A close-up of a logo

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*BI25M7- Energy For Life*

*Course Handbook 2023-2024*

*Undergraduate Medical Sciences*

*School of Medicine, Medical Sciences & Nutrition*

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# Course Summary

Energy is a central theme in biochemistry: cells and organisms depend on a constant supply of energy to oppose the inexorable tendency in nature for a system to decay to its lowest energy state. The storage and expression of information costs energy, without which structures rich in information inevitably become disordered and meaningless. The synthetic reactions that occur within cells, like the synthetic processes in any factory, require the input of energy. Energy is consumed in the motion of a bacterium or an Olympic sprinter, in the flashing of a firefly or the electrical discharge of an eel. Cells have evolved highly efficient mechanisms for coupling the energy obtained from sunlight or fuels to the many energy-consuming processes they carry out.

The above passage, a quotation from an early edition of one of our texts (Lehninger Principles of Biochemistry 2000, p.6), sets the scene for the work to be done in the Energy for Life course. We shall be concerned with the mechanisms by which organisms’ harness, transform and use energy for life-processes using metabolic pathways composed of controllable enzyme-catalysed reactions. At one level, this is an enormously complicated task, with much detail still to be discovered. In BI25M7, however, we shall emphasise the principles underlying the biochemical complexity. And, in fact, although we shall illustrate integration of metabolic processes by reference to human biochemistry, and consider some metabolism restricted to certain, other organisms, there are relatively few fundamental metabolic pathways, and these are common to all forms of life.

# Course Aims & Learning Outcomes

The aims of the course are to enable you:

* to establish a knowledge of the essential features of cell metabolism and insight into its organisation and control;
* to establish a knowledge of the activity and regulation of enzymes.

The subject-specific learning outcomes are such that, at the end of the course, you should be able to:

* describe major features of energy transformations occurring in living organisms;
* describe the thermodynamic principles underlying and processes of biological catalysis;
* describe the functions and general features of the major metabolic pathways of intermediary metabolism;
* describe the integration of flow through some of these metabolic processes and the ways in which intracellular flow patterns change in response to extracellular events;
* describe the effects on metabolic flow of controlled change in enzyme activity.

In addition, intellectual skills will comprise:

* recognition that much biochemical uniformity underlies biological diversity and complexity;
* ability to apply subject-specific knowledge and understanding to address problems (during practicals and tutorials);

practical skills will comprise:

* ability to obtain, record, collate and analyse information in the laboratory;

numeracy and communication skills are encouraged by opportunities to:

* analyse laboratory-acquired information;
* produce a written laboratory report and verbally address topics during practical classes;

interpersonal and teamwork skills are encouraged by opportunities to:

* work productively with others in the laboratory;
* recognise and respect the views and opinions of others during practical classes and tutorials;

self-management skills are needed in:

* balancing the various demands of this and other courses you are studying.

The course achieves these outcomes through a series of complementary lectures, tutorials and practical classes. The function of the lectures is to enable information to be transmitted to a large group. The lectures provide an indication of the quality and quantity of knowledge and understanding expected to be gained by the end of the course. The tutorials provide an opportunity to go beyond the lecture materials and apply the knowledge acquired in the lectures. The practical classes enable the class to use some of the techniques mentioned in the lectures, and to gain experience in the acquisition, recording, evaluation, interpretation and presentation of experimental results.

Subject-specific, intellectual and written communication skills are assessed in the practical report; practical and numeracy skills are assessed in this practical report; communication, interpersonal and teamwork skills, although encouraged in practical’s, are not formally assessed.

Learning to understand is not a passive process, and we encourage you to check and organise, in ways best suited to yourself. In the notes on the use of the Common Grading Scale by the School, it says that high marks are given for answers ‘showing both knowledge and comprehension’: this means that a well organised and argued response that demonstrates knowledge *and* understanding will attract the highest marks.

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Course Teaching Staff

Course Co-ordinator(s):

Prof John Barrow ([**j.barrow@abdn.ac.uk**](mailto:j.barrow@abdn.ac.uk))

Dr Virtu Solano ([**mariavirtudes.solanocollado@abdn.ac.uk**](mailto:mariavirtudes.solanocollado@abdn.ac.uk))

Other Staff:

# Prof Justin Rochford (JR – [**j.rochford@abdn.ac.uk**](mailto:j.rochford@abdn.ac.uk))

# Dr Michael Scholz (MS – [**m.e.scholz@abdn.ac.uk**](mailto:m.e.scholz@abdn.ac.uk))

# 

Assessments & Examinations

Assessment in BI25M7 consists of:

1. one lab report (contributing 30% of total assessment);
2. one mid-term multiple choice style exam (contributing 10% of total assessment)
3. one multiple choice style exam (contributing 60% of total assessment).

Re-sit examination for the course will consist of a single multiple-choice style examination following the same format as that used for the in-course exam. For re-sit candidates, marks for Practical Reports are normally considered.

# Class Representatives

We value students’ opinions in regard to enhancing the quality of teaching and its delivery; therefore, in conjunction with the Students’ Association we support the Class Representative system.

In the School of Medicine, Medical Sciences & Nutrition we operate a system of course representatives, who are elected from within each course. Any student registered within a course that wishes to represent a given group of students can stand for election as a class representative. You will be informed when the elections for class representative will take place.

What will it involve?

It will involve speaking to your fellow students about the course you represent. This can include any comments that they may have. You will attend a Staff-Student Liaison Committee and you should represent the views and concerns of the students within this meeting. As a representative, you will also be able to contribute to the agenda. You will then feedback to the students after this meeting with any actions that are being taken.

Training

Training for class representatives will be run by the Students Association. Training will take place within each half-session. For more information about the Class representative system visit [www.ausa.org.uk](http://www.ausa.org.uk) or email the VP Education & Employability [vped@abdn.ac.uk](mailto:vped@abdn.ac.uk) . Class representatives are also eligible to undertake the STAR (Students Taking Active Roles) Award with further information about this co-curricular award being available at: [www.abdn.ac.uk/careers](http://www.abdn.ac.uk/careers).

Problems with Coursework

If students have difficulties with any part of the course that they cannot cope with, alone they should notify the course coordinator immediately. If the problem relates to the subject matter general, advice would be to contact the member of staff who is teaching that part of the course. Students with registered disabilities should contact the medical sciences office, ([medsci@abdn.ac.uk](mailto:medsci@abdn.ac.uk)) (based in the Polwarth Building, Foresterhill) to ensure that the appropriate facilities have been made available. Otherwise, you are strongly encouraged to contact any of the following as you see appropriate:

* Course student representatives
* Course co-ordinator
* Convenor of the Medical Sciences Staff/Student Liaison Committee
* Personal Tutor
* Medical Sciences Disabilities Co-ordinator (Dr Derryck Shewan)

All staff are based at Foresterhill and we strongly encourage the use of email or telephone the Medical Sciences Office. You may have a wasted journey travelling to Foresterhill only to find staff unavailable.

If a course has been completed and students are no longer on campus (i.e. work from second half session during the summer vacation), coursework will be kept until the end of Fresher’s Week, during the new academic year. After that point, unclaimed student work will be securely destroyed.

# Course Reading List

The recommended text(s) for this course will be posted as a link on the BI25M7 MyAberdeen site.

# Lecture Synopsis

The lecture series for this course is split into four separate sections:

Section 1 – Bioenergetics & Enzymes

Section 2 – Carbohydrates, Citric Acid Cycle & Terminal Respiration

Section 3 – Lipid & Protein Metabolism

Section 4 – Metabolic control

*SECTION 1 – BIOENERGETICS & ENZYMES*

Title: Bioenergetics

No of lectures: 3

**Lecturer: Dr Michael Scholz**

* Review of thermodynamic principles: conservation of energy, Enthalpy and Entropy, free energy and chemical equilibrium, standard free energy, biochemical catalysis, thermodynamics of life, equilibrium versus non-equilibrium thermodynamics
* Review of organic reaction mechanisms: nucleophiles and electrophiles, Group transfer reactions, isomerisation and elimination, reactions that make or break C-C bonds
* Catabolism and Anabolism, oxidation and reduction in the metabolism, Nernst equation and redox potentials, thermodynamics of phosphate compounds, the role of ATP

Title: Enzymes

No of lectures: 2

Lecturer: Dr Michael Scholz

Enzymes are often referred to as the “engines” or “robots” of the cell, as they perform all major functions from catalysis of metabolites through to building important structures within cells. These lectures aim to give an overview of enzyme properties, and using specific examples, the mechanisms of common enzymes prior to in depth study of metabolic pathways. Areas that will be covered are:

* General enzyme characteristics
* How catalysis occurs through enzymes
* How rates of enzyme activity can be studied
* How cells are able to control enzymes within specific pathways

*SECTION 2 – CARBOHYDRATES, CITRIC ACID CYCLE & TERMINAL RESPIRATION*

Title: Carbohydrates and Intermediary Metabolism

No of Lectures: 3

Lecturer: Prof John Barrow

Without carbohydrates we would have little energy to survive, so this very important aspect of biochemistry will be given some in depth analysis and thought in these 4 lectures. Topics to be covered will be:

* Carbohydrate structure and function
* Dietary carbohydrate metabolism
* Overviews of the major catabolic and anabolic pathways of carbohydrates;
  + Glycolysis
  + Gluconeogenesis
  + Glycogen metabolism
  + Pentose phosphate pathway

Title: The Citric Acid Cycle

No of Lectures: 1

Lecturer: Prof John Barrow

Oxygen is used by the body to oxidise food molecules. These 2 lectures will cover the citric acid cycle as follows:

* The reactions of the citric acid cycle
* How the cycle fits into other metabolic pathways
* The cycle in catabolism

Title: Terminal Respiration

No of Lectures: 2

Lecturer: Prof John Barrow

This process utilises compounds that are generated in the citric acid cycle to fuel the final stage in the full breakdown of fuel molecules to provide us with the energy we need. Areas covered will be:

* The role of the mitochondria in terminal respiration
* The energetics of terminal respiration
* The components of the terminal respiratory system
* Production of ATP through ATP synthase

*SECTION 3 – LIPID & PROTEIN METABOLISM*

Title: Lipid Metabolism

No of lectures: 2

Lecturer: Dr Michael Scholz

Lipids are water-insoluble molecules found in all living cells and tissues. Most are esters of long hydrocarbon-chain carboxylic (‘fatty’) acids. As triacylglycerols, they are dietary fuel molecules, act as fuel stores in the body, and provide insulation. Structurally related but amphipathic phospholipids are membrane components. Prostaglandins, thromboxanes and leukotrienes are specialised fatty acids, with potent physiological activities. The sterol cholesterol is also classed as a lipid; it is a component of cell membranes, and a precursor of bile acids, steroid hormones and vitamin D. Topics to be covered in these lectures will include:

* Structural diversity of lipids.
* Structure and properties of lipids.
* Biochemical synthesis of fatty acids, triglycerides and phospholipids.
* Transport of lipids through the body
* Process of fatty acid b oxidation
* Fatty acids as signalling molecules.

Title: Protein Metabolism

No of Lectures: 2

Lecturer: Prof John Barrow

Proteins, and the amino acids that make up this macromolecule, are an important source of metabolic energy. Since amino acids cannot be stored, an excess of amino acids, either from dietary sources or from the breakdown of the body’s own protein, results in their oxidative degradation. This involves the breakdown of amino acids to a carbon skeleton (which can enter the citric acid cycle) and an amino group which can be used for the synthesis of amino acids and nucleotides. The nitrogen in amino acids and nucleotides ultimately comes from atmospheric N2. N2 is very unreactive, and only a few, mainly soil-living micro-organisms, can reduce it and ‘fix’ it in the biosphere. In this series of lectures, we will look at:

* The nitrogen cycle: nitrogen is fixed from the atmosphere and, ultimately, transferred to an amino acid (glutamate). From there, by the process of transamination, other amino acids can be formed.
* Amino acid degradation: What happens to the carbon skeleton of amino acids? The carbon skeletons of some amino acids are converted into pyruvate or intermediates of the citric acid cycle and hence could be converted to glucose (i.e. they are glucogenic) whereas others are converted into acetyl CoA or acetoacetyl CoA and can then form ketone bodies (i.e. they are ketogenic).
* Amino acid degradation: What happens to the amino group of amino acids? The amino group is transferred to α-ketoglutarate to form glutamate which can then be transported to the liver. Glutamate plays a central role in biosynthetic pathways (formation of other amino acids or nucleotides) or in excretion pathways (to remove excess ammonia from the body).

*SECTION 4 – METABOLIC CONTROL*

Title: Metabolic Retrospective

No of lectures: 3

Lecturer: Prof Justin Rochford

To appreciate fully the significance of individual metabolic pathways and their regulation it is important to view these pathways in the context of the whole organism. The specialised functions of tissues and organs of complex organisms such as humans impose characteristic fuel requirements and patterns of metabolism. Hormonal signals integrate and coordinate the metabolic activities of different tissues and optimise the allocation of fuels and precursors to each organ. The body must also adapt to stressful situations and periods of starvation and we will learn how failure of these processes leads to metabolic disturbances including obesity and diabetes.

* Tissue specific metabolism: the liver as the powerhouse of metabolism, the adipocyte and its role in the storage of fat, muscle and its role in preserving blood glucose through the use of fatty acids, and the brain as a major consumer of ATP fuelled through metabolism of glucose
* Hormonal regulation of fuel metabolism: the key role of insulin and glucagon in the maintenance of glucose homeostasis
* Adaptation to starvation: changes in fuel metabolism during short and prolonged periods of starvation. Implications for the present-day epidemic of obesity
* Diabetes mellitus: emphasis on metabolic derangements

Lectures: Metabolic crosstalk host-pathogen

No of lectures: 3

Lecturer: Dr Virtu Solano

During infection, the interaction between a pathogen with host immune cells will determine the outcome of the infection leading to either pathogen clearance or establishment of the infection. If we have a closer look, these interactions are characterised by metabolic changes in both the pathogen and the host.

Here, we will learn:

* Bacterial metabolism/macrophage metabolism
* Macrophage metabolic adaptation during infection
* Bacteria metabolic adaptation during infection: example intracellular bacteria

# Practical/Lab/Tutorial Work

Information on the practical classes and tutorials will be available on the course MyAberdeen site.

University Policies

Students are asked to make themselves familiar with the information on key education policies, available [here](https://www.abdn.ac.uk/staffnet/teaching/key-education-policies-for-students-11809.php). These policies are relevant to all students and will be useful to you throughout your studies.  They contain important information and address issues such as what to do if you are absent, how to raise an appeal or a complaint and how the University will calculate your degree outcome.

These University wide education policies should be read in conjunction with this programme and/or course handbook, in which School specific policies are detailed. These policies are effective immediately, for the 2022/23 academic year. Further information can be found on the [University’s Infohub webpage](https://www.abdn.ac.uk/students/) or by visiting the Infohub.

The information included in the institutional area for 2022-23 includes the following:

* Assessment
* Feedback
* Academic Integrity
* Absence
* Student Monitoring/ Class Certificates
* Late Submission of Work
* Student Discipline
* The co-curriculum
* Student Learning Service (SLS)
* Professional and Academic Development
* Graduate Attributes
* Email Use
* MyAberdeen
* Appeals and Complaints

Where to Find the Following Information:

C6/C7- University of Aberdeen Homepage > Students > Academic Life > Monitoring and Progress > Student Monitoriung (C6 & C7)

https://www.abdn.ac.uk/students/academic-life/student-monitoring.php#panel5179

Absences- To report absences you should use the absence reporting system tool on Student Hub. Once you have successfully completed and sent the absence form you will get an email that your absence request has been accepted. The link below can be used to log onto the Student Hub Website and from there you can record any absences you may have.

[Log In - Student Hub (ahttps://www.abdn.ac.uk/studenthub/loginbdn.ac.uk)](https://www.abdn.ac.uk/studenthub/login)

Submitting an Appeal- University of Aberdeen Homepage > Students > Academic Life > Appeals and Complaints

https://www.abdn.ac.uk/students/academic-life/appeals-complaints-3380.php#panel2109

Academic Language & Skills support

For students whose first language is not English, the Language Centre offers support with Academic Writing and Communication Skills.

Academic Writing

* Responding to a writing task: Focusing on the question
* Organising your writing: within & between paragraphs
* Using sources to support your writing (including writing in your own words, and

citing & referencing conventions)

* Using academic language
* Critical Thinking
* Proofreading & Editing

Academic Communication Skills

* Developing skills for effective communication in an academic context
* Promoting critical thinking and evaluation
* Giving opportunities to develop confidence in communicating in English
* Developing interactive competence: contributing and responding to seminar discussions
* Useful vocabulary and expressions for taking part in discussions

More information and how to book a place can be found here

Medical Sciences Common Grading Scale

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Grade | Grade Point | % Mark | Category | Honours Class | Description |
| A1 | 22 | 90-100 | Excellent | First | • Outstanding ability and critical thought • Evidence of extensive reading • Superior understanding •The best performance that can be expected from a student at this level |
|  |
| A2 | 21 | 85-89 |  |
|  |
| A3 | 20 | 80-84 |  |
|  |
| A4 | 19 | 75-79 |  |
|  |
| A5 | 18 | 70-74 |  |
|  |
| B1 | 17 | 67-69 | Very Good | Upper Second | • Able to argue logically and organise answers well  • Shows a thorough grasp of concepts  • Good use of examples to illustrate points and justify arguments  • Evidence of reading and wide appreciation of subject |  |
|  |
| B2 | 16 | 64-66 |  |
|  |
| B3 | 15 | 60-63 |  |
|  |
| C1 | 14 | 57-59 | Good | Lower Second | • Repetition of lecture notes without evidence of further appreciation of subject • Lacking illustrative examples and originality • Basic level of understanding |  |
|  |
| C2 | 13 | 54-56 |  |
|  |
| C3 | 12 | 50-53 |  |
|  |
| D1 | 11 | 47-49 | Pass | Third | • Limited ability to argue logically and organise answers • Failure to develop or illustrate points • The minimum level of performance required for a student to be awarded a pass |  |
|  |
| D2 | 10 | 44-46 |  |
|  |
| D3 | 9 | 40-43 |  |
|  |
| E1 | 8 | 37-39 | Fail | Fail | • Weak presentation • Tendency to irrelevance • Some attempt at an answer but seriously lacking in content and/or ability to organise thoughts |  |
|  |
| E2 | 7 | 34-36 |  |
|  |
| E3 | 6 | 30-33 |  |
|  |
| F1 | 5 | 26-29 | Clear Fail | Not used for Honours | • Contains major errors or misconceptions • Poor presentation |  |
|  |
| F2 | 4 | 21-25 |  |
|  |
| F3 | 3 | 16-20 |  |
|  |
| G1 | 2 | 11-15 | Clear Fail/Abysmal |  | • Token or no submission |  |
|  |
| G2 | 1 | 1-10 |  |
|  |
| G3 | 0 | 0 |  |
|  |

# BI25M7 Course Timetable: 2023-2024

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Day/Date | Time | Place | Topic | Session | Staff |
| Week 26 | | | | | |
| Mon 22 Jan | 14:00-15:00 | ZG18 | Introduction to the Course | Lecture | JB/VS |
| *Section 1 – Bioenergetics & Enzymes* | | | | | |
| Thu 25 Jan | 09:00-10:00 | Regent LT | Bioenergetics (1) | Lecture | MS |
| Fri 26 Jan | 09:00-10:00 | ZG18 | Bioenergetics (2) | Lecture | MS |
| Week 27 | | | | | |
| Mon 29 Jan | 14:00-15:00 | ZG18 | Bioenergetics (3) | Lecture | MS |
| Thu 1 Feb | 09:00-10:00 | Regent LT | Enzymes (1) | Lecture | MS |
| Fri 2 Feb | 09:00-10:00 | ZG18 | Enzymes (2) | Lecture | MS |
| 10:00-13:00 | STH 1.001 | Practical 1 – Standard Curves | Practical | JB/VS |
| Week 28 | | | | | |
| Mon 5 Feb | 14:00-15:00 | ZG18 | Enzymes (3) | Lecture | MS |
| Thu 8 Feb | 09:00-10:00 | ZG11 | Tutorial 1 Group 1 | Tutorial | JB/VS |
|  | 10:00-11:00 | ZG11 | Tutorial 1 Group 2 | Tutorial | JB/VS |
| Week 29 | | | | | |
| *Section 2 – Carbohydrates, Citric Acid Cycle & Terminal Respiration* | | | | | |
| Mon 12 Feb | 14:00-15:00 | ZG18 | Carbohydrates and Intermediary Metabolism (1) | Lecture | JB |
| Thu 15 Feb | 09:00-10:00 | Regent LT | Carbohydrates and Intermediary Metabolism (2) | Lecture | JB |
| Fri 16 Feb | 09:00-10:00 | ZG18 | Carbohydrates and Intermediary Metabolism (3) | Lecture | JB |
| 10:00-13:00 | STH 1.001 | Practical 2 – Drug Screening | Practical | JB/VS |
| Week 30 | | | | | |
| Mon 19 Feb | 14:00-15:00 | ZG18 | Citric Acid Cycle | Lecture | JB |
| Thu 22 Feb | 09:00-10:00 | Regent LT | Terminal respiration (1) | Lecture | JB |
| Fri 23 Feb | 09:00-10:00 | ZG18 | Terminal respiration (2) | Lecture | JB |
| Week 31 | | | | | |
| Mon 26 Feb | 14:00-15:00 | ZG11 | Tutorial 2 Group 1 | Tutorial | JB/VS |
| 15:00-16:00 | ZG11 | Tutorial 2 Group 2 | Tutorial | JB/VS |
| Thu 29 Feb | 09:00-11:00 | STH 1.001, 2.001 | MID TERM EXAM | Test | JB/VS |
| Fri 1 Mar | 10:00-13:00 | STH 1.001 | Practical 3 – IC50 | Practical | JB/VS |
| Week 32 | | | | | |
| *Section 3 – Lipid & Protein Metabolism* | | | | | |
| Mon 4 Mar | 14:00-15:00 | ZG18 | Lipid Metabolism (1) | Lecture | MS |
| Thu 7 Mar | 09:00-10:00 | Regent LT | Lipid Metabolism (2) | Lecture | MS |
| Fri 8 Mar | 09:00-10:00 | ZG18 | Protein metabolism (1) | Lecture | JB |
| 10:00-13:00 | STH 1.001 | Practical 4 – Type of Inhibitor | Practical | JB/VS |
| Week 33 | | | | | |
| Mon 11 Mar | 14:00-15:00 | ZG18 | Protein metabolism (2) | Lecture | JB |
| Thu 14 Mar | 09:00-10:00 | ZG11 | Tutorial 3 Group 1 | Tutorial | JB/VS |
|  | 10:00-11:00 | ZG11 | Tutorial 3 Group 2 | Tutorial | JB/VS |
| Fri 15 Mar | 10:00-13:00 | STH 1.001 | Practical 5 – Lab Report Workshop | Practical | JB/VS |
| Week 34 | | | | | |
| *Section 4 – Metabolic Control* | | | | | |
| Mon 18 Mar | 14:00-15:00 | ZG18 | Metabolic Retrospective (1) | Lecture | JR |
| Thu 21 Mar | 09:00-10:00 | Regent LT | Metabolic Retrospective (2) | Lecture | JR |
| Fri 22 Mar | 09:00-10:00 | ZG18 | Metabolic Retrospective (3) | Lecture | JR |
| Week 35 | | | | | |
| Mon 25 Mar | 14:00-15:00 | ZG18 | Metabolic crosstalk host-pathogen (1) | Lecture | VS |
| Thu 28 Mar | 09:00-10:00 | Regent LT | Metabolic crosstalk host-pathogen (2) | Lecture | VS |
| Fri 29 Mar | 09:00-10:00 | ZG18 | Metabolic crosstalk host-pathogen (3) | Lecture | VS |

Staff

# Prof John Barrow (JB)

# Prof Justin Rochford (JR)

# Dr Michael Scholz (MS)

# Dr Virtu Solano

Venues

ZG18 – Zoology Lecture Theatre

Regent LT – Regent Building Lecture Theatre

ZG11 – Zoology G11 lab

STH – Science Teaching Hub

Campus Maps - Foresterhill



Polwarth Floor Plans

Diagram, schematic

Description automatically generated

Diagram

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Diagram

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