C/D	G							I	C	F	I	A	G

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
878 <u>Nucleic acid metabolism</u>		110						180			180			270									150-200						100			115			140	
8781 RNA structure messenger RNA										I										C	G	III	C	F				I	C		I	C	E	II	C	E
8782 RNA synthesis transfer RNA										III												III	C	F				I	C		I	C	E	I	C	E
8786 DNA scructure & replication										I										C	G	III	C	F				II	B		II	C	E	II	C	E
8788 DNA Synthesis																						III	C	F				II	C		II	C	E	I	C	E
879 <u>Cell division</u>		100						120			360			90			75						50			90			95			120			270	
8791 Mitosis	II	C	E		D	F	II			III			II			II	A/B	E		B	E	II	B/C	E	II	B		II	A		II	C	F	III	A	E
8792 Meiosis	II	C	E				II			III			II			I	B/C	E		D	E	II	C/D	E	II	B		II	A		II	A	E	III	A	E
575 <u>EVOLUTION</u>																																				
01 <u>Evidence</u>		100						330			300			500			150						150-200			360			135			200			340	
011 Palaeontological	II	D	E		D	F	I			III	A	E				I	C	F	I		F	I	C	F	III			I	C		I	D	F	II	D	E
012 Anatomical	I	D	E				I			III	A	E				I	C	F		B	G	I	C/D	F	II			I	C		I	D	F	[illegible]	D	E
013 Genetical							III			I	A					I	C	F		B	F	I	C	F				I	C		I	C	F	I	C	E
014 Geographical	I	D	E		D	F	I									I	C	F		B	G	I	C	F	II			I	C		I	D	F	II	C	E
015 Natural variation	I	D	E		[illegible]		II			II		G				I	C	F				I	C	F	II			I	C		I	C	E	I	D	E
016 Comparative Embryology	I	D	E				II			II		G				I	C	F				I	C	F	II			I	C		I	C	E	I	D	E
017 Modern Evidence of natural selection	I	C	E							I						I	C	E		C	G	I	C	F	I			I	C		II	D	E	II	C	E
02 <u>Theories</u>		110						220			40			370			80						100			90			35			40			240	
021 Darwin and his work	I	C	E		D	F	II			I						I	C	E		C	F		C	F	II			I	C					III	C	E
022 Natural selection	I	C	E		D	F	III			I						I	C	E		C	F	I	C	F	II			I	C		I	C	E	II	C	F
023 Mutations & their importance	II	D	E		D	F	I									I	C	E				I	C	F	I			I	C					I	C	E
024 Lamarckism	II	C	E		D	F	I									I	C	F/G				I	C	F	II			I	C		I	C	E	II	C	E
07 <u>Evolution of Man</u>																																				

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
577 GENERAL PRINCIPLES	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
4 Morphological & physiological comparison of plants & animals	II				D	F				II			II	C	E					C	F	II	C	F							II	C	F	II	A	E
5 Symbiosis					D	F							I	C	E					B	E	I	C	F	I						I	B	F	II	C	F
7 Politico-ideological questions		15						60						120															60			40			30	
71 Problem of race							III						III	C	E							I	C	G				III	C		II	C	F	I	C	G
8 History of biology								120			120			120									25									60			160	
84 Life and work of famous biologists										III										C	F	I	C	G							I	C	F	II	C	G
580 REPRESENTATIVE TYPES OF PLANTS																																				
1 Principles of a taxonomy, characteristics of a species					D	F				III			II	B	F							II	C/D	G	II			I	C		II	C	E	III	A	F
582 VIRUSES																																				
1 Structure					D	E	II			II		F	II			II	C	G		C	G	II	C	F	I			I	C		I	C	F	III	C	E
2 Phisiological action							II			II		F	II			II	C	F		C	F	II	C	F	I			II	C		I	C	F	III	C	E
3 Transmission							II			II		F	II			II	C	F		C	F	I	C	F				I	C		I	C	F	III	C	E
589 THALLOPHYTA																																				
1 Lichens (1 or 2 examples studied)		30						10			20						20			60			25			30						90			120	
14 Structure	I				D	F	I													D	F	I	D	G	I						II	A	F	II	A	E
15 Life cycle & reproduction	I	D	F		D	F														D	F	I	D	G	I						II			II	A	E
2 Fungi		110						10									45			300			75			45			300			130				
21 Bosidiomycetes		30																					50						100			30				
214 Structure	I	B/D	F		D	F																						II	A		I	A	F			
215 Life-cycle & reproduction	I	B/D	F		D	F											C	F		A	E	I	B/C	G				II	C		I	A	F			
23 Ascomycetes & Fungi imperfecti								10															25						40			30				
234 Structure																				A	E	I	C	G				II	A		I	B	F			
235 Life cycle and reproduction							I													B	E	I	C	G	I			I	C		I	C	E			

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
589 THALLOPHYTA	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
25 Phycomycetes (1-3 examples)																													100			20				
254 Structure																				A	E	I	C	G				III	A		I	B	F			
255 Life cycle & reproduction																				A	E	I	C	G				II	C		I	B	F			
26 Nutrition of Fungi	I	C	F		D	E	I													B	E	I	C	G				II	C		I	C	E			
4 Algae																																				
44 Euglenophyta		30						20															25			90			30			15			120	
444 Structure	I	B	F				I															I	C	G	I			II	A		I	C	F	III	A	E
445 Life cycle & reproduction	I	D	F				I															I	C	G				I	C		I	C	F			
446 Behaviour & locomotion	I	B	F				I															I	C	G							I	B	F	III	A	E
45 Phacophyta (1 example studied)		50																																	140	
Structure & life cycle	II	B/D	F																	B	E	I	C	G	II									III	A	E
46 Chlorophyta (1-2 examples done)		50						20																								30			80	
Structure & life cycle	II	B/D	F				I													A	E	I	C	G	II						I	A	F	II	A	E
9 Bacteria		100						95									120			300			50-100			40			20			25			240	
90 General structure		B/D	F		D	E	I													A	E	I	C	F	II			I	B		I	A	F	II	A	E
91 Reproduction					D	E	I			II										B	E	I	C	F	I	B		I	B		I	B	F	III	A	E
92 Parasitic & symbiotic types					D	E	II													B	E	II	C	F	I	B		II	C		II	B	F	III	A	E
94 Saprophytic & autotrophic types					D	E	II			I	A	E								B	F	II	C	F	I			II	C		II	B	F	III	B	E
96 Effects of antibiotics					D	E	II			II										C	E	I	C	F				I	B		I	C	F	II	C	E
588 BRYOPHYTA																																				
2 Mosses (1 example studied)		50						20									30			60			25			30						70			120	
Structure & life cycle							I													B	F	I	B/C	G							II	A	F	III	A	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
587 <u>PTERODOPHYTA</u>																																				
31 Filicales (1 example studied)		50						40									15			60						40						60			180	
Structure & life cycle	II	B	F		D	F	I									I	C	G		B	E				III						II	A	F	III	A	E
585 <u>GYMNOSPERMS</u>																																				
2 Coniferae		50						10			120						15			60			25						30			60				
24 Structure	II						I			III						I						I	C/D	G				I	B		II	A	F			
25 Life cycle (alternation of generation)	II				D	F	III									I			III	C	E	I	C/D	G				I	C		II	A	F			
583 <u>ANGIOSPERMS</u>																																				
0 Identification to species by key	III				D	F	II										A	E													III	A	F	II	A	G
3 Characteristics of families			F		D	F																I	B/C	G												
5 Life cycle, alternation of generations	II	C	E		D	F	II													C	G	I	B/C	G	II			I	C		I	B	E	II	B	E
590 REPRESENTATIVE TYPES OF ANIMAL																																				
593.1 <u>PROTOZOA</u>																																				
0 Classification into classes					D	F										II				B	F	I	C	F	I											
1 <u>Rhizopoda</u>		50						50			60			45			120						25									60			195	
110 Habitat & locomotion	II									III						II			III	B	E	I	B/C	F							II	A	E	II	A	E
111 Structure	II				D	F				II						II			III	A	E	I	B/C	F							II	A	F	III	A	E
112 Nutrition & response	II				D	F				II						II			III	B	E	I	B/C	F							II	A	F	III	A	E
113 Excretion, osmoregulation	II				D	F										II			III	C	F	I	B/C	F							I	C	F	II	C	E
114 Respiration	II				D	F				I									III	C	F	I	B/C	F							I	C	F	I	C	E
115 Internal transport					D	F				I									III	C	F	I	B/C	F							I	C	F	II	C	E
118 Reproduction & growth.	II				D	F										II			III	B	E	I	B/C	F							I	C	F	II	C	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
593.1 PROTOZOA	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
17 Ciliophora		50						25			60						60			120			50			45			40			56			240	
170 Habitat																				C	F	II	A/C	G	I				C			A	F		A	F
171 Structure	II				D	F	I									II				A	E	II	A/C	G	II			II	A		II	A	F	II	A	F
172 Nutrition, growth & reproduction	II				D	F	I									II				C	E	II	A/C	G	I			I	C		I	B	F	III	B	F
173 Excretion & osmoregulation	I						I									I				A	E	II	A/C	G	II			I	B		I	A	F	III	A	F
174 Respiration	II				D	F	I			II	A					II				C	F	II	A/C	G	I			I	C		I	C	F	I	C	F
175 Internal transport							I			III	A									C	F	II	A/C	G	I			I	B		I	C	F	II	C	F
176 Locomotion & response	II				D	F	I			II	A									B	E	II	A/C	G				I	B		I	B	F	III	A	F
18 Flagellata		50						25									30						25			15			10			10				
181 Habitat & structure	II				D	E	I									I	C	G				I	C	G	I			I			I					
182 Nutrition	II				D	F	I									I	C	G				I	C	G												
188 Life cycle	II				D	F	I									I	C	G				I	C	F				I	C							
19 Sporozoa		50						30									20						50			30			10			25			105	
190 Habitat		D	F																			II	C	F	I			I	C		I	C	F	II	C	E
191 Structure					D	F																II	C	F	I						I	C	F	II	B	E
192 Nutrition & life cycle					D	F										I	C	F				II	C	F	II			I	C		I	C		III	B	E
196 Dispersal					D	F										I	C	F				II	C	F	I						I	C	F	II	B	E
593.4 SPONGES		30						10									10			60			25									25				
41 Structure & habitat	II	B/D	F		D	F	I										C	G	II	B	G	I	C/D	G							I	C	F			
593.5 COLENTERATES		50						30			120						15			60			25			40						55			200	
51 Structure																																				
511 External Morphology	II	B/D	E		D	F	I			III	A	E				I	C	F	III	D	F	I	C/D	G	I	B					II	A	F	II	A	E

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
593.5 COELENTERATES																																				
512 Diploblasty	I				D	F	I															I	C/D	G	I	B					I	B	F	II	A	E
513 Details of cell types	II				D	E	I			III	A	F				I	C	G				I	C/D	G	II						I	C	F	III	A	E
52 Nutrition, catching food, digestion	II				D	F	I			II	A					I	C	F				I	C/D	G	I						II	B	F	III	B	E
56 Locomotion& reproductive organs	II				D	E	I			II	A					I	C	G				I	C/D	G	II						II	B	F	III	B	E
57 Response & habitat					D	F	I			I	A											I	C/D	G	I						I	A	F	III	B	E
58 Polymorphism & life cycle					D	F										I	C	F				I	C/D	G	III						I	B	F			
539.9 ECHINODERMS																																				
90 Habitat																						I	C/D	G	I											
91 External morphology																						I	C/D	G	I											
92 Obtaining food																						I	C/D	G	I											
94 Respiration																						I	C/D	G	II											
594 MOLLUSCA																																				
02 Classification into classes					D	F																I	C/D	G	I						II	A	F			
1 General structure of example	II				D	F																I	C/D	G	II	B					II	B	F			
2 Habitat, obtaining food, digestive system	II				D	F				III			II	C	F/C							I	C/D	G							I	C	F			
3 Excretory system	II				D	F																I	C/D	G							I	C	F			
4 Respiratory organs	II				D	F				III			I									I	C/D	G	I	B					I	C	F			
5 Circulatory & nervous system	II				D	F				III												I	C/D	G	I	B					I	C	F			
6 Locomotion, circulation, sense organs	II				D	F				II												I	C/D	G							II	C	F			
8 Processes of reproduction	II				D	F				II												I	C/D	G							I	C	F			
595.12 PLATYHELMINTHES																																				
120 Habitat																																				

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
595.12 PLATYHELMINTHES	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
121 General structure	II				D	F				III							A	E				I	C/D	G	I						II	B	F			
122 Nutrition	II									III							C	E							I											
1221 Obtaining food																	C	E				I	C/D	G	I			II	C		II	B	F			
1222 Digestive system																									I			II	C		II	C	F			
128 Life cycle & reproduction																	D	E				I	C/D	G	II			I	C		I	C	F			
595.13 NEMATODES																	10			60			50			10			20			40			125	
130 Habitat					D	F										I	C	F/G		B	F	I	C/D	G							I	C	F	II	C	E
131 General structure					D	F										I	C	F	III	B	F										II	B	F	II	C	E
138 Life cycle & reproduction					D	F													II	D	F	I	C/D	G				I	C		I	C	F	III	B	E
595.14 ANNELIDA		120									120						30			120			50-100			140			80			55			620	
1401 Classification to classes																I				B	F	I	A/C	G	I			I	C		I		E			
1404 Habitat & external morphology		B	E		D	F				III	A	E								A	E	I	A/C	G	II	B		I	A		I	A	E	II	A	E
141 Coelom & metamerism																I				B	F	II	C	G	I	B		I	B		I	B	E	II	A	E
142 Nutrition	II			I						III	A	E				I			II	B	E	II	C	G	I			II			I			II	C	E
1421 Obtaining food					D	F					A	E				I				B	E	II	C	G	I			I	C		I	C	F	II	D	E
1422 Structure of gut					D	F					A	E								B	E	II	C	G	I	B		I	A		I	C	G	II	D	E
1423 Functioning of gut					D	F																II	C	G				I	A		I	C	G			
1424 Absorption, egestion					D	F														C	G	II	C	G				I	C		I	C	G			
143 Excretory, circulatory, reproductive system, locomotion					D	F														B	F	II	C	G				I	A		I	B	F	III	A	E
144 Respiration					D	F					A	E								B	E	II	C	G	I	B					I	C	F	III	C	E
145 Excretion, circulation, ~~coordination~~					D	F														B	F	II	C	G	II						I	C	G	III	B	E
147 Nervous system					D	F										I				B	E	II	C	G	II	B		I	A		I	C	F	III	B	E
148 Reproduction & life cycle					D	F														B	F	I	C	G	I			I	C		I	C	G	III	B	F

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
595.2 ARTHROPODA																																				
20 Classification into classes, exoskeleton & metamerism	I				D	F	I									I				B	F	I	C/D	G				I	C		I	B	F	III	B	E
22 Crustaceae		100									120												25			90			90			20				
220 Habitat & obtaining food					D	F														B	E				I			I	B		I	C	F			
221 General structure	II				D	F	I									I				B	E	I	C/D	G	II	B		I			I	A	F			
222 Organs systems for digestion,	II				D	F																I	C/D	G	II	B		II	A		I	C	F			
respiration, circulation, co-ordination & locomotion																																				
228 Reproduction & life cycle					D	F														C	F	I	C/D	G	I											
23 Insecta		150						15			120												50			90			75			150			585	
230 Classification to sub-classes (& orders)					C	F										I				B	F							I	C		I	C	F	II	B	E
2301 Habitat					C	F														B	E	I	C	F	I						I	C	G			
231 Morphology of larva, pupa & imago																				B	E				I			I	C		I	A	F	III	A	E
232 Obtaining food					D	F														C	E	I	C	F	II			I	C		II	A	F	III	A	E
233 Excretory & reproductive organs					D	F																			I			I	C		I	B	F			
234 Respiratory organs					D	F																I	C/D	F	II			I	B		I	A	F	III	A	E
2342 Gas exchange					D	F																I	C	G	I						I	C	G	III	C	E
235 Organ systems for digestion, circulation, locomotion, co-ordination					D	F																I	C/D	F	II			II	C		II	B	F			
237 Sense organs & egestion					D	F																I	C	G							I	B	F			
238 Reproduction					D	F														D	E	I	C	F	I						I	B	G			
24 Arachnida					D	F	I													B	F										I	B	G			
25 Miriapoda					D	F	I													B	F										I	C	G			
597 VERTEBRATES																																				
0 Classification into classes					D	F	I									II				B	F	I	C/D	G	I						I	C	G			

597. VERTEBRATES	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1. Fish								40									45									170			110			80			900	
101 Classification to sub-classes					D	F	II									I	C	F													I	C	G	II	C	E
11 External morphology					D	F	I									I	D	F							II	B		I	A		I	A	F	II	A	E
12 Obtaining food, digestives system & excretion					D	F										I									II	B		II	B		I	B	G			
131 Urogenital system					D	F																			I	B		II	A		I	C	G			
132 Osmoregulation					D	F	I									I												I	C		I	C	G	III	A	E
141 Respiratory organs					D	F	I									I									II	B		I	A		I	A	E	III	A	E
142 Gas exchange					D	F	I									I															I	C	F	I	C	E
151 Distribution of blood vessels					D	F	I																											III	A	E
152 Circulation					D	F										I									I			I	B					II	C	E
161 Locomotion & skeletal structure					D	F										I	C/D	F							II	B		I	B		I	B	F	III	B	E
162 Musculature					D	F	I									I	C/D	F										II						I	B	E
171 Cranial nerves					D	F																			I			I	B					III	A	
172 Structure of brain, ear, & heart					D	F	I																		II	B		I	A		I	B	F	III	A	E
18 Reproduction					D	F	I									I									I			I	C		I	C	F	I	B	F
2 Amphibia								120			420									20						125			15			120			595	
21 External morphology					D	F	II																		I	B					I	A	F	II	A	F
22 Obtaining food, digestive system					D	F																			I	B					I	A	F	II	A	E
23 Urino-genital system					D	F																			I	B					I	A	E			
241 Respiratory system					D	F	II																		II						I	B	F			
242 Ways of respiring					D	F	II																		I						I	A	F			
251 Structure of heart, circulatory system					D	F	II																		III						I	B	E	III	A	E

597 VERTEBRATES	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
252 Comparison with that of fish					D	F	II									I									III						I	B	E	III	A	E
281 Life cycle					D	F														A	E				I						I	B	F	II	A	E
282 Details of larval development							II									I				A	E										I	A	F	II	A	E
3 Reptilia								130									30									30			15			70				
31 External morphology					D	F	II									I									I			I			I					
5 Mammalia	(0-1035)						2160									1150						1500-2600				700			220			600		2075		
50 Classification to sub-classes					D	F	III									I	C	F		B	F										I	C	F	I	C	E
511 External morphology					D	F	I															I	C/D	F	II									III	A	F
512 Detailed structure of vertebrae					D	F	I															I	C/D	F	II									III	A	E
513 Appendicular skeleton					D	F														D	G	I	C	G							I	B		III	A	E
521 Dentition & structure of tooth	II				D	F	I			II						I	A/B	F		D	F	II	C/D	F							I	D	G	III	A	E
Dentition of man	I				D	F	I									I	A/B	F				II	C/D	F							I	D	G	I	A	E
522 Digestive system of rodent	II				D	F														A	E							I	B/D		II	A	E	II	A	E
523 Digestive system of man					D	F	III									II	C/D	E		C	E	III	C/D	E	III						I	D	E	II	C	E
524 Egestion					D	F										II	C	F		C	F	II	C	E	II						I			I	C	E
531 Urino genital system of man					D	F	III			III						II	C	F		C	E	II	C/D	F	II			I	C		I	C	E	II	C	E
532 Urino genital system of other mammals					D	F														A	E							I	B		I	A	E	II	A	E
541 Respiratory system of man					D	F	III									III	C/D	E		D	E	III	C/D	E	II			I	B		II	D	E	II	A	E
542 Respiratory system of other mammals	II	A/D	E		D	F														A	E							I	C					II	A	E
543 Mechanics of breathing & controls					D	F	III									II	A			B	E	II	C	F	II						I	A	E	II	A	E
553 Heart structure, blood vessels	I				D	F	III			II						II	C	E		B	E	II	C	E	I			I			I	D	E	III	A	E
554 Comparison with other vertebrates	II	D	E		D	F										II	B	E		B	E	I	C	E	I			I	C		I	C	F	III	C	E

597 VERTEBRATES	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
555 Functioning of circulation	II	D	E		D	F										II	B	E		B	E	I	C	E	I			I	C		I	C	F	II	C	E
561 Locomotion of man					D	F	II									I	C	F		C	G	I	C/B	F							I	D	F	II	A	E
563 Musculature					D	F										I	C	F		B	F	II	C	F				I	B		I	D	F			
570 Cranial nerves					D	F	II									II	B/C	E				I	B/C	F	I						I	B	F	II	A	E
571 Peripheral nerves	II		E		D	F										II	C	E		B	F	II	C	F	I			I	C		I	D	F	III	C	E
572 Brain of man	III				D	F	III			III	A	E				II	C	E		C	E	I	C/D	E	I			I	B		II	D	E	II	C	E
573 Brain of other mammal	I				D	F														B	G	II	A	G				I	B					I	C	E
574 Autonomic system					D	F										II	C	F		C	E	II	C	F				I	C		I	C	E	II	C	F
5751 Eye structure & functioning	I				D	F	III			III	A					III	A/S	E		C	E	II	C/D	F	II			I	A		II	B	E	III	A	E
5752 Correction of eye defects					D	F	III									II	F			D	F	I	C	G							I	C	E			
5761 Ear structure & functioning except cochlea					D	F	I									II	B	D		D	F	II	C	F				I	B		I	C	E	III	B	E
5762 Functioning of cochlea					D	F	I									II	C					I	C	F				I			I	C	E	II	B	E
5771 Skin structure of man	I				D	F										I	A/E	F		B	E	I	A/C	F	I						I	B	E	II	A	E
5773 Skin as a sense organ	I				D	F	II									I	A/E	F				II	A/C	F	I						I	B	E	II	A	E
5774 Skin function in temperature control	I				D	F	I									II	C	E		C	E	I	C	F	II						I	C	E	III	D	E
5775 Protective functions of skin	I				D	F	I									I		E		C	E	I	C	F	I						I	C	E	II	C	E
58 Reproduction of man	III				D	F	III									II	C	E		C	E	I	C/D	G	II		G	III	C		I	D	E	II	C	E
614 BIOSOCIOLOGICAL PROBLEMS																																				
1 Personal Hygiene								85									60						25			30									60	
3 Public Health								550			240						480						225-275			125			230			60			550	
32 Alcohol, drug, tobacco					D	E	III									III	C	E				I	C	G	II			II	C							

614 BIOSOCIOLOGICAL PROBLEMS	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
34 Control of disease								200									120						100-150			90			20			40			180	
341 Natural immunity, vaccination																																				
343 Chemotherapy, isolation					D	F	III									II	C	E		C	G	II	C	F	II			I	C		I	C	E	III	C	E
344 Innoculation by serum					D	F	II									II	C	F				I	C	F	I			I	C		I	C	E	III	C	E
345 Disinfection, sterilisation asepsis					D	F	II									II	C	E		B	G	I	C	F	I			I	C		I	B	E	III	C	E
348 Quarantine, epidemics					D	F	I									I	C	F				I	C	F	I						I	C	F			
35 Specific diseases								230									180						50			70			40			105			100	
351 Bacterial								85									55						25						40			65			40	
3511 Venereal diseases, transmission							II									I	C	F				I	C	G	I			III			I	C	E	II	C	F
3512 Tuberculosis																						I	C	G	II											
352 Virus diseases								50									20						25									20			50	
3521 Smallpox	II				D	F	I									I						I	C	G	I						I	C	E	II	C	E
3522 Polio	II				D	F	I									I	C	G				I	C	G	I						I	C	E	II	C	E
353 Zoonoses								20									30						25									15			50	
3531 Malaria					D	F	I															II	C	F	I						I	C	F	III	B	E
354 Cancer							I									II	C	E				I	C	F	II						I			II	B	E
36 Eugenics					D	F	II									I	C	E				I	C	F							I	C	E			
37 Water supplies								50									20						25			15			80			20			70	
371 Sources, purification					D	F	I									I	C	F				I	C	G				II	C		I	B	E			
372 Fluoridation						F	I									I	C	F				I	C	G				I	C		I	B	E	II	C	G
374 Sewage disposal							I									I	C	F				I	C	G	I			I	C		I	C	E			

98

	B			CY			DK			F			D			IC			EIR			NL			N			S			CH			UK		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
614 <u>BIOSOCIOLOGICAL PROBLEMS</u>																																				
375 Refuse disposal							I									I	C	F										I	C		I	C	E			
376 Industrial pollution							I									I	C	F		B	E	I	C	F				II	B		I	C	E			
377 Agricultural pollution							I									[illegible]	C	F				I	C	F				II	B		I	C	E			
38 <u>Air pollution</u>							I													B	E	I	C	F				III	B		I	B	E			
39 <u>Mental Health</u>							I									II	C	F							I			II	B		I	C	E			
4 <u>World Health</u>								70			135						185						50-100						220							
41 Equilibrium in nature										III	A	E				I		F		C	E	II	C	E				II	C							
42 Population problem							II			I						III		F		C	E	I	C	G				II	C							
43 Birth control							I			I						III	E					I	C	F				II	C							
44 Food problems					D	E	I			I						I	E			C	E	II	C	F				II	C							
45 Conservation							I									I				C	E	I	C	F				I	C							
47 World Health organisation							I									I						I	C	F				I	C							
6 <u>Economic biology</u>								25			180						40						25												269	
61 Fermentation processes					D	E	I			III						I	C	F							I									II	A	E
65 Antibiotics					D	E	I									II	C	E		B	E	I	C	F	I									III	C	E

APPENDIX II a

"CORE" TOPICS STUDIED BY OVER 90 % OF RESPONDENT COUNTRIES (At varying depths)

574 PHYSIOLOGY

. 1112	Paths through plant and mechanisms	
. 112	Blood circulation	
. 1121	Respiratory transport	
. 1122	Saturation levels of haemoglobin	(not France)
. 1123	Defence, by clotting, by phagocytosis	(not France)
. 1125	Defence by antibodies	(not France)
. 113	Lymphatic system Structure and physiology	(not France)
. 121	Gas exchange	
. 1210	Experimental evidence (plants)	(not Iceland)
. 1311	Digestion of starch and proteins	
. 1316	Digestion of fats	(not France)
. 132	Assimilation and absorption (of glucose, amino-acids and fats)	(not France)
. 134	Vitamin requirements	
. 1341	Sources	(not France)
. 1343	Effect of deficiency of A, B, C, D, E, K	
. 135	Mineral requirements	
. 1351	Sources and role in plants of nitrates, phosphates, sulphates, iron	
. 1355	Mode of entry to plants	(not France)
. 1356	Role in animals of calcium phosphates and iron	(not Germany)
. 16	Reproduction	
. 1614	By budding (animals)	
. 1615	Principles of vegetative reproduction	(not Sweden)
. 162	Alternation of generations (principle)	(not Sweden)
. 1631	Gamete formation and fertilisation	

. 181	Irritability	
. 1811	Physiology of animal sense organs	(not Norway)
(. 183	Plant tropisms)	
. 186	Animal hormones	
. 1862	Metabolic role of adrenalin, thyroxin, pituitary and sex hormones	
. 187	Nervous coordination	
. 1871	Transmission of impulses, reflex arc, autonomic system, regions in cerebrum	
. 1873	Responses via cerebrum	(not Switzerland)
. 188	Muscle action	(not Germany)
. 24	Stomatal action	(not France)
. 31	Photosynthesis	
. 310	Beginning and end products	
. 311	Experimental evidence	(not Belgium)
. 315	Other photosynthetic pigments	(not Belgium)
. 35	Food storage	
. 46	Secondary thickening in stems	(not Sweden)

574.19 BIOPHYSICS AND BIOCHEMISTRY

. 192	Osmosis and osmotic pressure	
. 193	Organic chemistry (in living cells)	(not Germany)
. 1936	Monosaccharides (structure and test)	(not Cyprus)
.19381	Starch - structure and test	(not Cyprus)
. 1939	Proteins	
.19394	Chemical tests	(not Cyprus)
.19396	Nucleic acids	(not Norway)
. 197	Enzymes	
. 1974	Theories of mode of action	
. 3	EMBRYOLOGY	
. 42	ANATOMY	
. 421	Dicotyledon (mesophyte)	
. 4211	Leaf	(not Cyprus)
. 82	HISTOLOGY	

. 821	Plant histology	
. 8212	Xylem and phloeme cells, schlerenchyma	(not Sweden)
. 822	Animal histology	
. 8227	Blood	
. 87	CYTOLOGY	
. 873	Structures within a 'typical' cell	
. 8731	Chromosomes, nucleolies, mitochondria	
. 8738	Vacuoles	(not Germany)
. 879	Cell division	
. 8791	Mitosis	
. 8792	Meiosis	(not Cyprus)
575	EVOLUTION	
. 01	Evidence	
. 011	Palaeontological	
. 012	Anatomical	(not Cyprus)
. 014	Geographical	(not France)
. 015	Natural variation	(not Belgium)
. 017	Modern evidence of natural selection	(not Cyprus)
. 02	Theories	
. 021	Darwin and his work	(not Switzerland)
. 022	Natural selection	
. 07	Evolution of man	
. 1	GENETICS	
. 11	Laws of heredity	
. 112	Mendelism : laws, inheritance and recombination of unlinked genes, calculations on expected ratios	
. 113	Chromosome theory of heredity	
. 115	Recombination of linked genes	
. 117	Sex linkage ; calculations of expected ratic	
. 12	Genotype and phenotype	
. 14	Examples of human inheritance, including blood groups	(not Cyprus)
. 15	Artificial mutations and mutagenic agent	(not Cyprus)

577		GENERAL PRINCIPLES RELATED TO BIOLOGY	
	. 1	Origin of life and conditions necessary	(not Sweden)
580		REPRESENTATIVE TYPES OF PLANTS	
	. 1	Principles of taxonomy, characteristics of a species	(not Belgium)
582		VIRUSES	
	. 1	Structure	
	. 2	Physiological action	(not Cyprus)
589		THALLOPHYTA	
	. 9	Bacteria	
	. 90	General structure	
	. 91	Reproduction	(not Germany)
	. 94	Saprophytic and autotrophic types	(not Germany)
585		GYMNOSPERMS	
	. 25	Life cycle (alternation of generations)	(not U.K.)
583		ANGIOSPERMS	
	. 5	Life cycle. Alternation of generations	(not France)
590		REPRESENTATIVE TYPES OF ANIMALS	
593	. 1	PROTOZOA	
	. 17	Ciliophora	
	. 171	Structure	
	. 174	Respiration	(not Germany)
595	. 14	ANNELIDA	
	. 1404	Habitat and external morphology	(not Denmark)
	. 2	ARTHROPODA	
	. 20	Classification into classes, exoskeleton and metamerism	(not France)
	. 22	Crustaceae	
	. 221	General structure	(not U.K.)
597		VERTEBRATES	
614		BIOSOCIOLOGICAL PROBLEMS	
	. 3	Public health	
	(. 37	Water supplies)	(not France)

APPENDIX II b

TOPICS STUDIES BY FEWER THAN 44 % OF COUNTRIES

551 EARTH SCIENCES AND RELATED MATTERS

. 0	Formation of the Earth	
	Structure of the earth's crust : Iceland, Italy, Switzerland, Turkey	
	Earth's Interior, Volcanology, Earthquakes : Iceland, Italy, Turkey	
	Tectonics : France, Iceland, Italy, Turkey	
. 3	Agents of rock weathering and Erosion : France, Iceland, Italy, Switzerland, Turkey, United Kingdom	
. 31,.35	Glaciers, physical and chemical action of water : France, Iceland, Italy, Switzerland, Turkey	
. 352,.39	Action of waves and of living organisms : France, Iceland, Italy, Turkey	
. 36	Thermal change, sand blast, dune formation : France, Iceland, Italy	
. 37	Wind : France, Iceland, Italy, Switzerland	
. 38	Frost action of rocks and soil : France, Iceland, Italy, Turkey, United Kingdom	
. 4	Hydrology : Iceland, Ireland, Italy, Switzerland, Turkey, United Kingdom	
. 6	Petrology : France, Iceland, Italy, Switzerland, Turkey, United Kingdom	
. 61	Igneous rock	
. 611	Origin and/or occurrence : France, Iceland, Italy, United Kingdom	
. 612	Composition and/or classification : France, Iceland, Italy	
. 64,.65	Metamorphic and sedimentary rocks Origin and/or occurrence : France, Iceland, Italy, Switzerland, United Kingdom Composition and/or classification : France, Iceland, Italy, Switzerland	
. 7	Stratigraphy and Palaeontology : France, Iceland, Italy, Switzerland, Turkey, United Kingdom	

. 70 **Fossils**

. 701 Types of formation : Iceland, Italy, Switzerland, Turkey, United Kingdom

. 702 Microfossils : France, Iceland, Italy

. 703 Collection : Iceland, Italy, Switzerland

. 71,.79 Rocks formed in each geological era : Iceland, Italy

Fossils found in each geological era : Iceland, Italy, United Kingdom

. 79 Quaternary – Glaciation, Palynology : Iceland, Italy

. 8 Regional geology : France, Iceland, Ireland, Italy, Switzerland

. 81 Interpretation and use of geological maps : France, Iceland, Switzerland

. 82 Interpretation and use of aerial photographs : France

. 83 Topography : France, Iceland, Ireland

. 84 Geomorphology : France, Iceland, Italy

. 85 Local geological studies : France, Iceland, Italy, Switzerland

. 86 Other aspects : Iceland, Italy

		F	IC	EIR	I	S	TU	UK
. 9	Land and Soil		220			75		95
. 95	Soil conservation							
. 951	Irrigation and drainage		x	x		x		
. 952/3	Effects of mineral ions, fertilisers and leaching	x	x			x		x
. 954	pH effects			x		x		x
. 955	Erosion, causes and effects		x		x	x	x	x
. 956/8	Erosion control, land use problems		x		x	x		x
. 957	Accumulation of eroded matter				x	x		
. 959	Degradation of soils	x			x	x		

574 PHYSIOLOGY

	. 13	Nutrition
	. 1342	Vitamin structure : Belgium, Denmark, Sweden
	. 1356	Trace elements in plants other than iron : Sweden, United Kigdom
	. 1359	Magnesium and other trace elements in animals : Denmark, Iceland, Ireland, Sweden
	. 136	Roughage : Iceland, Ireland, United Kingdom
	. 18	Response
	. 182	Plant hormones - molecular structure : Sweden - Giberellins and kinetin : Ireland, United Kingdom
	. 183	Tropisms - hydrotopism : Cyprus, Denmark, Ireland, United Kingdom - chemotropism : Cyprus, Denmark, Iceland, Ireland
	. 184	Nastic responses - to humidity : Cyprus, Ireland, United Kingdom
	. 185	Taxes - rheotoxis : Cyprus, Ireland - chemotaxis : Cyprus, Denmark, United Kingdom
	. 186	Animal hormones - additional examples : Denmark Iceland, Sweden - chemical structure : Denmark, Sweden, Switzerland, United Kingdom
581	. 2	Plant water relations
	. 234	Calculations on suction pressure, etc. : Belgium (?), United Kingdom
	. 236	Guttation : Ireland, Sweden, Switzerland, United Kingdom
581	. 3	Plant syntheses
	. 31	Photosynthesis - biochemical pathways : Iceland, Sweden, Switzerland, United Kingdom
	. 33	Proteinsynthesis - Nitrate reduction : Sweden - Amination and transamination : Iceland, Sweden
	. 34	Fat synthesis : Cyprus, Denmark, Sweden, United Kingdom
	. 41	Types of germination : Cyprus, Ireland, Scotland, United Kingdom

Intrusive growth in primary tissues of plants : Cyprus, Ireland, United Kingdom

574.19 BIOCHEMISTRY

. 193 Organic chemistry with respect to metabolic activites

. 1931 Carboxylic acids : Denmark, France, Iceland

. 1932 Aldehydes : Denmark, Iceland

. 1933 Alcohols : Denmark, Iceland, Ireland

. 1934 Organic groups e.g. $-NH_2$: Denmark, France, Iceland, Ireland

N.B. In BELGIUM, GERMANY, SWEDEN, SWITZERLAND, and the UNITED KINGDOM the above four topics are covered in the chemistry course in so far as they are done.

. 1935 Lipids (.19354) Chemical tests to identify : Denmark, Sweden, United Kingdom

. 1939 Proteins

. 19392 Structural links in the molecule other than the peptide link : Denmark, Iceland, Sweden, United Kingdom

. 19395 1st and 2nd class proteins : Sweden, United Kingdom

. 194 Redox potential (with reference to enzymes) Sweden, United Kingdom

. 197 Enzymes : Denmark, France, Spain, Sweden, (Switzerland ?)

. 3 EMBRYOLOGY

. 33 of vertebrates - Fish : Denmark, Scotland, Sweden

. 41 MORPHOLOGY

. 4116 of climbing plants : Cyprus, Iceland, Ireland

. 4117 of storage and perennating organs : Denmark, Iceland, Ireland, (United Kingdom ?)

. 42 ANATOMY

. 421 Dicotyledon - Xerophyte leaf and hydrophyte stem : Denmark, France, Iceland

. 422 Monocotyledon - Xerophyte leaves : Iceland, United Kingdom

. 5 ECOLOGY AND ETHOLOGY

. 51 Experimental Techniques

. 516 Measurement of biological factors other than presence and numbers : France, Ireland, Sweden

. 518 Simple statistical methods : France, Ireland

. 52 Antecology - Aquatic and aerially dispersed spores : Cyprus, France, Ireland, United Kingdom

. 53 Synecology - further experimental work related to habitat studied : Ireland, Sweden

. 54 Nutritional relationships - Phosphorus cycle in nature : Ireland, Norway, Spain

. 55 Larger communities - Climax communities : France, Ireland, Sweden

. 82 HISTOLOGY

. 822 Animal Histology

. 8221 Skeletal Tissue - Development of limb bone : Denmark France, Iceland

. 8223 Glandular tissue - Spleen : Cyprus, Iceland
Additional : Iceland

. 8226 Connective tissues : Areolar : Ireland, Spain, United Kingdom

Fibrous and elastic : Denmark, Ireland

. 87 CYTOLOGY

. 873 Cell structure - Blepharoblasts : Denmark, Iceland, Sweden

. 879 Cell Division: in Atypical cells after treatment with mutagens : Denmark, Germany, Sweden, United Kingdom

575 EVOLUTION

. 06 Evolutionary cycles : Cyprus, Iceland, Sweden, Switzerland

. 1 GENETICS

. 13 Incomplete dominance - calculations on ratios expected in these circumstances : Denmark, France, Sweden and United Kingdom

. 16 Population genetics

. 161 Effects of outbreeding normally inbreeding, and outbreeding, species : Denmark, Norway, Sweden

. 162 Genetic devices ensuring outbreeding : Denmark, Ireland, Sweden

. 163 Effects of inbreeding a normally inbreeding species : Belgium, Denmark, Sweden

. 164 Effects of inbreeding a normally outbreeding species : Denmark, Sweden

. 165 Species interfertility : Denmark, Iceland, Sweden, Switzerland

. 166 Spread of genes in a population : Switzerland

. 167 "Random drift" of genes : Denmark, Iceland, Sweden

. 23 Bacterial genetics : Denmark, France, Iceland, Ireland

577 GENERAL PRINCIPLES RELATED TO BIOLOGY

. 6 Philosophical abstractions, e.g. Body and soul, ethics of modern surgery : Cyprus, Germany, Switzerland, United Kingdom

. 7 Politico-ideological questions

. 72 Soviet Biology : Iceland, Switzerland, United Kingdom

. 8 History of Biology

. 81 From early Greeks onwards : Cyprus, Iceland

. 82 For the past 250 years or less : Switzerland

. 83 Development of a particular field: Denmark, Norway, United Kingdom

. 9 Psychology : Belgium (Enseignement technique), Germany Switzerland

580 REPRESENTATIVE TYPES OF PLANTS

. 3 Collection of herbarium : Belgium, Ireland, Norway, Switzerland

589 THALLOPHYTA

. 2 Fungi

. 20 Identification of species : Belgium, Cyprus, Switzerland

. 4 Algae

. 40 Identification of species : Belgium, Switzerland

. 43 Diatoms - structure and life cycle : Belgium, Norway Sweden, Switzerland

. 48 Cyanophyta : Belgium, Iceland, Switzerland

588 BRYOPHTYA

. 3 Hepaticae-structure and life cycle : Belgium, Iceland, (United Kingdom if done instead of moss), Ireland

587 PTERIDOPHYTA

. 31 Filicales - Identification of species by key : Denmark

. 91 Lycopodiales - Structure : Iceland, (Norway)

- Life cycle : Iceland, (Norway), United Kingdom

. 92 Equisotales - Identification by key : Denmark

- Structure : Belgium, Denmark, Iceland, Switzerland

- Life cycle : Denmark, Iceland, Switzerland (Turkey ?)

. 93 Selaginella : Denmark, (Norway)

585 GYMOSPERMS

. 0 Identification by species using key : Denmark

. 1 Cycads : Iceland

583 ANGIOSPERMS

. 1 Classification to classes, subclasses and orders : France, Iceland, Ireland, Switzerland

590 REPRESENTATIVE TYPES OF ANIMALS

593 . 1 PROTOZOA

. 18 Flagellata - Osmoregulation and respiration : Denmark

- Locomotion : Belgium, Cyprus, Denmark, Switzerland

. 19 Sporozoa - excretion and respiration, briefly : Cyprus, Switzerland

593 . 4 SPONGES

. 42 Nutrition, respiration and life cycle : Belgium, Cyprus, Denmark, Switzerland

	.43	Excretion : Belgium, Cyprus, Switzerland
	.45	Internal transport : Belgium, Cyprus
593	.5	COELENTERATES
	.50	Classification to subphyla : Iceland
	.524	Assimilation and Egestion : Belgium, Cyprus, (Switzerland), United Kingdom
593	.9	ECHINODERMS
	.90	Classification into classes : Belgium , Iceland
	.923	Digestion and response : Belgium, Cyprus, France
	.924	Assimilation, egestion, excretion, osmoregulation, internal transport and reproduction : Belgium, Cyprus
	.96	Locomotion : Belgium, Denmark, France, Iceland
594 MOLLUSCA		
	.2	Nutrition - Digestion, Assimilation, Egestion, Excretion gas-exchange, reproductive organs and osmoregulation : Belgium, Cyprus, (Switzerland)
595	.12	PLATHELMINTHES
	.120	Classification into classes : Belgium, Cyprus, Ireland (Malta)
	.121	Structure - Triploblasty : Ireland, Switzerland Acoelomate - also locomotion : Belgium, Iceland, Ireland, Switzerland
	.122	Assimilation, egestion, excretion and excretory system, respiration, nervous system, sense organs : Belgium, Switzerland
	.128	Reproductive organs : Belgium, Ireland, Switzerland
595	.13	NEMATODES
	.132	Nutrition : Cyprus, Sweden, Switzerland
	.134	Respiration : Switzerland
	.136	Locomotion and response : Cyprus, Switzerland, United Kingdom
	.138	Reproductive organs : Cyprus, Switzerland
595	.14	ANNELIDA
	.141	Structure - Triploblasty and histological details : (Ireland), Sweden, Switzerland and United Kingdom

. 148 Sense organs : Belgium, Cyprus, Ireland, United Kingdom

595 . 2 ARTHROPODA

. 21 Haemocoel : Iceland, Switzerland, United Kingdom

. 22 Crustaceae : - classification to subclasses : Belgium, Cyprus, Switzerland

- digestion, circulation, excretion (and excretory and reproductive systems and sense organs) : Belgium, Cyprus, (Sweden), (Switzerland)

. 23 Insecta : - digestion, excretion, circulation : Belgium Cyprus, Switzerland

596 PROVERTEBRATA

. 1 Structure, circulation, locomotion, nervous system : Belgium, Cyprus, Denmark, Iceland

. 2 Nutrition, excretion, respiration, reproduction : Belgium Cyprus, Denmark

597 VERTEBRATES

. 04 Habitats : Cyprus, Iceland, Ireland, Switzerland

. 1 Fish

. 112 Cross section : Cyprus, Sweden, Switzerland

. 114 Metamerism : Cyprus, Iceland, Switzerland, United Kingdom

. 175 Eye : Cyprus, Denmark, Sweden

. 177 Skin and scale structure : Cyprus, Iceland, Switzerland United Kingdom

. 2 Amphibia

. 20 Classification to subclasses : Cyprus, Denmark, Switzerland

. 212 Skeleton : Cyprus, Switzerland, United Kingdom

. 233 Comparison urinary system with homologous structures in fish : Cyprus, Sweden

. 254 Circulation and musculature : Cyprus, France

. 26 Locomotion : Cyprus, Switzerland

. 271 Spinal nerves : Cyprus, United Kingdom

. 272 Brain : Cyprus, Denmark, Switzerland, United Kingdom

. 273 Pithing : Cyprus, France, Switzerland

- 112 -

. 275	Sense organs : Cyprus, Switzerland, United Kingdom
. 3	Reptilia
. 30	Classification to subclasses (and orders) :(Cyprus) Denmark, (Switzerland)
. 32	Feeding : Cyprus, Switzerland
. 33	Urino-genital system compared with other vertebrates : Cyprus, Denmark, Sweden
. 34	Respiratory system and gas exchange : Cyprus, Denmark, Switzerland
. 35	Circulatory system compared with other vertebrates : Cyprus, Denmark, Sweden
. 36	Locomotion : Cyprus, Switzerland
. 37	Brain : Cyprus, Denmark
. 38	Reproduction : Cyprus, Denmark, Iceland, Switzerland
. 4	Aves
. 40	Classification to orders : Cyprus, Switzerland
. 41	General structure and feeding : Cyprus, Denmark, Iceland, Switzerland
. 43	Urino-genital system compared with other vertebrates : Cyprus, Denmark, Sweden
. 44	Respiratory system (and breathing) : (Cyprus), (Denmark), Iceland, (Switzerland)
. 451	Structure of heart (and also circulatory system) : (Cyprus), (Denmark), Switzerland
. 452	Comparison with homologous structures in other vertebrates : Cyprus, Denmark, Sweden, Switzerland
. 46	Locomotion : Cyprus, Iceland, Switzerland
. 47	Brain and eye : Cyprus, Denmark, Switzerland
. 48	Reproduction : Cyprus, Denmark, Iceland, Switzerland
. 49	Identification to genus or species : Cyprus, Switzerland
. 5	Mammalia
. 514	Detailed structure of skull : Cyprus, Denmark
. 521	Dentition of animals other than man : Cyprus, Denmark, United Kingdom
. 522	Digestive system of ruminants : Cyprus, Sweden, United Kingdom
. 533	Comparison of urino-genital system with other vertebrates: Cyprus, Denmark

.544 Interpretation of X-ray plate of lungs : United Kingdom

.552 Heart and blood vessels in mammal other than man : Cyprus, Ireland, United Kingdom

.555 Analysis of cardiographs : France, Iceland, Sweden

.556 Effects of adrenalin and acetylcholine on heart : Denmark, France, Sweden

.562 Locomotion in other mammals : Cyprus, Switzerland, United Kingdom

.5772 Skin structure of mammal other than man : Denmark, Sweden

.582 Reproduction of mammal other than man : Denmark, Iceland, Ireland, United Kingdom

.59 Identification to genus or species : Cyprus, Ireland

BIOSOCIOLOGICAL PROBLEMS

.1 Personal hygiene - fresh air, sunlight : Cyprus, Iceland Ireland, United Kingdom

- cleanliness : Cyprus, Iceland, United Kingdom

- clothing, exercise, posture, nervous exhaustion : Cyprus, Iceland

- sleep, and sex hygiene : Cyprus, Denmark, Iceland

.3 Public Health - food preservation : Cyprus, Denmark, Iceland, Sweden

- food hygiene : Cyprus, Denmark, France

.34 Control of disease - Sanatoria, endemics : Belgium, Cyprus, Denmark, Iceland

- pandemics, international health control : Denmark

.3541 Radiation diseases : Belgium, Denmark, Iceland

.6 Economic Biology

.62 Baking : Belgium, Cyprus, France, United Kingdom

.63 Vinegar making and cheese making : Belgium, Cyprus, Denmark, United Kingdom

.66 Plant products, edible and otherwise : No-one !

.68 Animal pests other than disease vectors : France, United Kingdom

(Where the name of a country is underlined it indicates that a particularly large amount of time is devoted to that topic by that country)

APPENDIX III

SAMPLE EXAMINATION QUESTIONS

Belgium

(these are examples from a school's internal examinations in the terminal year of the upper academic secondary school. Pupils were expected to answer three or four such questions, in one examination, with no choice of question. Question 1 was set to pupils in the Latin-Science "branch" and numbers 2, 3 and 4 to those in the "Modern-Science" branch. The remainingones were common to both branches).

1. How does the cell obtain the energy needed for life and which biological regulators play a role in this ?

2. What do you know about anaerobic respiration ?

3. How does fertilisation occur in angiosperms ?

4. What are the characteristics of enzymes ?

5. Define the following organelles and explain their role : chromosome, lysosome, mitochondrion, ribosome, the Golgi apparatus.

6. Explain the following five phenomena :
   a) Frozen potatoes lose their turgor
   b) Water vapour is breathed out
   c) A metal spoon should not be left in mayonnaise
   d) Intestinal worms give rise to a feeling of hunger (after a meal) greater than one would expect
   e) not translated

7. How would you explain the simultaneous evolution of sexual and asexual fertilisation ?

8. What do you understand by alternation of generations
   a) In the plant kingdom
   b) In the animal kingdom

9. Give four methods whereby selection can be brought about and explain how occasionally a selective form persists.

10. Work out all possible crosses between 2 Drosophila with the following characteristics, as far as the F1.

A black male with red eyes and short wings with a grey female with white eyes and long wings.

Grey is dominant over black.

Long wings are dominant over short.

Red eyes are dominant over white.

Red and long, and black and short respectively are linked.

Red eyes are linked to the X-chromosome.

P1 is not necessarily homozygous.

Give the symbols which indicate phenotype and genotype.

Denmark

Written examination for the biological branch. First day - 4 hours.

1. Adaptation to the environment

It is characteristic of the living organisms that they show adaptation to their environments. Describe a single species or group (systematic or ecological) with respect to morphology, physiology and behaviour, which shows the adaptations of the species or of the group to the life in freshwater or in the sea.

How do you try to explain the development of such an adaptation ?

2. The morphology and function of the neurons

Draw first a sketch of a neuron with accompanying explanation about morphology and function. Include observations and results from the following experiment : a heart recently taken out of a frog placed in an adequate solution (e.g. Ringer-solution) continues beating. If you stimulate the appendant parasympathetic nerve the rhythm of the heart will be reduced. If some of the solution is transferred to another vessel with a beating heart the rhythm of this heart will be reduced too.

How is it possible to make the rhythm of the heart increase by a corresponding experiment ?

Mention other experiments and observations, which further illustrate the function of the neuron.

When the general facts are discussed, you are wanted to draw a sketch of a simple reflex arc with explanations. By a few examples from research, illustrate briefly the biological importance of the reflexes for the behaviour of animals.

Written examinations for the biological branch. Second day - 3 hours.

1. What modifications of the composition of blood can take place when passing through

   a) the pancreas,

   b) the wall of the small intestine, and

   c) the kidneys ?

2. Feedback is a system or regulation where organs have mutual effect on each other directly or indirectly. Illustrate such a system by an example from the human organism.

3. It has recently been found that a decline in the percentage of CO_2 in the intercellular space within the stomata affects the guard-cells, so that the turgor in them increases. What influence can it possibly have to the plant ?

   How is it possible experimentally to reduce the percentage of CO_2 in the leaf ?

4. Where in the cell does the protein synthesis take place ; how is it controlled ; which proteins are produced ? Mention some cells with particularly great protein production.

5. In spite of great variations of the species there are fundamental points of similarity between most species of plants and animals both as to cell structure and to the biochemical processes. Mention at least 2 examples of such general cell structure and 2 examples of biochemical processes.

   How can the presence of these similarities between organisms be explained ?

France

The actual examination questions are secret, so it is not permitted to publish any actual examples of them, but the following brief extract from the Baccalaureate regulation for 1969 gives an idea of the sort of questions which might be asked.

"The intention of this examination is not to test the extent of the candidate's knowledge but to judge his ability to analyse, to reflect, to pass judgement and to synthesise, to think logically and to express his thoughts clearly.

The questions to be answered will test understanding rather than memory. In order to achieve this aim they will take the form of problems.

The candidate will be provided with documents of a varied nature : (as is usual in practical lessons) tables, graphs, drawings, photographs, accounts of experiments, extracts from books, etc. He will be asked to manipulate this data, and to interpret it in both a quantitative and a qualitative manner, if this is possible, and should show the progress of his thought and the conclusions he has made in a short essay.

This type of examination will not come as a surprise to candidates as it involves the type of exercise in which they have practice, and reflects the emphasis given to practical work in the new courses in natural sciences ".

Germany

1. Explain the concept of mutation, with special reference to molecular genetic changes.

2. Explain, with reference to the photograph, the multiplication of bacteriophages. Give special consideration to the chemical processes of albumen synthesis.

3. "Observations on crocus flowers in spring.

   In the early morning hours all flowers are closed ; during the morning they open, and in the afternoon they close again. Opening follows a softening of the flower petals that is equal in all directions. In a remarkable way all crocuses in a given area perform this movement at the same time.
   There is further agreement between the tempo and extent of this movement - with one exception to be shown later. If the time and amount of the opening of the crocus flowers are measured on different days there are noticeable differences. Some days blooms open early, others late or not at all. Surprisingly, on bright sunny days they sometimes remain closed. In contrast to these observations and the similarities mentioned above, the following observations might be made : if the shadow of a building passes through a clump of crocuses, the plants open on the sunny side, if they open at all, but remain closed where they are in shadow. If all crocuses open, the flowers in the shade open less".

   Explain the statements in the text with facts known to you from the physiology of plant response.

4. Explain, with respect to energy, the connections between photosynthesis and respiration.

5. Describe and explain the biological phenomena in the pictures, and define their importance for evolution.

   (The pictures were of a series of anthropoid skulls, the evolution of the horse, a slowworm and a whale).

6. Compare the microscope photographs of cross sections of leaves of beech and oleander, and, from the histological peculiarities of these leaves, draw conclusions about the ecological conditions under which the plants have grown.

7. Explain the concepts of reflex, instinct, and intelligent behaviour of animals from examples selected by yourself.

8. The development of eye and lens (from Schmeil : General Biology p. 167 onwards)
After the spinal cord has been connected to the brain, the brain can be divided into 5 parts, of which the second, the middle brain, protrudes to form eyeballs. It is dented to accommodate the 2-walled eye socket. The dented part is the retina, whose out-growing nerve fibres lead through the optical nerve to the brain, and whose outer fibres are a layer of pigment. This eye socket is near the outer skin of the body which separates a small ball, later to be the pupil, the lens ball. The skin stretched over this becomes transparent and forms a cornea.

Experiments with newts

1. Experiment - The body skin is lifted from the eyeball, the eyeball is loosened from the optical nerve and is removed. The body skin heals again.

Result : No lens develops although the position of the skin which should have formed it remains untouched.

2. Experiment - A piece of skin is cut from the growing eye and is replaced by a piece of skin from the stomach.

Result : This piece of skin forms a typical lens in the right place and at the right time.

3. Experiment - An eyeball with its opening directed towards the outside is planted under the skin of the stomach.

Result : A lens develops, and with it, an eye in the stomach, formed in the usual way and unable to "see" only because the nerves of sight are not attached to the brain.

Explain the results of these 3 experiments.

9. Describe and explain the behaviour of the spider catching its prey that was shown in the film strip.

10. The evolution of Man, according to the opinion of Professor Heberer, is based on a Darwinian model of evolution. Can Heberer's conclusions be reconcerted with the views of Teilhard de Chardin ? Give a brief summary of Chardin's views on evolution.

Ireland

4 Honours level papers in the Leaving Certificate Examination contain questions on some aspect of Biology, but there is no 'Biology' paper as such at present.

General Science Honours

Candidates are asked to illustrate their answers by means of diagrams wherever possible, and are expected to do from 2 - 4 questions from the biology section, which contains 4 questions in all. Sample questions are given below :

1. Distinguish between respiration and transpiration. Describe an experiment you have performed in connection with

   a) respiration,

   b) transpiration.

   Discuss the factors governing rate of transpiration. (66 marks)

2. Describe the general structure of a living cell. Compare and contrast the structure of a living plant cell with that of a living animal cell. (66 marks)

3. With regard to carbohydrate, fat, protein,

   i) describe essential tests to distinguish these types of food from one another,

   ii) describe experiments, one in each case, associated with the digestion of any two of them. (67 marks)

Physiology and Hygiene. Honours

Candidates are expected to answer 6 out of 9 questions in 2 1/2 hours of the types given below. Diagrams are requested in the same terms as for the General Science papers.

1. Describe the structure of the vertebral column and explain how its structure is suited to its functions. Give a detailed account of the two topmost vertebrae. (66 marks)

2. Describe, with the aid of sketches,

   a) the hepatic circulation of the blood,

   b) the renal circulation of the blood in each case.

   Describe an experiment to demonstrate a principle by which food passes from the digestive system into the blood stream(66 marks)

3. Write an explanatory note on each of the following :

a) the functions of vitamins in a diet,

b) the importance of water in the human body,

c) the way in which a constant temperature is maintained in the human body. (66 marks)

4. Describe, with the aid of a diagram, the structure of the human eye and state the functions of its various parts. Show, with the aid of diagrams, how images of near objects and distant objects are focussed in the human eye. (67 marks)

5. Distinguish between

a) antiseptic and disinfectant,

b) epidemic and carrier.

Discuss the causes of the spread of infectious diseases and describe how the body defends itself against attack from such diseases.

Explain the purpose and effects of inoculation in the case of diphtheria. (67 marks)

Botany Honours

This is a 2 1/2 hours paper. The rubric states :

"Five questions to be answered.
All questions are of equal value.
Answers should be illustrated by simple drawings where appropriate".

Sample questions (out of 9 on the paper) :

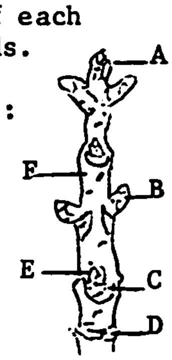
1. Give an account of the process of photosynthesis, stating the conditions necessary for it and indicating the connection between each of these conditions and photosynthesis. Describe an experiment to show that the green plant gives off oxygen during photosynthesis. What is the source of this oxygen ?

2. Name a flower from each of four families and in the case of each flower describe the structure of the ovary and the type of fruit which develops from it. Show how the structure of each of these fruits is adapted to the dispersal of the seeds.

3. With regard to the diagram of the winter twig opposite :

a) Name the parts labelled A,B,C,D,E,F and explain their significance

b) Describe the changes which the twig undergoes during the course of the year.



Describe the characteristic features of a named evergreen tree.

4. Give a short account of the nature and importance of enzymes. Describe the action of two plant enzymes and show how you would demonstrate the action of one of them by means of an experiment.

5. What is meant by vegetative multiplication ? Name four different ways in which vegetative multiplication occurs. In each case give an example of the plant organ concerned and describe its structure and the changes it undergoes during the course of the year.

Agricultural Science. Honours

6 questions to be answered in 2 1/2 hours. Sample questions :

1. How would you extract and examine the principal types of micro-organisms in a sample of soil ? In what ways are soil micro-organisms beneficial and what soil conditions favour them ? (66 marks)

2. Describe, with the aid of drawings, a plant cell and write short notes on the following parts : cytoplasm, nucleus, vacuole, mitochondria. (66 marks)

3. Give short answers to the following questions:

   a) What is the function of protein in animal nutrition ?

   b) What element other than carbon, hydrogen and oxygen is always present in protein ?

   c) What do you understand by the term 'crude protein' ?

   d) Which farm foods contain the least protein ?

   e) What crops could be grown to obtain the highest yield of protein per acre ?

   f) What happens to protein in the intestine ? (66 marks)

Italy

No actual questions have been sent, but if any questions on biology are included in the purely oral exam, they would be asked on the topics below :

1. Essential elements of anatomy and physiology of man.

2. Plants and animals observed in their fundamental structure and in the respective biological activities.

(Source : Ginnasio Superiore, Liceo Classico, Liceo Scientifico, Orari e Programmi d'Insegnamento Esami di Maturità Classica E Scientifica, Milano 1964)

Netherlands

Questions such as the following would each be answered orally in about ten minutes :

1. Which nerves are responsible for maintaining the heart beat, and how do they operate ?

2. What is the chemical structure of a protein ? Which enzymes can break it down ? Which amino-acids are essential, and which innessencial ?

3. Describe Morgan's experiment,... crossing over,... chromosome maps.

Scotland

Scottish Certificate of Education : Science - Biology (Higher Grade)

The rubric at the head of the two papers is :

Answers should be illustrated by labelled diagrams of reasonable size

a) where these are asked for in the questions, or

b) if they help to clarify the answers.

Marks may be deducted for bad spelling and bad punctuation, and for writing that is difficult to read.

The value attached to each question, or to each part of a question, is shown in the margin.

8 questions are normally set in each paper. Sample questions are :

		Marks
1.	Explain how the temperature of the human body, (or other mammal) is regulated.	8
	State three other conditions or processes which are regulated in the body and, in each case, explain, with a minimum of reference to structure, how the control is brought about.	12
2.	What features do the respiratory surfaces of earthworm and a fish have in common ?	5

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Marks

Describe the structures and processes by which oxygen is able to reach the tissues of

a) a cockroach,

b) the twig of a tree. 9,6

3. Living organisms show modifications in relation to environment. Give an account of modifications in leaves choosing your examples to include a wide range of functions. 20

4. Give an account of any detailed study you have done in fieldwork. Your answer should be arranged under suitable paragraph headings, such as :

a) object of study

b) location

c) species studied

d) observations and measurements made

e) results and conclusions

f) further problems arising from your study 20

5. If, in cattle, white colour is recessive to red, what types of offspring could be expected to result from crosses between a red bull and a white cow ?

Give an explanation, including in your answer the following terms, correctly used - phenotype, dominant, allele, heterozygous. In short-horn cattle, however, when a red bull is crossed with a white cow, the offspring are always roan, a coulour midway between red and white. How do you account for this ? 15

What result would you expect from crosses between such roan animals ? 5

6. What main differences enable you to separate the families Liliaceae, Ranunculaceae and Rosaceae ? Include in your answer a labelled diagram of one named flower, shown in longitudinal section, from each of the families, Liliaceae and Rosaceae. 14

Write a note on the dispersal of seeds in Rosaceae, choosing three named examples as varied as possible. 6

United Kingdom

It is not permitted to reproduce complete papers, but one of the examining boards - the Cambridge University Local Examinations

Syndicate - has kindly given me permission to reproduce the following examples of the main types of questions. These have been extracted from Advanced Level Biology papers set in two different years.

Practical biology

Each paper has three questions.

1. The first question is a dissection, not necessarily one which the candidate is expected to have done before.

Examples

A. i) Pin out the frog, DORSAL SIDE UPPERMOST.

Make a median longitudinal incission through the skin from the level of the forelimb to the cloaca. Continue this incision through the skin down the right hand limb to the foot. Reflect the skin of the body and of the leg and pin it out on either side, taking great care not to damage any small nerves, blood vessels or other structures.

Make a few brief notes to describe your observations at this stage, and answer the following questions :

How is the skin attached to the body ?

Suggest what might be the significance of the loose nature of the skin.

ii) Make a median longitudinal cut through the dorsal muscles from the posterior end of the vertebral column to the cloacal region ; the muscles on the right hand side should now be reflected to one side to reveal the spinal nerves of the posterior region. Trace these nerves backwards as far as possible down the right leg to the foot, noting any branches of the main nerves. This should be done by separating the muscles of the thigh and shank with the fingers, or the back of a scalpel, and pinning the muscles aside to display the nerves and their branches. At the same time the principal blood vessels should be noted and, in the foot region, the tendons.

Pin and display your dissection on the cork mat provided... Make an accurate labelled drawing of your dissection and answer the following questions.

What do the tendons look like and what structures do they connect ?

What properties would you expect the tendons to have in order that they may fulfill their role efficiently.

(Then followed directions of how the dissection should be preserved and packed to be posted to the examiner).

B. i) Examine the head of the fish, investigating particularly the structure and action of the jaws and gills. Make a cut through the body just behind the operculum on either side in order to sever the head from the rest of the body. Now answer the following questions :

a) What is the function of the jaws ?

b) Describe briefly any other structures to be seen in the mouth cavity suggesting their functions.

c) Make side view drawings to illustrate the jaws in the open position and in the closed position.

ii) Make a mid-vental cut between the pectoral fins and extend this cut as far forward as possible in order to expose the heart and the gills from the ventral side. Dissect away any connective tissue which may be necessary to reveal the blood vessel leading forward from the heart and the junction with this vessel of any arteries leading to the gills. You are not expected to trace any of these arteries to the gills. Now answer the following :

a) Make a labelled drawing of your dissection to show the heart, blood vessels and position of gills. No detailed drawing of the gills is required.

b) State the number of pairs of gills present and comment on their relative sizes and positions.

iii) Dissect out one complete gill, place it in a watch-glass of water and examine it with a lens and low-power microscope.

Cut out a few of the gill filaments, place them on a slide and examine them in more detail. Then :

a) Make a labelled drawing to show the appearance of the dissected gill.

b) Write a few brief notes suggesting how the various parts of the gill are adapted to their particular functions.

(9o minutes)

2. A second question is designed to test some aspect of physiology, and is again usually set in such a way as to be new to the candidate, at least in details.

Examples

C. You are provided with :

i) a 0.25 % solution of glucose

ii) a 1.0 % solution of glucose - 1 - phosphate

iii) the top portion of a centrifuged extract of potato

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Using these solutions, make up a series of tubes as follows :

1. 1 ml. glucose solution + 1 ml. potato extract
2. 1 ml. glucose-1-phosphate + 1 ml. potato extract
3. 1 ml. glucose solution
4. 1 ml. glucose-1-phosphate
5. 1 ml. potato extract
6. 1 ml. potato extract boiled for 2 minutes and cooled, + 1 ml. glucose-1-phosphate

Shake the tubes well to ensure thorough mixing. At 0 minutes, and after 6, after 12 and after 18 minutes remove a drop of solution from each tube, place it on a white tile and test it with a drop of iodine solution. Record your observations.

Briefly give your interpretation of the results you have obtained.

What is the purpose in setting up tubes 3,4 and 5 ?

What is the purpose in setting up tube 6 ?

In what natural situations would you expect to find the reaction similar to the one in tube 2 ? Give three examples.

(45 minutes)

D. You are required to devise an experiment, using the solutions, U-tube capillary manometer and other apparatus provided, to measure the rate of yeast activity on sucrose solution at the following temperatures :

a) the temperature of tap water in your laboratory

b) at 40°C

c) at 65°C

i) Make a drawing of your assembled apparatus

ii) <u>Very briefly</u> describe your experiment

iii) Tabulate your results at each of the three temperatures

iv) Plot a graph, yeast activity against time at each of the three temperatures

v) What evidence, if any, would support the view that yeast activity is due to enzyme action ?

(60 minutes)

3. A third question usually tests ability to use a microscope and interpret plant sections.

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Example

E. a - i) Make a labelled plan-drawing to show the distribution of tissues in the section K4. (No cell drawing is required).

ii) Examine the regular single layer of cells surrounding the stele and make a high-power drawing of different cells in this layer. Briefly describe the structure of these cells and suggest what their function might be.

b - Stain the sections K5 provided in phloroglucin solution for 5 minutes, then transfer them to watch glass containing concentrated hydrochloric acid for about 2 minutes. Mount in dilute glycerol.
Examine the sections with a microscope and describe with the aid of a plan-drawing what you see in the sections.

(45 minutes)

Schools receive confidential instructions, 4 - 6 weeks before the date of the examination, in which are listed the materials to be supplied by the school (or examination centre). E.g. for a paper composed of Questions B, D and E, above, the instructions would have been: "Each candidate must be provided with the following apparatus and materials :

i) The usual apparatus and instruments for dissection

ii) Microscope

iii) Hand lens

iv) Slides, coverslips, watch glasses

v) Fresh herring or mackerel. Fish as obtained from a fishmonger should be immersed in 5 % formalin for 3 - 4 days before the examination. They should then be well washed in water before issue to candidates.

vi) Card on which candidate may write centre number and candidate's number ; cotton wool and 5 % formalin solution for packing dissection.

vii) Two boiling tubes, bunsen burner, tripod, gauze.
Two rubber bungs to fit the boiling tubes, bored with two holes and fitted with glass tubing as shown in drawing".
(Drawing here omitted).
"Two pieces rubber tubing about 2 in. long to fit on the glass tubing. Two spring clips or screw clips.
Two pieces rubber tubing about 9 in. long to fit onto the glass tubing in rubber bung and U-tube manometer specified below.
Simple glass capillary U-tube, with limbs approximately 3 1/2 in. long for use as a manometer.
Beaker of suitable size to be used as a water bath to hold two boiling tubes.

Thermometer reading 0-100°C.

Watch or clock with seconds hand.

15 % sucrose solution. Allow each candidate 25 ml.

Yeast 'solution' made by mixing 1gm. dried yeast with 100 ml. water. Allow each candidate 25 m.".

viii) Phloroglucin and conc. hydrochloric acid.

TO BE SUPPLIED FROM CAMBRIDGE Specimens K4 and K5.

Biology Theory

The Cambridge University Examinations Syndicate sets two theory papers in addition to the practical. The first question on each is compulsory, and is of the type which presents data (in prose, in a graph, or in a table) and asks questions such as :

a) What do the ratios of plants occurring in each of the classes suggest to you about the number of the factors governing the inheritance of grain colour ?

b) What further tests might you make to confirm your hypothesis ?

c) Draw up schemes, with suitable symbols for each factor, showing the genotypes of each cross at each stage, including the parental genotypes.

d) In which parts of the grain are the blue and the black pigments located ? Give reasons for your answer.

4 questions must be done out of the remaining 8, on each paper. Examples of these questions are :

U. Describe the movements made by a fish as it swims, and relate these movements to muscle contraction and the skeleton.

Outline briefly the biochemical changes that occur during a single muscle contraction.

V. In winter the Northern Forest regions of the Northern Hemisphere have heavy snowfall and the air temperature may fall to minus 50°F. In these regions mice live through the winter under the snow, while their predator, the fox, lives above the snow.

Answer the following questions from the point of view of the maintenance of body temperature :

a) Why do both animals lose body weight throughout the winter ?

b) How is the habitat of each animal related to its size ?

c) What other features help these animals to live under such conditions ?

W. In a field of wheat, early in Spring, there may be on average one plant per m^2 of Papaver rhoeas, an annual poppy. A plant of this species, if grown in good conditions, is capable of producing more than 1,000 seeds, and yet is it unlikely that there will be as many as 1,000 plants per m^2 in the next crop. Outline those factors which determine the density of poppy plants that will appear in the next crop. What experiments might you carry out to support your answers ?

X. a) What is the relationship between amino acids and proteins ?

What structural features of amino acid molecules make this relationship possible ?

b) What is the role of

i) the stomach,

ii) the liver, in the metabolism of proteins in a mammal ?

Y. What difficulties in locomotion have animals which possess exo-skeletons, and how do they deal with them ?

What different kinds of movement can you observe in plants and in parts of a plant ?

Z. Compare, by means of annotated diagrams only, the main features of the life-history of a named fern with that of a named angiosperm (monocotyledon or dicotyledon).

What features in the life-history of the fern would you regard as likely to make it more difficult for it to increase in numbers than it is for the angiosperm ?

Mark Schemes

An indication is given below of the sort of (fairly detailed) mark scheme used for the example quoted on the previous page of the compulsory questions on a theory paper. This is most certainly testing qualities and skills of the candidate, not just factual knowledge, as they are asked to consider information they have not met before.

a - Do they understand what a ratio is ? Can they sort out the correct ratios from the data given ?

Mark scheme :		
	First ratio, correctly stated	2
	Second ratio correctly stated (a more complex one)	3

b - They were asked to design further tests. This discovers their degree of comprehension of the situation, and ability to apply previous knowledge to a new situation.

Mark scheme : Appropriate test (e.g. statistical, further crosses etc.) correctly described. Examiners would be told in more detail which tests could be accepted 3

c – This section tests ability to communicate by diagrams the understanding of the conventions of genetics and (in the context of the information provided) deductive ability.

Mark scheme :

First ratio	– suitable symbols	1/2	4
	– correct scheme	3 1/2	
Second ratio	– suitable symbols	1/2	4
	– correct scheme	3 1/2	

d – Tests deductive ability again.

Mark scheme : Correctly stated location of blue pigment reason 2

Correctly stated location of black pigment reason 2

Total : 20

In a similar way, a detailed scheme can be used on the practical paper to test for e.g. skills in dissection and manipulation, observation, drawing ability. By setting a dissection, or an animal, the candidate has not seen before any possibility of his scoring high marks simply by learning his notes thoroughly is eliminated, e.g. in the dorsal dissection of frog nerves already mentioned :

a – Asked to describe observations verbally. (The comments in parentheses are the author's)

1 mark might be given for each of the following :

- Visual point of origin of nerves, direction of spread
- Urostyle and ilia seen (even if not named as such)
- Pigment spots on skin
- Fine blood vessels inside skin surfaces) (Would not be seen in a clumsy
- Fine nerves to skin surfaces) or careless dissection, nor by) a careless observer.)

b – Asked to draw the dissection.

- Label – sciatic plexus) 1/2 mark
- drawing : 2 thick nerves) 2 marks (obvious marks)

  Fine Xth nerve) 1 mark (would not be noticed by careless worker)

Sciatic nerve to knee	1 mark	
Short branch on inside of leg	2 marks	(would not be noticed by careless worker)
Branch at knee	2 marks	) i.e. does the pupil complete
Nerve continues into shank	1 mark	) what he was told to do ? Can) he trace the nerve between) muscle blocks etc. ?

- Label : iliac or sciatic artery 1/2 mark
- Drawing : artery shown, groin to knee 1 mark (obvious mark)

  small lateral branches etc. 1 mark (a careless worker or observer might fail to notice these)

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APPENDIX III a

ANALYSIS OF ANSWERS TO AN EXAMINATION QUESTION

The following questions were set to pupils during a study tour of schools in Europe :

" Give an account of the processes involved in the following :

a) Uptake of alveolar oxygen by blood.

b) Transport of oxygen from lungs to muscle cells of the heart.

c) Uptake and transport in the opposite direction of carbon dioxide produced by the heart cells ".

The sample of scripts is very small - only seventeen - eighteen from each of France, Switzerland and the United Kingdom, and four from Sweden. Only in the United Kingdom does this sample represent two schools. So obviously the following results must be approached warily despite their striking nature. (The Swedish pupils had been asked to teach themselves this topic from their textbooks. This is not an unusual method, but may make their answers not strictly comparable with the others).

Facts stated in answer to question   % of pupils stating fact

	France	Sweden	Switzerland	United Kingdom
a + Air enters through nose, results	-	-	42	12.5
+ Trachea or long wind-pipe	-	-	67	12.5
+ Details of passage from bronchi to alveoli	-	-	58	12.5
Alveoli surrounded by capillary network	17	50	75	44
Separating membrane thin and/or permeable and/or moist	28	-	8	87.5
Gas exchange occurs in alveoli	(-)	-	67	(-)
Oxygen enters blood in capillaries	17	25	75	44
* Oxygen dissolves	-	-	-	75
* in alveolar fluid	-	-	-	69

		France	Sweden	Switzerland	United Kingdom
	* Partial pressure of oxygen	61	-	-	31
	* High in lungs	78	-	-	44
	* Oxygen diffuses	61	-	-	75
	* Diffusion gradient maintained	11	-	-	50
	* between alveolar fluid and red blood cells	33	-	8	56
	* By continuous circulation of blood	22	-	8	12.5
	* Some oxygen in solution in plasma	56	25	-	6
	* Haemoglobin (in red blood cells)	94	100	25	94
	structural details	39	50	-	6
	* combines with oxygen→oxyhaemoglobin	94	75	-	69
	* Loss of carbon dioxide from blood promotes formation of oxyhaemoglobin	-	-	-	19
	+ Details re control of inspiration	-	-	-	12.5
	+ Other points	17	-	-	25
b	* Blood flows from lungs to heart	22	25	-	50
	* Pumped by heart	-	50	25	31
	* Via capillaries in lungs	- -	25	42	37.5
	* pulmonary veins	17	25	83	69
	* left auricle	-	50	33	31
	* left ventricle	-	50	75	37.5
	(or) left side of heart	6	-	17	6
	any mention of action of heart valves	-	50	42	-
	* leaves by aorta	6	75	67	31
	* Coronary arteries	-	50	83	56
	* branch off aorta at base	-	-	33	37.5
	* Capillaries within heart tissue	6	25	67	44
	Partial pressure of oxygen in blood in heart, and that in cells	56	25	-	37.5

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	France	Sweden	Switzer land	United Kingdom
* such that oxyhaemoglobin → oxygen + haemoglobin	72	50	-	44
rate of dissociation increased by rise in temperature	-	-	-	-
rate of dissociation increased by greater acidity	-	-	-	25
* rate of dissociation increased in presence of carbon dioxide	-	-	-	25
Oxygen diffuses	44	-	-	19
via tissue fluid	11	-	-	12.5
into cardiac muscle cells	61	25	25	31
c * Carbon dioxide gradient/partial pressure such that gas diffuses	56	-	-	6
* out of muscle cells	50	-	17	12.5
* into tissue fluids	6	-	-	12.5
* into blood/plasma	44	-	17	5
* in heart capillaries	-	-	8	6
* (CO_2) enters red blood corpuscles/ cells	11	-	8	56
* combines with water	56	25	-	37.5
* is catalysed by carbonic anhydrase	-	-	-	50
* carbonic acid	28	-	-	75
* dissociates into	-	-	-	25
* bicarbonate ion which	78	25	-	62.5
<u>either</u> reacts with KHb → potassium bicarbonate	67	-	-	12.5
* <u>or</u> diffuses into plasma	11	-	-	44
* and a hydrogen ion which	50	25	-	25
* is accepted by the haemoglobin (in place of the K^+)	50	25	-	12.5
* Any reference to chloride ion shift	-	25	-	25
* 85 % (or major part)	11	-	-	25
* of carbon dioxide carried in plasma	22	-	-	19
* as sodium bicarbonate	17	50	-	6
* 10 % (some, a little)	22	-	-	37.5
* carried as carboxyhaemoglobin/ combined with haemoglobin	83	50	-	50

	France	Sweden	Switzerland	United Kingdom
:: 5 % (a little)	17	-	-	44
:: carried in solution in plasma	44	-	-	62.5
:: Passes through coronary veins	-	25	67	37.5
:: Into right auricle	-	25	50	25
:: Right ventricle (or right side of heart)	-	25	75	37.5
:: pulmonary arteries	17	25	75	37.5
:: lungs/capillaries in lungs	22	25	67	56
Details of CO_2 partial pressure gradient in lungs	44	-	-	-

Other facts were mentioned by pupils in all countries, but as they were not relevant to the question they have been omitted from the analysis.

+ Not relevant to this question

:: included in original points expected for an English A level standard answer

These results seem to bring out very clearly the differences between the approaches of the teachers concerned. In the French school the teacher had obviously emphasised the biochemical aspects of respiratory transport, if not to the exclusion of anatomical detail then at least to the extent that the pupils failed to comment on the essential connections between their anatomical knowledge and their biochemical knowledge in this field. Conversely the Swiss teacher had obviously emphasised the significance of the anatomy of certain parts of the respiratory and circulatory systems, but the biochemical mechanisms of gaseous transport had not been tackled at all. The two or three English teachers involved had, on the other hand, all covered both aspects, but the results seem to be that - with a greater choice of facts at their disposal - fewer pupils record any one fact than in France or Sweden. As there was a time limit on the question perhaps this is only to be expected.

These findings also accord reasonably well with the estimates of "depth" in the syllabus analysis tables for the relevant sections. France records them as I, Switzerland does not claim to study paths of gaseous diffusion and does respiratory transport as I, and the United Kingdom records a "depth" study of II.

Limited though this study has been, it seems to indicate that it could be a fruitful line of investigation for further comparisons in certain key areas - provided, of course, that a statistically valid technique was used for the sampling.

APPENDIX IV

ORGANISATION OF COURSES

Austria :

Ministry organises conferences.

Belgium :

Journées pédagogiques. A few teachers attend longer courses outside Belgium.

Cyprus :

Plans to set up a Pedagogic Information Centre, with the help of UNESCO. Meanwhile some seminars have been organised by the Ministry to discuss the use of the 'Nuffield' Foundation's projects approach.

Denmark :

Courses are organised by a committee composed of one member from the Ministry of Education and two from the Union of Biology Teachers. The instructors are Inspectors and university teachers.

France :

Courses are generally organised by the general inspectorate in consultation with Further Education, the regional administrations, and the national associations of teachers of biology and geology. As the instructors are university teachers, the emphasis tends to be on updating of scientific knowledge rather than on new pedagogic methods. Cooperation between school and university teachers is growing gradually, stimulated initially by the formation of a new national ecological society of which both levels of teacher became members. However, university staff are very much occupied at present with their own reforms, and it is not yet possible to arrange enough short courses of the type described above.

Germany :

Courses may be organised by the school boards or by the universities, or by the teacher associations, or by industry, with university teachers, inspectors or occasionally Gymnasium teachers as instructors. The most usual events, however, are meetings or excursions. The total lack of cooperation of universities with the schools was a frequent complaint.

Iceland :

A sabbatical year, on full pay, is granted after ten years service.

Ireland :

Refresher courses are organised every summer by the Education

Department, and others are arranged by the Teacher Association. Instructors are university lecturers and experienced teachers. After attending one of these courses, the classes taught by that teacher are eligible for grants for equipment.

Italy :

For the last ten years refresher courses of varying lengths have been organised by the Centres Didactiques Nationaux (a branch of the Ministry). Teachers involved in the 62 classes trying out the 'Pilot' scheme, based on the American BSCS, have had courses arranged for them at the universities of Catania and Pavia, in each case directed by a university professor. In addition, periodic seminars and discussions have been held in the "Laboratoire Central des Sciences Expérimentales" in Foligno, often in connection with the apparatus and experiments used on the course.

Luxembourg :

Many facilities are available for teachers who wish to keep up to date academically. They are officially recommended to participate in symposia and laboratory research work, and about 5 % of teachers acquire a doctor's degree in a university faculty. Some scholarships are available.

Malta :

The Education Department organises refresher courses ; sometimes instruction is given by well known specialists. Several scholarships are offered to teachers to enable them to undertake further studies abroad.

Netherlands :

The organisation and coordination of courses is the responsibility of the Biological Council of the Royal Dutch Academy of Sciences and Letters. As its responsibility is for all levels of biological interest, the courses are arranged to appeal to university specialists as well as school teachers. This tends to emphasise academic updating at the expense of pedagogic method, but does provide opportunity for cooperation between school and university. Courses are also organised by the Teacher's Associations for academic instruction which is usually given by university lecturers. Incidental meetings on various subjects are also arranged occasionally. Currently running are courses of 230 hours per year for M.A.V.O. teachers (1 evening per week plus excursions) on the raw syllabus proposals. Each course has a laboratory assistant and two tutors who are good, experienced teachers from the Gymnasium or H.B.S

Norway :

Norsk Lektorlag organises summer courses on such subjects as marine biology or cell biology. These are often held at Bergen University, which usually provides the instructors. There are 30 places on each course. It is hoped the position will improve in the next five years.

Spain :

Conferences are held at which teachers can bring their scientific knowledge up to date.

Sweden :

When the curriculum is revised (once every seven years) the National Board of Education provides training courses for the new one, both academic and pedagogic. Academic courses take place during the school term. Teachers wishing to attend them are paid living expenses. Pedagogic refresher courses are run in the summer holidays, and here also costs are paid. In very recent years the emphasis has been on courses for biology teachers, so the proportion attending has been high. In 1970 the major part of the available finance will go to another subject so numbers of biologists attending will drop. Cooperation between school and university teachers is considerable. Both are active members of the Biology Teachers Association. Throughout the country 24 District Boards of Education each appoint one official to plan courses for teachers. Headmasters may also organise short courses in a local school. Instructors are various specialists.

Switzerland :

Courses are organised by the "Vereinigung Schweizerischer Naturwissenschaftslehrer", with a gradually increasing amount of financial aid from the government. The instructors are usually university teachers. There is also a newly organised "Centre for further training", but no details were made available about this.

United Kingdom :

Some teachers never attend courses, but an average attendance would be one course every two years. Courses during school terms are rare, but if a teacher could get permission to attend one, he would obtain his leave on full salary. The extent and efficiency of inservice training is increasing. The following types of courses are available :

1. National courses usually lasting one week arranged by the Department of Education and Science. Recently there have occasionally been six week courses.

2. Short courses, e.g. one evening a week for a term (or a year), one day, sometimes a whole week to a fortnight : arranged by Local Education Authorities and/or Colleges of Education, and/or University Institutes of Education.

In addition :

3. Part-time study can usually be arranged for individual teachers to obtain higher qualifications. Some universities offer "school teacher studentships" for one term of individual study.

TEACHERS' CENTRES

In addition to formally organised courses five countries have 'Teachers' Centres' which provide opportunities for keeping in touch with information, ideas, and other teachers throughout the year.

France :

The 'Institut Pédagogique National' has many regional centres, each attached to a university. These "Centres régionaux de documentation pédagogique" provide all the indispensable materials such as reference libraries, film libraries, etc. Regional meetings of teachers are also focussed in these centres, and may occur as frequently as monthly or even fortnightly. Some may be rather longer, such as the Journées d'Information, and some are academic lectures whilst others may involve practical sessions or excursions. Reprints of lectures are available subsequently to interested teachers, and the Centres also publish bulletins of background information likely to be of use to teachers, e.g. on topics new to the syllabus.

Germany :

There exist Institutes for Study for trained teachers. Both individual and serial lectures are organised, on academic and pedagogical topics.

Netherlands :

Three types of pedagogical centres exist - catholic, protestant and general. They do not provide a physical centre for teachers to meet and discuss common problems or new apparatus. Instead they function mainly in an advisory capacity where asked. One or two of these centres have organised courses occasionally.

Spain :

A "Didactical Guidance Centre", attached to the general directorate of secondary education, is run by inspectors chosen from the most suitable teachers in (state) schools. Teachers can meet in this centre for discussions.

Sweden :

At the office of each district board is an audio-visual centre where teachers can inspect new material as well as discuss common problems informally.

United Kingdom :

In most areas centres have developed organised by teachers and for teachers. They are often open every weekday evening, and are usually held in a school or technical college so that some laboratory facilities may be available for testing new ideas for experiments. Different groups meet according to their own wishes and needs. Such centres are in general more frequently used by primary school teachers than by sixth form teachers. For these latter people the local meetings of the science teachers 'organisation tend to fulfil a similar function to the teachers' centres.

PROFESSIONAL TEACHERS ORGANISATIONS (FOR TEACHING OF SCIENCE OR BIOLOGY) (OTHER THAN THE MINISTRIES OF EDUCATION)

Belgium :

1. V.E.L.E.W.E.
2. Association Nationale de Professeurs de Biologie

activities (of both)
- a) Production of a "Bulletin"
- b) Organisation of "Journées Pédagogiques" for their members

Denmark :

Biology Teachers Association

activities
- a) 1 national and very occasional local meetings
- b) 2 week courses in summer holiday
- c) Small journal produced 3 - 4 times yearly in conjunction with geography teachers

France :

Association des Professeurs de Biologie et Géologie de l'enseignement public.

activities
- a) Excursions and visits
- b) Teachers' meetings
- c) Bulletin, issued four times a year, containing news, administration and articles

Ireland :

1. Irish Science Teachers Association ; this produces a quarterly journal 'Science', dealing with science in general
2. National Commission for the teaching of biology. This has just been set up.

Italy :

1. Comité National pour l'Education Scientifique (CNES)
2. Association Nationale des Enseignants des Sciences (ANISN)

3. Commission pour les problèmes de l'Enseignement de la Biologie. This is the body which has formed the pilot classes using the American BSCS texts.

Luxembourg :

Commission Nationale pour Biologie. Deals with syllabuses and curricula.

Netherlands :

The Biology Teachers Association is run voluntarily by school teachers in "spare time". Only 30 % of eligible teachers belong, perhaps partly because membership has only recently been extended to biology teachers outside the Gymnasium. There are separate sections.

activities a) Annual course for 25 - 30 teachers

b) Part sponsor of two-monthly "Bulletin for docenten in de Biologie". Articles include laboratory planning and equipment and pedagogical discussion. (The other sponsors are the Biological Council of the Royal Dutch Academy, which also provides the editor, the pedagogical centres and the biology departments of the University Institutes of Education)

Norway :

No national body, but there are professional committees appointed by Norsk Lektorlag. This is concerned with teachers of any subject in the Gymnasium, but is divided into subject sections. They published "Gymnaset : Søkelyset I and II" and also a general fortnightly bulletin (all subjects) - "Den Högreskole". (For teachers in the compulsory schools there is a separate, but equivalent, organisation, the Norsk Lararalag.

activities meetings, about four a year in the Oslo area

a summer course, each year for the last five years

Scotland :

1. Association of Biology Teachers

Activities regional branches run local meetings and conferences under a coordinating central committee

2. Association for Science Education) as for United Kingdom
3. Institute of Biology)

Spain :

" Cuerpo de Catedraticos y Agregados de los Centros de enseñanza oficial" - section for biology specialists

Sweden :

Biology Teachers Association ; this produced a journal "The Biologist and arranges talks and excursions at an annual, three-day conference.

Switzerland :

Vereinigung Schweizerischer Naturwissenschaftslehrer

activities a) Publication of "Chemie und Biologie" periodically

b) Organises courses

c) Publicises modern methodology of science teaching

United Kingdom :

1. The Association for Science Education (ASE)

activities a) Two journals are published quarterly

i) School Science Review - includes comments on methodology by teachers of Biology, Chemistry and Physics

ii) Education in Science

b) National meeting annually with :

i) Lectures

ii) Exhibitions by manufacturers of apparatus and equipment

iii) Exhibitions by publishers of textbooks, reference and background books in science

iv) Members exhibition of home made apparatus and experiments

c) Branch meetings throughout country, 3 or 4 times a term. Activities similar to those at national meeting, often in separate sections for biology, etc.

d) Advisory committees on aspects of science teaching, e.g. ASE inititated the 'Nuffield' Project.

2. The Institute of Biology

activities a) Public lectures

b) Joint committee with Royal Society to produce a survey 'Biological Sciences in Sixth Forms at Universities in the United Kingdom'.

c) Publishes Journal of Biological Education.

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