

**La Trobe University
Faculty of Health Sciences
School of Human Biosciences**

**HBS3APB Advanced Physiology B:
Normal Function, Drugs and Disease**

**Semester 2
2008**

Student Manual

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UNIT COORDINATORS

Elizabeth Brown and Andrew Bendrups coordinate this unit. Please see Elizabeth Brown in the first instance if you have some question or problem, especially if it is of an administrative nature. Contact details can be found on the front cover of this manual.

INTRODUCTION to HBS3APB

OBJECTIVES

The 3rd year Physiology course, of which Advanced Physiology B is the second part, teaches selected aspects of advanced physiology, focussing on recent research findings, general physiological principles and their applications, particularly in the fields of pathophysiology and pharmacology.

Unlike Year 2 Physiology, the course is not comprehensive: not *all* body systems, and not *all parts* of a body system, are covered. Rather, the intent is to revisit and develop selected areas in greater depth, aiming to achieve a level of understanding of physiology which exposes the *evidence* on which knowledge is based.

A student who has successfully completed Advanced Physiology A and B should be able to:

OBJECTIVE	TEACHING & LEARNING STRATEGY
Describe and explain advanced aspects of <i>systematic</i> physiology, by applying knowledge obtained from experimental research and from clinical evidence.	Develop topics covered in Year 2 at a greater depth in lectures, by giving details of experimental and clinical evidence in lectures and by providing selected readings drawn from the research literature.
Apply systematic physiology to predict variations in physiological function e.g. in extreme circumstances such as exercise, high altitude, and extremes of heat and cold.	In many topics, include lecture content which relates to physiological function in relatively extreme conditions, including pathological states.
Apply principles of pharmacology to allow understanding of the general mechanisms of drug action and the operation of factors which influence the absorption, storage and elimination of drugs from the body.	Introduce the general principles of pharmacology at the beginning of the course.
Apply knowledge of physiology to explain effects of certain drugs on normal function and in treatment of disease.	Apply pharmacological principles in each topic area, using selected examples relevant to the details of physiology covered in each topic area. Include specialized pharmacology lectures in each topic module and, where appropriate, integrate pharmacological examples into teaching of physiology.

Apply knowledge of physiology to explain effects of certain pathological conditions on normal function.	Include specialized pathology lectures in each topic module and, where appropriate, integrate pathophysiological examples into teaching of physiology.
Interpret and evaluate current journal articles about physiology, applied physiology, aspects of pathophysiology, pharmacology.	Include practical activities which require searching and evaluation of the scientific literature (journal article evaluation practical class, "internet-library projects")
Interpret and evaluate current "information" in the media about physiology, applied physiology, aspects of pathophysiology, pharmacology.	Include practical activities ("internet-library project") requiring searching and evaluation of information available from the internet and the scientific literature. Set topics for investigation which include aspects of physiology, pathology and/or pharmacology.
Select and apply information (from the course and other sources) about physiology and/or pathology and/or pharmacology for personal and community health promotion.	Include examples of applications of knowledge to personal and community health in lectures.
Teach (aspects of) human biology.	Include practical activities which require formal presentation of course-related content to the student cohort, allowing use of conventional lecture aids (Powerpoint, OHP, video etc.)
Discuss selected common diseases in our community with respect to aetiology, pathophysiology, management options (e.g. pharmacological) and health promotion.	Include examples of diseases and their management in the lecture content, selected on the basis of frequency in the community, interest and health promotion (rare diseases which exemplify some aspect of function or health promotion could be included).
Develop and execute an investigation into some aspect of the content addressed by this unit, and subsequently collect, interpret and report data.	Include a laboratory project which requires students to develop and conduct a research project under expert supervision and prepare a report in the format of a peer-reviewed journal article

CONTENT OVERVIEW: Advanced Physiology A and B

Lectures in Advanced Physiology A initially cover the principles of cell communication and their application in the field of pharmacology. The endocrine, immune and nervous systems are then presented as complex examples of biological communication.

For each physiological system covered, lectures in physiology are followed or interleaved with lectures on related topics of pharmacology and pathology. This pattern continues in the second semester unit Advanced Physiology B, which covers aspects of the cardiovascular, respiratory, musculoskeletal and reproductive systems.

GRADUATE ATTRIBUTES

The components of the units have been designed to provide students with a range of desirable “graduate attributes”.

Knowledge base

The lectures are intended to provide a level of understanding sufficient to serve as a foundation for further independent study and research. Together with the content of 2nd year physiology, completion of a 3rd year “major” in physiology (Advanced Physiology A and B) should provide a sound understanding of the function of all major body systems, and sufficient knowledge of the principles of pharmacology and pathology to support more comprehensive study in these sub-disciplines (as would be necessary, for example, for a career in medicine or, say, forensic pathology). Graduates should feel confident to call themselves “Physiologists”.

Practical training

The practical activities are diverse, including traditional laboratory experiments but also computer-based simulations, multimedia presentations, and analysis of published data. The laboratory experiments expose students to the nature of scientific experimentation and evidence. They provide *preliminary* training in the use of scientific equipment, including computer-based data acquisition and analysis systems (further training to develop full competence would be expected to occur in subsequent years e.g. Honours and postgraduate study).

The other practical activities serve to reinforce the lecture content or develop other practical skills, such as “literature searching” and the critical evaluation of published literature.

All practical activities are written up in the form of a concise report, developing the skills of rigorous and accurate data collection and analysis. A minor research project forms a major part of the practical component and is written up in the style of a formal journal article, providing preparatory training for an important skill, the publication of scientific work.

Communication skills

The ability to communicate with co-workers, clients and the general public is an important graduate attribute for a scientist. One role of the practical component of the units is to develop the skill of written communication, through the writing of concise and accurate practical reports. In preparing the reports, students can practise the use of computer technology for analysis and presentation of data.

In all practical classes students are required to work in groups, providing experience in team-work and the negotiation of responsibility that flows from interaction with others in a shared task.

Sense of enquiry and commitment to life-long learning

Lectures generally aim to stimulate intellectual curiosity and some specifically focus on recent research in the field of study, exposing students to the limits and limitations of knowledge.

Students are encouraged to further expand their knowledge, as independent learners, by being required to search for research articles via the library and the internet. Practical classes are used to develop general analytical and problem solving skills. The ability to collate and evaluate information, in a rigorous and critical way, is crucial to continuation of effective life-long learning.

Ethical principles

The importance of complete honesty and impartiality in data collection and analysis is emphasized, so that students are made aware of high ethical standards expected of scientific work.

LECTURE AND OTHER SUPPORT MATERIAL - WEBCT

Copies of Powerpoint slides used in lectures will usually be made available via WebCT prior to the lecture. Other information, including announcements and results, will be made available via WebCT as appropriate. The web page for this unit is accessed and run in the same way as the web page for HBS31APA Advanced Physiology A.

COMMUNICATION: WebCT

Unit information such as the timetable will be posted on the LMS site.

Should you wish to communicate with either of the unit coordinators, please either telephone or use regular email. See the front cover of this manual.

PRACTICAL CLASS NOTES

Introduction to practical classes

Practical class assessment

Internet-Library Projects

Practical class protocols

INTRODUCTION TO PRACTICAL CLASSES

Welcome to practical classes for *HBS3APB Advanced Physiology B: normal function, drugs and disease*.

The practical classes for this unit are all designed to reinforce material covered in the lectures and to introduce new material in a way that will not only be enjoyable but also an important learning tool.

Practical classes include educational, ethical and occupational health and safety considerations. The aim of this INTRODUCTION TO PRACTICAL CLASSES is to inform you of these.

Practical classes which require student participation as subjects have obtained ethics approval. The Faculty Human Ethics Committee (FHEC) is the authority approving teaching practical classes involving human participation. Any queries or complaints not able to be sorted out by the staff member in charge should be addressed to The Secretary, Faculty Human Ethics Committee, Faculty of Health Sciences, or telephone 9479 3583 or email n.humphries@latrobe.edu.au.

Any risk inherent in a practical class has been minimised by appropriate means, including having at least one appropriately qualified and experienced staff member in charge of the practical.

There are some rules regarding laboratory classes:

Eating and drinking are prohibited in the laboratories, unless this is a part of the practical class protocol. Please do not bring food or drink into the laboratories.

Closed shoes must be worn whilst in the laboratories. This means that bare feet, sandals and thongs are not permitted. Students may wear a laboratory coat to laboratory classes, however, the wearing of a laboratory coat is not compulsory. Bags are to be placed in cupboards at the front of the class. Information is also provided in this introduction regarding *Infection control procedures* and *Physical activity readiness*.

Each laboratory class commences with a brief talk designed to instruct on correct use of equipment, and to outline any Occupational Health and Safety issues relating to the protocol. Please note that if you arrive more than 15 minutes after the class has commenced, you will not be allowed to stay.

Staff and students alike have a duty of care to make laboratory classes a safe and enjoyable experience, and to help to create an environment which facilitates learning and teaching. Students are asked to read the practical class protocols for *HBS3APB Advanced Physiology B: normal function, drugs and disease* prior to the laboratory classes where experimental procedures are carried out. We ask you to sign a document stating that you will read these notes and, for each of these classes will make an effort to understand:

- the aims
- the practical class protocols
- safety precautions (described in this INTRODUCTION TO PRACTICAL CLASSES), and

- that circumstances can affect some students which could make it advisable for them not to volunteer to be a subject for the protocol.

Notes for “Measurement of cardiac output” are provided here. Notes for the respiratory and skeletal muscle practical classes will be made available in time for the class.

Should any student require clarification regarding the aims, procedures, safety precautions and advice regarding participation as a subject, there will be an opportunity to obtain this in class discussion. Students are normally required to participate in the laboratory class program unless they have ethical objection to the class. Note however, that a student may choose, without prejudice, to not act as a subject for a particular class.

The remainder of the laboratory program relies on demonstrations and computer assisted learning.

In order to make the most effective use of any practical, whether experimental, demonstration or computer assisted learning, the following should be kept in mind:

- Always read the practical class protocol prior to attending the class.
- Attend the class punctually in order to hear the pre-lab talk where the class aims and the procedure will be explained, including any use of equipment and any particular safety precautions.
- Ask questions if you don't understand what you are doing.
- Get involved in the classes and enjoy them.

What skills will I obtain from these practical classes and internet-library projects and how will they assist in my finding a job?

This is a question often asked by students. The La Trobe University Careers Advisory Service recently asked prospective employers what skills they expected from a Science Graduate. The following list indicated skills these employers expected a Science graduate to have upon completion of their degree.

- Research
- Analysis of information
- Organisation and development of ideas
- Presentation of ideas
- Interpersonal skills
- Working with others in teams
- The use of mathematical ideas
- Problem solving
- The use of technology

The practical class program for HBS3APA and HBS3APB builds on skills acquired in HBS2HPA and HBSHPB, and furthers their development.

*Elizabeth Brown and Andrew Bendrups
Coordinators, HBS3APA and HBS3APB*

Standard (or Universal) precautions for practical classes

Certain infections such as the human immunodeficiency virus (HIV) and the hepatitis B and C viruses can be transmitted via infected blood or other body fluids. The following infection control procedures are adapted from “*Sure Protection Against Infection*” (March 1998), which is available from the Victorian government Department of human services. These procedures reduce the risk of transmission of such an infection. Note these procedures have application in everyday life. The Human Services booklet also includes information regarding various topics such as food preparation, general cleaning and first aid.

Infection control procedures

Assume that all samples/everyone are/is potentially infectious and treat all samples/everyone in the same way by practising infection control procedures. (Note that protection of the client is implicit in these precautions).

Procedures

Thorough hand washing:

- after client contact
- after contact with used equipment
- as soon as possible should exposure to blood or other body fluids occur
- before preparing food
- before eating
- after removing gloves.

Thorough hand washing means:

- use soap and running water (a 15-20 second wash with soap and water)
- rub hands vigorously
- wash backs of hands, wrists, between fingers, under fingernails
- rinse well
- dry hands well, with a single-use paper towel where possible.

Gloves should be worn when:

- handling blood or body fluids
- handling equipment contaminated with blood or body fluids
- touching mucous membrane
- touching non-intact skin of any person
- performing venipuncture
- performing any invasive procedure.

Gloves are not necessary for contact with intact skin.

Any person at risk of splashes of blood or body fluids should:

- wear goggles or glasses
- wear protective clothing

Procedures for cleaning spills of blood or body fluids:

- wear gloves
- prevent splashing onto mucous membranes such as the eyes and mouth
- use bleach, in accordance with the manufacturers instructions
- soak up the substance with absorbent paper
- cover area with bleach for 10 minutes
- wipe and dry the area
- dispose of gloves and paper towelling in a plastic bag and seal the bag
- dispose of in accordance with institutional guidelines
- wash hands thoroughly.

Physical activity readiness questionnaire*

For most people, physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of medical activity most suitable for them.

1. Has your doctor ever said you have heart trouble?
2. Do you frequently suffer from pains in the chest?
3. Do you often feel faint or have spells of severe dizziness?
4. Has a doctor ever told you that you have a bone or joint problem such as arthritis that has been aggravated by exercise, or might be made worse with exercise?
5. Is there a good physical reason not mentioned here why you should not follow an activity program even if you wanted to?
6. Are you over age 65 and not accustomed to vigorous exercise?

If a person answers “yes” to any question, vigorous exercise or exercise testing should be postponed. Medical clearance may be necessary.

*Reference: PAR-Q Validation Report
British Columbia Department of Health
June 1975 (Modified version)

PRACTICAL CLASS ASSESSMENT

Assessment of laboratory-based practical activity contributes a total of 24% to the assessment for this subject. The assessment is generally made on a weekly task, depending on the activities carried out each week. *Note that information from practical classes is also assessable by examination.*

Practical classes involving collection of experimental data during class are assessed by a practical report. Most reports will be written during the practical class session and handed in at its conclusion. If a report is to be handed in, it should normally consist of no more than 1-2 pages of typed text, plus graphs or tables, if relevant. Please adhere to these guidelines.

Each weekly (approximately) practical report is marked out of 10 and returned.

Laboratory-based practical classes are alternated with internet/library projects, which contribute a total of 6% to the assessment.

Submission of Internet/Library Projects & some Practical Reports

Practical reports which are not required on the day of the class should be submitted in accordance with the instructions at reception, Schools of Human Biosciences and Public Health – in the foyer of Health Sciences 1. Authorship statements and envelopes are available for your use. The instructions are on a poster above the assignment submission area.

Please write my name, Elizabeth Brown, on ALL work submitted for HBS3APB – I will ensure that it is distributed to the appropriate staff member for marking.

If you post your work via Australia Post, ensure that it will arrive at the School of Human Biosciences not later than the due date.

Marked reports and projects will be available for collection at a subsequent practical class, and then in the “Assignment Pickup” filing cabinet in the Physiology Laboratory (PS3 228), usually within 2 weeks after submission.

Policy on late submission of work for assessment

Late work will not be accepted unless there has been prior written approval, normally by the unit coordinator, of a request for an extension to the assessment submission date. Any work submitted late, without prior approval, will only be considered for assessment if it is accompanied by a valid Application for Special Consideration, with supporting documentation such as a medical certificate or police report.

“Application for Extension to the Due Date for an Assignment Task” and “Application for Special Consideration” forms are available at Human Biosciences/Public Health Reception.

Inability to attend a laboratory class

Students must normally attend practical classes with the group to which they have been assigned.

If you are unable to attend a practical class because of illness, or for some other valid reason, but you can attend another scheduled session of the class, please contact Elizabeth Brown, 9479 5869 or e.h.brown@latrobe.edu.au for approval. Please supply a doctor's certificate or other appropriate documentation which explains your absence. Please understand that overcrowded practical classes become an Occupational Health & Safety issue.

If you miss out on a practical class entirely, but have a valid reason for doing so, please fill out a copy of the form entitled "Absence from a practical class" (the last page of this manual) and post or give this to Elizabeth Brown, along with any relevant documentation. Your practical mark will then be the average of the work you were able to complete. In the absence of a completed form and documentation, you will be given a mark of zero for any class that you did not attend and therefore any work that you did not complete.

An overview of Laboratory Classes & Internet –Library Projects for HBS3APB, 2007

Practical classes	Staff	Discipline
1. Measurement of cardiac output	AB	Physiology
2. Cardiovascular system pathology	RP	Pathology
3. Cardiovascular system pharmacology	ED	Pharmacology
4. Respiratory physiology	JS	Physiology
5. Respiratory pathology	RP	Pathology
6. Skeletal muscle physiology	AW	Physiology
7. Drugs acting at the neuromuscular junction	KA	Pharmacology
8. Bone physiology	BG	Physiology
9. Fracture repair and bone disease	BG	Pathology
10. Reproductive system pathophysiology	EB	Physiology
11.&12. Drug profiles-seminar presentations	KA/ED	Pharmacology

Internet-Library Projects	Staff	discipline
1. Cardiovascular system	AB	physiology
2. Cardiovascular pathology	RP	pathology
3. Respiratory pharmacology	ED	pharmacology
4. Musculo-skeletal	AW	physiology
5. Bone	BG	physiology/pathology
6. Reproduction	EB	physiology/pathology

INTERNET/LIBRARY PROJECTS

Practical activities in Advanced Physiology include a series of projects based on searches of internet and library resources. These projects run in parallel with laboratory-based classes.

Timetable

The internet/library projects are normally conducted without supervision, nominally in the same time-slot as laboratory-based classes. Depending on your practical group (A or B), you will be expected to attend laboratory classes on either Tuesday or Thursday afternoon and carry out the internet/library projects on the corresponding Thursday or Tuesday of the same week—refer to the subject timetable. However, as the internet/library projects are unsupervised, you may choose to conduct this part of your work in your own time, making your own arrangements for computer access.

Requirements of the project

You will be given a task to carry out every few weeks (see subject timetable) requiring you to find a single journal article or internet web site on a particular topic, and write a brief (300 word) summary and critical review of the article or site. You are free to follow your interests in choosing the article or site, as long as it is relevant to the set topic. You should try to do something different from what the rest of the class is doing. The article or web site must be substantial: “abstracts” of research or brief internet “press releases” on a topic are not acceptable. The aim is to find useful resource material and not “dud” web sites (of which there are many) or incomprehensible papers beyond the depth and scope of the course.

Your review should both summarize the contents of the article or site and include a critical commentary — it must evaluate the quality of the article or site. For example, it is not enough to re-word the abstract of a journal article. The value (or lack thereof) of the item need not lie in its scientific merit, which you may find difficult to judge at this stage of your academic development. It could lie in its educational merit (e.g. you may find an excellent web-site produced by a credible source) or its accessibility to a third-year student (e.g. a good review article that provides useful background information on the topic). You should consider the credibility and qualifications of the author(s), especially for internet sites which, unlike journal articles, are generally not subjected to peer review.

Joint submissions (i.e. prepared by 2 students) are allowed. Both contributors must participate in researching and preparing the report and both should be clearly identified by name and student number. Make sure the report contains a full reference to the publication details of the article or the full address of the web-site. You must include a copy of the article or web site with your submission (at least the abstract or first key page).

Deadlines and assessment

The schedule for handing out and submission of Internet-Library projects is provided on the unit timetable. Projects are normally handed out on a Monday and submitted for assessment the following Friday week. Refer to the policy on late submission of work for assessment.

Projects are assessed as satisfactory (1 mark) or unsatisfactory (zero marks) and contribute 6% to the total assessment. Refer to the policy on late submission of work for assessment.

Suggested databases

You may search the print literature through the La Trobe Library web site, which has links to useful databases such as Medline, Biological Abstracts and Current Contents. In some cases, you may be able to view the text of an article on-screen but generally you will have to find the article on the library shelves. Alternatively, you may perform an *internet* search which will broaden the scope of your inquiry to web sites and other resources, but will not reliably find relevant journal articles.

To access the library via the internet, find an internet-capable computer (e.g. in Room HS3 401 of the Health Sciences 3 building) and start up an internet browser (e.g. Internet Explorer). Then type the following address or “URL” in the appropriate text entry “box” and press the Enter key: <http://www.latrobe.edu.au>

If you use a University computer, this may happen automatically. Follow the link to the library by clicking on the appropriate part of the La Trobe Home Page and find your way to the section of the library site which provides links to databases (point and click!). Using the library website to access Medline allows you to quickly check whether the Journals you have found are actually held in the LaTrobe library.

Another way of doing a Medline search is to access the Medline database more directly:

<http://www.ncbi.nlm.nih.gov/PubMed> or <http://intapp.medscape.com> (requires free registration). To perform an internet search, you need to use an internet “search engine”, as provided by: <http://www.google.com> or <http://www.nln.com> (accesses many search engines).

Follow the instructions when you get there and don’t be afraid to experiment. Alternatively, your internet browser usually provides built-in access to a limited selection of search engines—look in the software menus and buttons for an item called “search” or similar.

Check list:

- Is the article/web-site relevant and substantial?
- Have you written both a summary and a critical evaluation?
- Have you included a full reference or web address (URL) (and date accessed)?
- Have you identified joint contributors by name and student number?
- Have you attached a copy of the article/web-site?

LABORATORY CLASS PROTOCOLS

Measurement of cardiac output using the “Indirect Fick” method.

1. Introduction.

1.1 The Fick Principle. The principle named after Adolf Fick (1829-1901) forms the basis of measuring the cardiac output (\dot{Q}). It is used in this laboratory exercise, so it is important that you understand it. The theory is as follows. In its passage through the lungs, each litre of blood loses, say, 40 ml of CO_2 . We excrete, say, 200 ml of CO_2 each minute. If 40 ml of CO_2 are lost from one litre of blood, how many litres of blood must flow through the lungs if we are to lose 200 ml/min? The answer is $200/40 = 5$ litres per min = pulmonary blood flow = cardiac output.

Note the correctness of the stated unit: ml of CO_2 produced per min divided by ml of CO_2 added per litre of blood gives “L of blood per min”.

To express the relation formally:

$$\dot{Q} = \dot{V} \text{CO}_2 / (C_v\text{CO}_2 - C_a\text{CO}_2) \quad \text{Eqn 1}$$

Three measurements are made:

- (i) the CO_2 concentration of arterial blood ($C_a\text{CO}_2$). The unit is ‘ml of CO_2 per litre of blood’. A typical value is 480 ml of CO_2 per litre of arterial blood;
- (ii) the CO_2 concentration of venous blood ($C_v\text{CO}_2$). Again, the unit is ‘ml of CO_2 per litre of blood’. A typical value is 520 ml CO_2 / per litre of venous blood;
- (iii) the rate of CO_2 produced by the body (the $\dot{V} \text{CO}_2$). This quantity is measured from the CO_2 content of a Douglas bag containing a timed sample of expired air. The $\dot{V} \text{CO}_2$ has the unit of ‘ml of CO_2 per minute’. A typical resting value is 200 ml/min.

Next, the following calculations are done:

- (i) the arterio-venous (a-v) CO_2 difference. This is the difference between the arterial and venous CO_2 concentrations = $C_v\text{CO}_2 - C_a\text{CO}_2 = 40$ ml of CO_2 per litre of blood. This means that 40 ml of CO_2 is added to each litre of blood that flows around the body (or each litre of blood releases 40 ml of CO_2 when blood flows through the lungs);
- (ii) the (a-v) CO_2 is then divided into the rate of CO_2 production ($\dot{V} \text{CO}_2$) to give \dot{Q} .

1.2 The Indirect Fick method. The measurements required for the Direct Fick principle have the disadvantage of requiring arterial and venous blood samples. In the present practical class, the "Indirect Fick" Principle is used, which has the benefit of being "non-invasive" i.e., not requiring surgical procedures. The “ CO_2 -re-breathing method" is used, in which the arterial and

venous CO₂ concentrations are estimated from expired air (following two different procedures described below), and the difference is divided into the rate of CO₂ production ($\dot{V} \text{ CO}_2$). This is how we go about measuring the three variables we require:

(i) $\dot{V} \text{ CO}_2$ = the rate of CO₂ production, measured from the analysis of expired air collected into a Douglas Bag, you measured this last year:

(ii) $C_v \text{ CO}_2$ = the CO₂ concentration of mixed systemic venous blood = venous [CO₂]. This is calculated from the equilibrium value of the PCO₂ in a “re-breathing bag” (see the Figure below). The re-breathing bag contains (originally) 10% CO₂ in O₂. The subject breaths in and out of this bag until the contents of the bag and the lungs have equilibrated. This is the tricky bit to understand. In this procedure, the subject re-breathes a gas mixture containing a high partial pressure of CO₂ (ie, PCO₂), higher than in pulmonary artery. The air in the bag mixes with alveolar air, and CO₂ diffuses into the pulmonary capillaries until an equilibrium occurs between the bag, alveolar air, and blood in the pulmonary capillaries. Equilibrium indicates the absence of net diffusion, so when this occurs, alveolar air has the same PCO₂ as mixed venous blood in the pulmonary artery (i.e., P_vCO₂) and as the air in the bag. But firstly, the P_vCO₂ must be corrected for dead space by using Eqn 2, then the PCO₂ in the re-breathing bag is converted to a value for the PCO₂ in venous blood.

$$P_v \text{ CO}_2 \text{ (mmHg)} = P_b \text{ CO}_2 - (0.24 P_b \text{ CO}_2 - 11) \quad \text{Eqn 2}$$

$P_b \text{ CO}_2$ = equilibrium value for PCO₂ in the re-breathing bag

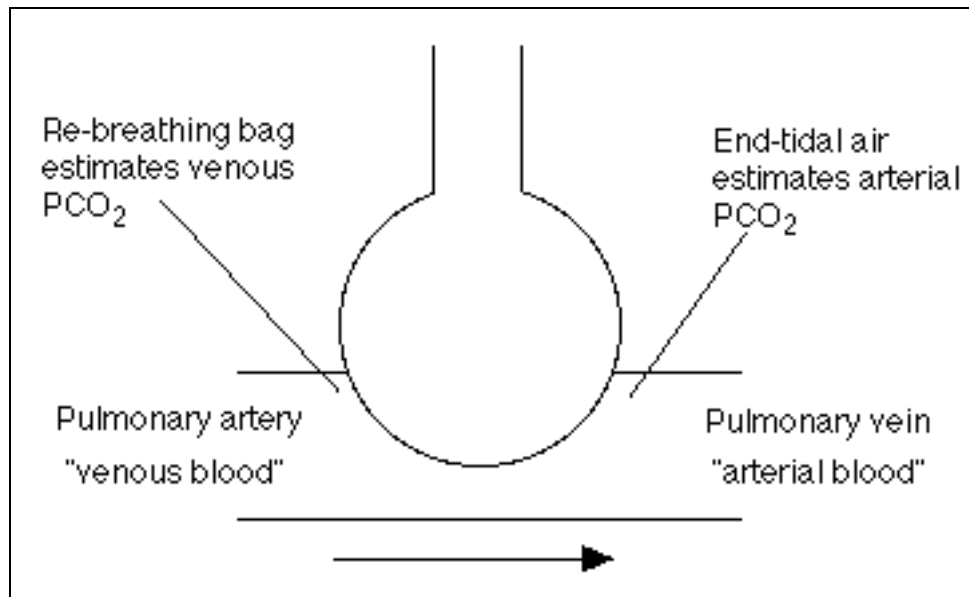
Venous CO₂ content has the units "ml CO₂/ L of blood", while P_vCO₂ has the units "mm Hg". We calculate concentration from partial pressure by making use of the solubility of CO₂ in water, assuming that haemoglobin is fully saturated with O₂ (which affects the binding of Hb to CO₂), and calculate the mixed venous CO₂ content per 100 ml, from the following equation:

$$\text{Log}_e (C_v \text{ CO}_2) = (0.396 \times \text{log}_e P_v \text{ CO}_2) + 2.4 \quad \text{Eqn 3}$$

In this equation, logarithms to base "e" are the natural logs, obtained from the "LN" key on a calculator. After calculating the quantity on the RHS of Eqn 2, the value of P_vCO₂ is obtained by hitting the "e^x" key, which gives the antilog.

Multiply by 10 to get a value for C_vCO₂ in the units “ml CO₂/L blood”.

(iii) $C_a \text{ CO}_2$ = the CO₂ concentration of systemic arterial blood = arterial [CO₂]. This quantity is calculated from the PCO₂ in the last few ml of air to be expelled from the lungs during a maximum expiration (i.e., "end-tidal" air), when the subject has been breathing room air, as shown in the Figure below.



Why does end-tidal PCO_2 equal the arterial PCO_2 ? End-tidal air is assumed to have equilibrated with pulmonary capillary blood draining the lungs, so the P_aCO_2 in pulmonary venous (= systemic arterial) blood and end-tidal air ($PETCO_2$) should be the same. In today's experiment, we will assume this is the case. (For more accurate measurements, particularly during exercise, corrections can be made for respiratory fluctuations, consult the reference list for details).

The arterial CO_2 concentration per 100 ml is calculated using the following equation:

$$\text{Log}_e (C_aCO_2) = (0.396 \times \text{log}_e P_aCO_2) + 2.4 \quad \text{Eqn 4}$$

Hit the “e^x” key to get the anti-log. Multiply by 10 to get C_aCO_2 in the units in ml CO_2/L blood.

2. Procedure.

The value for total pulmonary ventilation is used to measure $\dot{V} CO_2$. The techniques are familiar to you from last year.

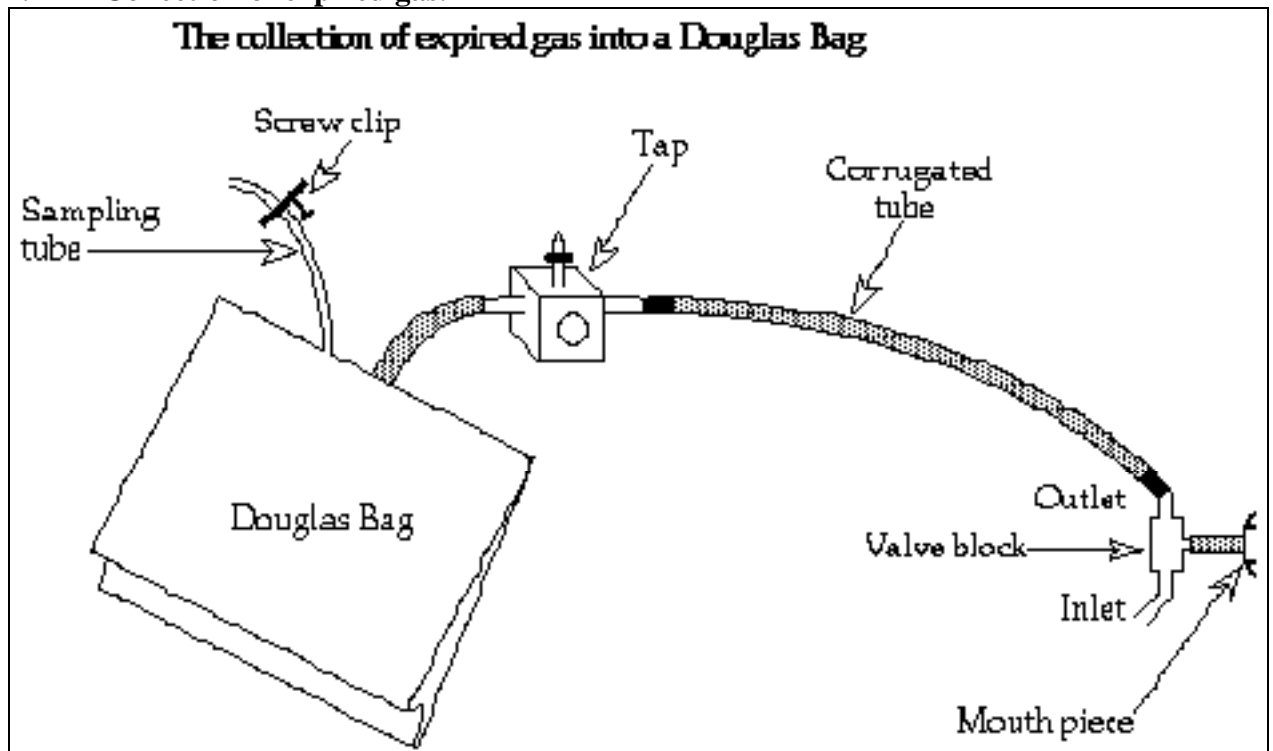
Each group should have three members, whose duties are as follows:

- (i) one member is the subject, who should remain lying down throughout. Other groups can apply the procedure to a rested subject who is standing throughout. A comparison of the results from the two postures may demonstrate that the upright posture decreases the stroke volume and \dot{Q} , and increases the heart rate.
- (ii) the 2nd member is the time-keeper, who defines the start and finish of the gas collection period;
- (iii) the 3rd member calculates the conversion factor between BTPS and ATPS, as shown in Section 3.1. This calculation is time-consuming, and should be undertaken at the end of the introductory talk.

The values for room temperature ($^{\circ}\text{C}$) and barometric (atmospheric) pressure (P_B), will be measured by a demonstrator and written on the blackboard, the water vapour partial pressure ($P_{\text{H}_2\text{O}}$) is given in Section 3.1

(iv) During the collection of expired air, measure the heart rate over one full minute, and record the value in Table 1. This will enable stroke volume to be calculated from the cardiac ($\dot{Q} = \text{SV} \times \text{HR}$)

2.1 Collection of expired gas.



Take a 100 L Douglas bag and as shown in the diagram above, fit a tap to it. The tap must be fitted in the right way to permit expired gas to pass either back into the room, or into the bag. A flexible hose connects the tap to a one-way valve with an attached mouthpiece. Before attaching the valve block to the hose pipe, identify the inlet and outlet side of the valve. The outlet of the valve block is inserted into the hose pipe. With the mouthpiece in the mouth and the nose clipped, the subject should be able to inhale easily and expire into the Douglas Bag.

Prior to collection of gases, close off the side tube of the bag using the screw clip.

Next, rinse the Douglas Bag (including the small sampling side arm) with the subject's expired gases in order to replace any residual gas in the bag by the subject's own expired gases.

The subject lies down and with the nose clipped breathes via the mouthpiece into the bag for a few minutes with the side arm clamped. Then the side arm is unclamped and the bag is completely emptied by rolling and squeezing. Be firm but gentle when squeezing the bag to empty it as completely as possible. This will ensure that residual air in the bag is expired air. Clamp the side tube.

The subject continues to breathe into the tube, but the tap is set so that the expired gases are not collected, but are diverted to the room. When the subject's breathing returns towards a normal involuntary pattern, turn the tap to direct the subject's expired gases into the bag and commence a 5 min collection. Note that the collection period can be longer or shorter than 5 min, as long as it is known accurately. After 5 min, close the tap and detach it and the bag from the subject, and enter the data in Table 1.

2.2 Measurement of CO₂ concentration of expired gas in the Douglas Bag.

The Beckman LB-CO₂ Analyser used to measure the percentage of CO₂ in gas samples should have both the "power" and "operate" lights illuminated, and the readout should be 0.03% CO₂ when room air is drawn through the sample tube. The machine will have been calibrated previously using a gas mixture of exact composition; final adjustments are then made against room air.

The MacIntosh method is used similarly. Room air is drawn through the sample tube at a rate shown by the pitot flow tube on the analyser. When the reading for CO₂ is stable, enter the value in Table 2.

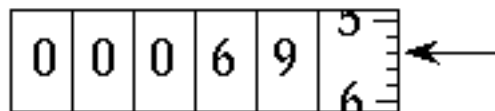
Next, sample the air in the Douglas Bag by unclamping the side arm of the bag, connect the sample tube to it, and allow gas to be drawn through the analyser for 30 s. Do not force air out of the bag or erroneous readings will result. Disconnect the sample tube and reclamp the side tube on the bag. The volume of gas lost through sampling must be added to the volume in the Douglas Bag which you will measure later. Enter the volume sampled in Table 1, against "Beckman analyser".

During sampling time, enter your values for %CO₂ in Table 2. The % should be converted into the units of mmHg by multiplying by the atmospheric pressure/100.

2.3 Measurement of the volume of expired gas in the Douglas bag.

The volume of expired gas in the Bag is measured using the Aichi Tokei gas meter.

The dial reading is a cumulative digital measure of volume, and cannot be reset to zero. The right-most digit is litres, and this is further divided into 200 ml units by graduations to the right of this digit. Thus the reading below is 695.4 L.



Check the direction of gas flow (arrow on the top of the meter) and connect the hose pipe from the Douglas bag to the inlet of the meter. Note the initial meter reading, and record this in Table 1. Do not waste time setting the initial reading to a convenient "round" value. Turn on the tap and roll out the Douglas bag. If the bag requires re-rolling to exhaust the gas, turn off the tap and rearrange the bag before re-rolling the bag. Take the final reading when the bag is exhausted, record this value in Table 1, and calculate the difference. Add the volume lost to the Analyser to give the volume expired into the Douglas Bag.

2.4 Measurement of end-tidal PCO₂ (= arterial PCO₂)

At the end of a normal quiet expiration, the subject breathes out to Residual Volume, and the last few ml of air expired is collected into an anaesthetic bag. Do not inspire before expiring, as this will lower the alveolar PCO₂. The %CO₂ of the gas in this bag is measured using the

Beckman analyser. Alternatively, exhale maximally through a tube that has the sensor inserted through the wall of the tubing. Repeat the collection and measurement several times. Enter the highest %CO₂ from these trials in Table 2. Convert to the units of mmHg and enter the value in Table 4.

2.5 Measurement of PCO₂ in the re-breathing bag (= venous PCO₂).

The re-breathing bag has 10% CO₂ and 90% O₂:

- (a) the subject re-breathes from the bag for 1 min, or until ventilation noticeably increases. This procedure raises the CO₂ content of the lungs and lowers the CO₂ in the bag to a level near that of mixed venous blood, but also results in the retention of CO₂ in the body. Start by breathing into the bag and end by breathing out into the bag; failure to follow these instructions will empty the re-breathing bag;
- (b) turn the tap to room air and breath room air for 3 min, this eliminates the retained CO₂;
- (c) repeat the re-breathing for a further 20 s, or 5 breaths. This process brings the PCO₂ in the bag (i.e., P_bCO₂) to the same level as in mixed venous blood which has been saturated with O₂. The gas in the re-breathing bag is then analysed for %CO₂ using the Beckman analyser. Enter the value in Table 2. Convert to the units of mmHg and enter the value in Table 4.

Important: the subject should stop breathing from the bag, and breath room air if at any stage of this procedure the subject feels uncomfortable.

	Name	
	Posture	
	Ambient temp (°C)	
	P _B (mmHg)	
	Heart rate (per min)	
Douglas Bag	Collection period (min)	
Beckman analyser	Vol sampled (ATPS)	
Aichi meter	Initial (L)	
	Final (L)	
	Difference (L)	
	Total vol of Douglas Bag (L; ATPS)	

Table 2: CO₂ content of air and gas samples

$$P_{CO_2} \text{ (mmHg)} = \frac{\% CO_2 \times P_B}{100}$$

	% CO ₂	Fraction of CO ₂	P _{CO₂}
room air			
Douglas Bag			
end-tidal air			
equilibration bag			

3. Calculations

3.1 Conversion factor. The volume of expired air in the Douglas Bag is measured "cool and dry" in the laboratory (i.e., ATPS), but came from the lungs "warm and wet" (i.e., BTPS). The "laboratory volume" is smaller than the "physiological volume", so the conversion factor must be applied:

$$V_{BTPS} = V_{ATPS} \times 310 / (273 + T^{\circ}C) \times (P_B - P_{H_2O}) / (P_B - 47)$$

P_B is the barometric pressure. P_{H₂O} is the saturated vapour pressure of water at the ambient temperature T°C; P_{H₂O} at the current room temperature, is obtained from the following table:

temp (°C)	P _{H₂O} (mmHg)
20	17.5
21	18.6
22	19.8
23	21.1
24	22.4
25	23.7

Insert the value of the constant from the right hand side of the previous equation, on the dotted line below:

$$V_{BTPS} = V_{ATPS} \times \dots\dots\dots \text{Eqn 5}$$

3.2 Calculation of $\dot{V} CO_2$.

The rate of CO₂ production is simply calculated from the volume of CO₂ in the Douglas Bag divided by the collection time (STPD). This must be adjusted to BTPS, as follows:

Multiply the value of "fraction of CO₂ in the Douglas Bag" (Table 2) by "Total volume of Douglas Bag" (Table 1) and divide by "Collection period" (Table 1). This gives L CO₂/min (ATPS). Enter this value in Table 3. Multiply this value by the conversion factor (Eqn 5) to get CO₂ (L/min; BTPS). Enter the value for VCO₂ in Table 3.

Table 3: Summary of calculated values in the accepted units

Variable	Units	Value
$\dot{V}CO_2$ (L/min)	ATPS	
$\dot{V}CO_2$ (L/min)	BTPS	

3.3 Calculate arterial CO₂ concentration (arterial [CO₂]).

Insert the value from Table 4 (Arterial PCO₂) into Eqn 4 (Section 1.2). Enter this value in Table 4.

3.4 Calculate venous PCO₂ and venous [CO₂] from the re-breathing bag.

Insert the value for P_bCO₂ (equilibrium bag) from Table 2 into Eqn 2 (Section 1.2) in order to correct the P_bCO₂ for dead space. Then insert this value you have just calculated (P_vCO₂) into Eqn 3 (Section 1.2) in order to calculate C_vCO₂. Enter the value for C_vCO₂ in Table 4.

3.5 Calculate the (a-v) CO₂.

This is the difference in values obtained from paragraphs 3.3 and 3.4

3.6 Calculate \dot{Q}

This is the division (Eqn 1) of $\dot{V} CO_2$ by (a-v) CO₂, both given in Table 4

3.7 Calculate stroke volume.

Divide \dot{Q} by heart rate.

Table 4: Calculation of \dot{Q}

	Measure	Refer	Value	Units
Arterial PCO ₂	End-tidal	Table 2		mmHg
Arterial [CO ₂]		Eqn 4		ml CO ₂ /L of blood
Venous PCO ₂	Equilib bag	Table 2		mmHg
Venous [CO ₂]		Eqn 2 & 3		ml CO ₂ /L of blood
(a - v) CO ₂				ml CO ₂ /L of blood
$\dot{V}CO_2$		Table 3		ml/min (BTPS)
\dot{Q}		Eqn 1		L/min
SV		\dot{Q}/HR		ml

Record the posture of your subject in Tables 1-4

4. References.

Cotes, J.E. (1975): "Lung function", 3rd ed., Blackwell Scientific, Oxford, p189 - 194

Hatcher, D.D. & Srb, O.D. (1986): Comparison of two noninvasive techniques for estimating cardiac output during exercise, Journal of applied physiology 61: 155 - 159

Jones, N.L., Campbell, E.J., Edwards, R.H. & Robertson, D.G. (1975): "Clinical exercise testing", Saunders, Philadelphia p58 - 61.

5. Writing up.

The following rules apply in general to all your physiology prac reports. While not wishing to stifle individuality or flair, a failure to adhere to a sound scientific form of report writing will lose marks. Note that different prac reports may need to be written up differently.

The write up should be no more than 1-2 pages.

All the standard subheadings should be included: Aim, Methods, Results, Discussion, References.

The Aim should be one simple sentence. Methods should be a one-line reference to prac notes. Results should always commence with an introductory sentence or two, eg, "The results are set forth in Table 1" A summary of your results should be presented in a numbered Table which carries a title. State the units. Get the units right. Discussion should include comment on comparison with text-book values, and on the effects of posture on cardiac output, sources of error in the methods, and any interesting observations. Consider organising your Discussion

using numbered paragraphs (i), (ii), (iii), etc. Do not include References to 2nd-year texts, lifesaving manuals, nursing journals or any other elementary texts, or reference to lecture notes.

Read through your report before you submit. Check the spelling, grammar and meaning before you submit. Do not expect that your first draft is your final draft. Do not use the personal pronoun: replace “I consider the values to be” by “The values were considered to be ...”.

Reproductive system pathology: selected aspects

The aim of this practical session is, from a Health Science perspective, to:

- observe certain specimens, identifying the pathological condition(s) present, and incidentally to identify as many of the normal structures present as possible, and to review the function(s) of each of these
- discuss the (possible) aetiology of each condition demonstrated
- discuss the obstetric, gynaecological or other significance of the condition
- discuss current possibilities for prevention and/or treatment of this condition.

- A1 Ruptured tubal pregnancy
- A3 Eclamptic haemorrhages
- A4 Perforation and fatal infection following attempted criminal abortion
- B2 Gonadal dysgenesis
- B3 Ventricular septal defect
- C2 'Benign prostatic hypertrophy'
- C4 Carcinoma of the cervix (fistulae)
- C5a) Granulosa cell tumour of the ovary
- C5b) Fibromyomata of the uterus

For each of these:

1. Name the condition and briefly explain what is meant by this.
2. Outline the obstetric, gynaecological or other significance of the condition.
3. Discuss current possibilities for prevention and/or treatment of this condition.

VIDEO: “Learning more about Turner’s syndrome.”

After watching this video you should be able to:

1. state the cause of Turner syndrome.
2. describe the main features of the syndrome, and how it is usually recognised
3. explain the specific causes, particularly the commonest cause
4. discuss the use of growth hormone for girls with Turner syndrome
5. explain the consequences of ovarian dysgenesis to pubertal development, and to fertility.

Note that some of these specimens were collected many years ago. Note also that there have been significant decreases in maternal and neonatal morbidity and mortality this century.

SPECIMEN NUMBER/S	LABEL
A Complications of pregnancy	
1 B2903/69	Ruptured tubal pregnancy
2 1021	Twin placenta fibrosis and infarction of one component death of one twin
3 1612 A239/64	Brain/liver eclamptic haemorrhages
4 1623 B43031/54	Perforation following attempted criminal abortion: Fatal Clostridium Welchii septicaemia
B Developmental anomalies	
1 B588/72	Bicornuate state - early pregnancy
2 JollyB2044/69	Gonadal dysgenesis
3 1725 A5018	Ventricular septal defect
4 A206/65	Multiple renal arteries Single umbilical artery
C Neoplasia	
1 see special item	Broad ligament myoma
2	Benign prostatic hypertrophy
3 336 A68/65	Pericardial and epicardial metastases from carcinoma of the cervix
4 323 A233/64	Fistulae Vesicovaginal, ileovaginal, rectovaginal, carcinoma of the cervix
5 1342 B32852	a) Granulosa cell tumour of ovary b) Fibromyomata uterus
6 B1146/69	Leiomyosarcoma
7 B1283/70	Mixed germ cell tumour
8	Benign ovarian cysts
D Miscellaneous	
1 211 B15483/47	Cervix Nabothian follicles

SAMPLE MULTIPLE-CHOICE QUESTIONS

The questions below represent the two styles of multiple-choice question used in the HB32APB examination. Make sure you are familiar with the instructions for each type of question. Apologies for the small number of WXYZ questions!

DIRECTIONS: Questions 1 – 21

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select ONE response which is BEST or MOST APPROPRIATE in each case.

1. Ion channels in ventricular myocytes:
 - a are highly specialised phospholipid molecules.
 - b extend from one side of the cell to the other.
 - c let any substance pass through, so long as it is an ion.
 - d stay open for several seconds at a time.
 - e are generally controlled by the voltage across the membrane.

2. A class of ion passes through an open channel:
 - a when there is an electrochemical gradient for this ion across the membrane.
 - b because ion pumps transport the ion across the membrane.
 - c because the selectivity filter conducts the ion through it.
 - d because other ions of the same class link up together, and drag the ion with it.
 - e because the voltage gates act as paddles, to sweep the ions through.

3. A voltage-gated ion channel in a ventricular myocyte:
 - a usually has a single gate that opens and closes.
 - b sometimes have two gates that open and close together.
 - c is always closed when the cell is resting.
 - d selects the type of ion that passes across the membrane.
 - e usually close when the membrane potential depolarizes.

4. Pulmonary surfactant:
 - a prevents large alveoli from emptying into smaller alveoli.
 - b prevents forced expiratory efforts from emptying the alveoli.
 - c increases the filtration of fluid from pulmonary capillaries into the alveoli.
 - d prevents small alveoli from emptying into large alveoli.
 - e keeps the lungs and thoracic wall together.

DIRECTIONS: Questions 1 – 21

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select ONE response which is BEST or MOST APPROPRIATE in each case.

5. Concerning the flow rate of air into or out of the lungs:
- a the greater the effort of inspiration, the greater the flow rate.
 - b the greater the effort of expiration, the greater the flow rate, particularly at low lung volumes.
 - c expired air flows fastest at lung volumes near residual volume.
 - d the greatest overall resistance to airflow occurs at the level of the narrowest bronchioles.
 - e radial traction increases the resistance to airflow during inspiration.
6. Compliance:
- a has the units of cm water pressure per ml of air.
 - b is the change in volume for a given change in pressure.
 - c has the units of cm water pressure per ml of air per minute.
 - d of the human lung can only be measured when the lung has been removed from the body.
 - e is decreased by an increased airways resistance.
7. The increase in tidal volume during dynamic exercise:
- a increases the expiratory reserve and inspiratory reserve volumes.
 - b increases linearly with work rate, up to about 5 L
 - c is caused by recruitment of motor units in the muscles of breathing.
 - d is 10 times the resting tidal volume.
 - e is 10 times the vital capacity.
8. During physical exercise:
- a parasympathetic stimulation increases blood flow to active skeletal muscle.
 - b vasodilation occurs in all organs.
 - c sympathetic stimulation vasoconstricts the coronary circulation.
 - d sympathetic nerve fibres supplying the viscera are inhibited.
 - e the duration of ventricular diastole is shortened considerably, compared to the duration of systole.
9. During an endurance event:
- a heart rate could increase by 200 beats per minute.
 - b stroke volume could increase by about 100 ml.
 - c cardiac output would increase only when the air temperature increased.
 - d it takes several minutes from the start of the event, for the heart rate to increase.
 - e total peripheral resistance decreases.

DIRECTIONS: Questions 1 – 21

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select ONE response which is BEST or MOST APPROPRIATE in each case.

10. The blood flow through active skeletal muscle:
- a is phasic.
 - b increases primarily due to sympathetic vasodilatation in skeletal muscle blood vessels.
 - c increases only because mean arterial pressure increases.
 - d increases during contraction, and decreases during relaxation.
 - e occurs at the same rate as blood flow through resting muscle.
11. Which of the following values obtained during dynamic exercise could be considered abnormal?
- a A heart rate of 150 bpm.
 - b A cardiac output of 20 L/min.
 - c A stroke volume of 100 ml.
 - d A diastolic arterial blood pressure of 80 mmHg.
 - e A systolic blood pressure of 80 mmHg.
12. In a physically trained person:
- a heart rate can reach higher levels than in an untrained person exercising at an equivalent workload.
 - b stroke volume is greater than in an untrained person.
 - c vagal tone is lower than in an untrained person.
 - d vascular resistance is lower than in an untrained person.
 - e left ventricular end-diastolic volume is less than in an untrained person.
13. In a typical capillary the:
- a pressure at the venous end exceeds that at the arterial end.
 - b radius exceeds that of a typical arteriole.
 - c tension in the wall increases as the hydrostatic pressure rises.
 - d radius is more than three times as great as the radius of a red blood cell.
 - e tension in the wall is proportional to the fourth power of the radius.
14. If the heart of a resting normal person is increased from 60 to 90 beats per minute by artificial atrial pacing:
- a cardiac output will increase by at least 50%.
 - b stroke volume will not be affected appreciably.
 - c cardiac output will not be affected appreciably.
 - d arterial pulse pressure will increase.
 - e central venous pressure will increase.

DIRECTIONS: Questions 1 – 21

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select ONE response which is BEST or MOST APPROPRIATE in each case.

15. An 8 year old normal girl (30 kg body weight) has a breathing frequency of 20 per minute at rest and a tidal (breath) volume of 80 mL. Her total ventilation is closest to:

- a 0.25 L/min.
- b 0.6 L/min.
- c 1.6 L/min.
- d 2.4 L/min.
- e 32. L/min.

16. In a 60 year old hypertensive person, the commonly observed increase in arterial pulse pressure is caused by:

- a increased stroke volume.
- b increased myocardial contractility.
- c decreased mean circulatory pressure.
- d decreased arterial compliance.
- e increased heart rate.

17. Hypoxia, such as occurs at high altitude:

- a increases partial pressure of arterial blood CO₂.
- b decreases blood pH.
- c decreases peripheral resistance.
- d increases the respiratory rate.
- e decreases blood pressure.

18. Which of the following statements is correct?

- a An increase in pressure in the pulmonary artery may cause hypertrophy of the left ventricle.
- b Rupture of the myocardium is not life threatening as long as the pericardial sac remains intact.
- c Myocardial rupture would most likely occur sometime after two weeks following a myocardial infarction.
- d A disease which increases blood pressure in the pulmonary artery may lead to right ventricular failure.
- e None of the above statements is true.

DIRECTIONS: Questions 1 – 21

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select ONE response which is BEST or MOST APPROPRIATE in each case.

19. Predominant emphysema:
- a is typically characterised by a productive cough.
 - b is a reversible disease of large and small airways.
 - c has a more severe course in people with high levels of antiproteases (anti-elastase).
 - d is caused by pulmonary hypertension.
 - e none of the above is correct.
20. Angiotensin converting enzyme (ACE) inhibitors:
- a inhibit the conversion of angiotensin to renin.
 - b reduce the synthesis of angiotensin II and the subsequent release of aldosterone.
 - c inhibit the release of renin by the kidneys.
 - d inhibit the conversion of angiotensinogen to angiotensin I.
 - e increase blood pressure by their vasoconstrictor actions in renal arteries.
21. Bronchodilator drugs include all the following EXCEPT:
- a salbutamol.
 - b aminophylline.
 - c isoprenaline.
 - d propranolol.
 - e adrenaline.

DIRECTIONS: Questions 22 - 25

For each of the questions or incomplete statements, ONE or MORE of the suggested answers given is correct.

- Answer:
- a if only W, X and Y are correct
 - b if only W and Y are correct.
 - c if only X and Z are correct.
 - d if only Z is correct.
 - e if all are correct.

22. A single cross-bridge cycle can move a thin filament:

- W without the release of energy from ATP.
- X about 2.5 mm (2.5×10^{-3} m).
- Y along the entire length of an intact myosin molecule.
- Z about 10 nm (10×10^{-9} m).

23. Survival of a fetus to birth at 40 weeks gestational age (term) is possible despite the absence of:

- W cerebral hemispheres.
- X an oesophagus.
- Y kidneys.
- Z a cardiovascular system.

24. During the later stages of pregnancy, maternal blood pressure can fall if the woman lies on her back (supine hypotension). This is due to:

- W a reduction in maternal venous return.
- X a decrease in maternal heart rate because of the uterus pressing on the heart through the diaphragm.
- Y compression of the vena cava.
- Z increased fetal activity associated with discomfort due to compression of the fetus against the maternal vertebral column.

25. Active vitamin D:

- W receptors are found in osteoblasts.
- X facilitates bone formation.
- Y increases calcium ion transport across the intestinal brush border.
- Z facilitates bone resorption.

Answers:

1e	2a	3d	4d	5a	6b	7c	8e	9e	10a
11e	12b	13c	14c	15c	16d	17d	18d	19c	20b
21d	22d	23a	24b	25e					

LA TROBE UNIVERSITY
SCHOOL OF HUMAN BIOSCIENCES
HBS3APB Advanced Physiology B

Absence from a laboratory class

For the attention of Elizabeth Brown, unit coordinator.

Student number: Name:

Practical Class Group:

Class title:

.....

Class day and date:

Reason for absence. *Note that if the matter is private, a brief indication will be sufficient.*

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Signed:

.....

Date:

Documentation attached: doctor's certificate police report other (*please indicate*)

Noted:

Approved:

Please give this completed form to the unit coordinator, or hand in at School of Human Biosciences Reception, Level 3 HS2, or post to Elizabeth Brown, School of Human Biosciences, La Trobe University 3086.