

SIS - Sport, Fitness & Recreation Training Package

SIS30315—Certificate III in Fitness

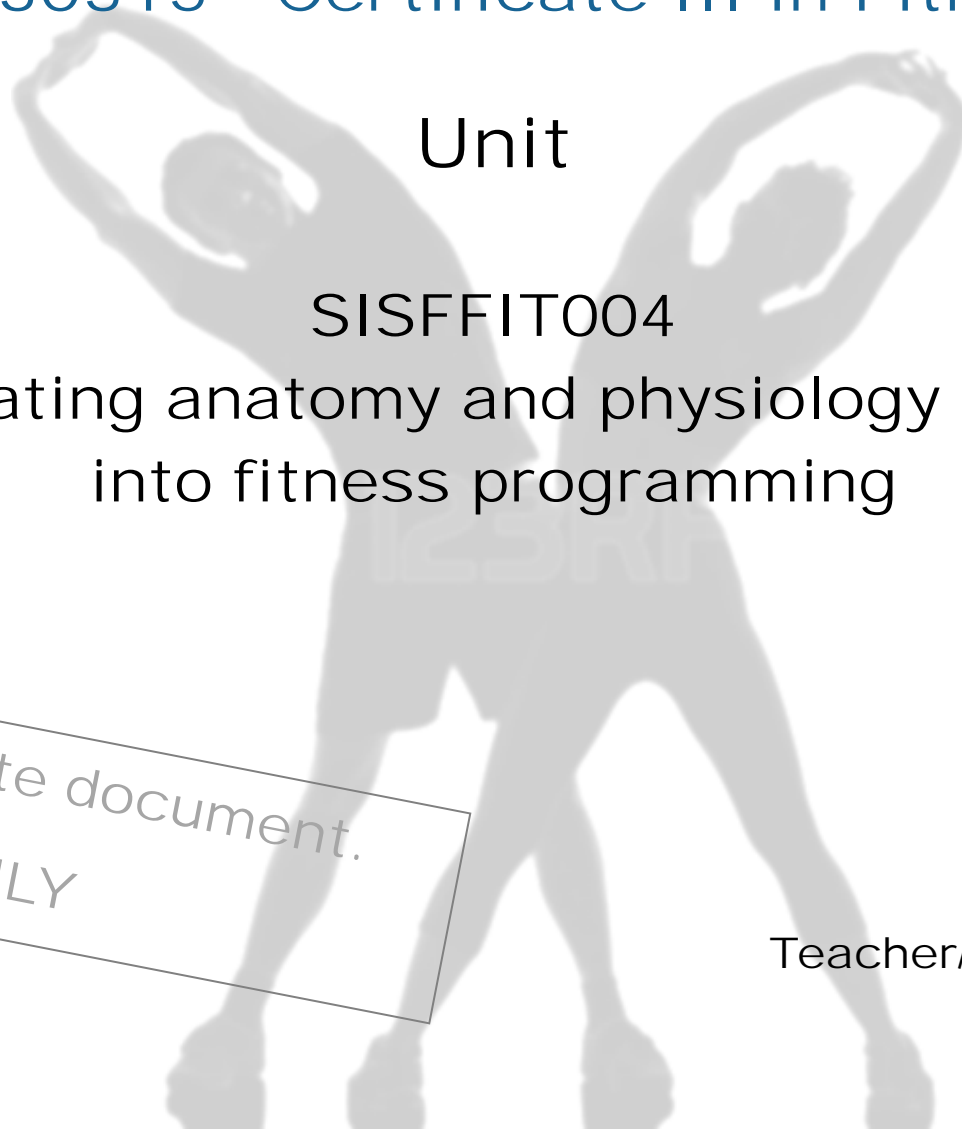
Unit

SISFFIT004

Incorporating anatomy and physiology principles
into fitness programming

*This is not a complete document.
SAMPLE ONLY*

Teacher/Trainer Manual





LANE

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STUDENT/TRAINEE DETAILS

Student/Trainee Name**Student/Trainee Email****Teacher / Trainer Name****School / Institution / Training Organisation / Employer**

SAMPLE SAMPLE

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INTRODUCTION

This manual is developed to provide training content that addresses the specific 'Unit of Competency' as outlined on the following pages.

It provides the teacher and/or trainer with a document that includes all that the student and/or trainee manual content plus guidance notes as well as answers to the learning activities in the student/trainee manual.

This manual can be packaged with various manuals addressing other 'Units of Competency' in order to meet the 'Packaging Rules' of a particular Australian Training Package Qualification.

This resource has been designed to be delivered in a form that is conducive to the learning environment including:

- ☆ Online delivery
- ☆ Classroom delivery
- ☆ On the job training

The documents are designed in a 'landscape' format in order to make reading on a computer screen easier as well as reduces the need to scroll down pages. Documents can be easily printed if the learning environment requires the student or trainee to have hard copies of the learning materials.

INTRODUCTION—CONT'D

LEARNING ACTIVITIES

The learning activities in the student and/or trainee manuals are 'Form Enabled' so that if the resources delivered online, the activities can be filled in using the computer keyboard.

Each learning activity is identified with the following icon.

**Learning
Activity**

Learning activities come in the following forms.

- ☆ Questions
- ☆ Research
- ☆ Tasks
- ☆ Interviews

Questions

Questions would relate to the information presented on previous pages.

Research

This type of learning activity would require the student or trainee to locate information by using research methods. The information they would be required to locate would be in line and/or support the information that the manual had outlined in previous pages.

INTRODUCTION—CONT'D

Tasks

This learning activity type would require the student/trainee to actually do or undertake something and would be reinforcing the knowledge they have gained from reading the manual's previous pages.

Interviews

This learning activity type would require the student/trainee to interview person(s) in an actual workplace environment or a person(s) who are experienced in the industry sector which the student/trainee is currently undergoing training.

The student/trainee is made aware of the type of learning activity by noting the learning activity type displayed under the learning activity icon.

Learning
Activity

Research

SELF ASSESSMENT

At the end of each manual is a series of questions that the student/trainee should review and answer.

This self assessment is to ensure in the student's or trainee's mind that they have reviewed and understood the information that was presented in their manual.

If they are unsure of their understanding in any of the topics reviewed, they are encouraged to go back and review the information again and/or seek the assistance of their teacher or trainer.

UNIT OF COMPETENCY OVERVIEW

The following pages are extracts from Training.gov.au website and outlines this specific 'Unit of Competency' including the 'Elements' and the 'Performance Criteria'. The content within this manual has been developed to address this unit.

SISFFIT004 - INCORPORATING ANATOMY AND PHYSIOLOGY PRINCIPLES INTO FITNESS PROGRAMMING

ELEMENT	PERFORMANCE CRITERIA
1. Consolidate understanding of anatomy and physiology.	1.1 Source and access information on anatomy and physiology relevant to fitness outcomes. 1.2 Use knowledge of anatomy and physiology in day-to-day professional practice. 1.3 Discuss/explain how understanding of anatomy and physiology contribute to safe/optimum technique and skill development. 1.4 Use a wide range of anatomical terminology relevant to injury prevention and fitness outcomes. 1.5 Identify how anatomical structures respond to physical activity. 1.6 Apply a sound understanding of injury prevention techniques to fitness instruction and programming.
2. Apply knowledge to own professional practice.	2.1 Assess ways in which knowledge of anatomy and physiology may be used, adapted or challenged in instruction and provision of fitness advice. 2.2 Identify current and emerging knowledge of anatomy and physiology relevant to development of own professional practice. 2.3 Modify approach to fitness programming activities and advice as required.
3. Maintain and update knowledge of anatomy principles.	3.1 Identify and use opportunities to update and expand own knowledge of anatomy and physiology. 3.2 Monitor response to changes made to own professional practice or instruction. 3.3 Continue to adjust own practice to optimise results.

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Section One

Consolidate Understanding of Anatomy and Physiology

SAMPLE SAMPLE

INCORPORATING ANATOMY AND PHYSIOLOGY PRINCIPLES INTO FITNESS PROGRAMMING

SECTION ONE – CONSOLIDATE UNDERSTANDING OF ANATOMY AND PHYSIOLOGY

INTRODUCTION

The definition of fitness is to be physically fit and healthy. To be physically fit encompasses numerous body parts and systems that collectively are known as anatomy and physiology. As a fitness professional you will need to develop a sound knowledge of the human anatomy and physiology and how fitness programs and relevant exercise affect the human body.

The assessment requirements of this unit of competency requires you as a student or trainee to provide evidence that you have, can use, explain and demonstrate how the human anatomy and physiology is used in planning fitness programs and instructing clients in fitness.

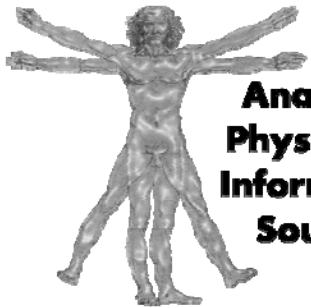
To help you we have provided a “Glossary” at the end of these training materials which you will need to refer to if there are anatomical terms you are still learning. These materials will have numerous activities where you will be required to demonstrate your knowledge on anatomy and physiology.

At any point while completing this unit you feel that you need assistance, do not hesitate to contact your teacher or trainer.

SECTION LEARNING OBJECTIVES

At the completion of this section you will learn information relating to:

- ☆ Sourcing and accessing information on anatomy and physiology relevant to fitness outcomes
- ☆ Using knowledge of anatomy and physiology in day-to-day professional practice
- ☆ Discussing/explaining how understanding of anatomy and physiology contribute to safe/optimum technique and skill development
- ☆ Using a wide range of anatomical terminology relevant to injury prevention and fitness outcomes
- ☆ Identifying how anatomical structures respond to physical activity
- ☆ Applying a sound understanding of injury prevention techniques to fitness instruction and programming



Anatomy Physiology Information Sources

SOURCE AND ACCESS INFORMATION ON ANATOMY AND PHYSIOLOGY RELEVANT TO FITNESS OUTCOMES

The aim of this unit is to help you as a fitness trainer to understand what goes on in the human body during exercise and how the different parts of the body coordinate to bring about movement.

Anatomy and physiology help us understand the body structure and how it functions. Anatomy is the study of the body structure; while, physiology is the study of the functioning of the body systems.

Many fitness professionals will have had taken high school courses in biology and anatomy which is a good basic starting point when it comes to relating the human body's anatomy to fitness training.

Not having any basic knowledge of the human anatomy and physiology should not prevent any person from aspiring to be fitness trainer or instructor, however should the decision be made to start a career in the fitness industry an understanding of anatomy and physiology and how it relates to fitness training is important.

Anatomy and physiology will provide you the basis of knowledge to create exercises that use the proper muscles at the proper times. To provide proper angles and ranges of motion for clients that have different body alignments and to recognise imbalances in strength and stability of muscle groups that will need to be remedied. The more you know and understand the body, the better you will be at creating successful fitness programs. Anatomy is not limited to the muscles and bones of the body; you will also want to have a significant knowledge of how the cardiovascular system works to understand how exercise affects the oxygenation of the blood and therefore the working muscles.

In these training materials we have provided a glossary of commonly used anatomical and physiological terms. As you go through the next few Sections of these training materials we will introduce some of those terms as they relate to fitness training and exercise and supplement them with graphics.

However, you are encouraged to locate other sources of information about anatomy and physiology and how they relate to fitness and training. Some sources include:

- ☆ The internet
- ☆ Libraries
- ☆ Teachers and/or trainers
- ☆ Fitness professionals
- ☆ Health professionals

**Learning
Activity**

Task

LEARNING ACTIVITY ONE

To start this unit off we want you to tell us in your own words what the following terms mean.

Anatomy***Physiology***

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Anatomy—the branch of science concerned with the bodily form and structure of humans.

Physiology—the branch of biology that deals with the normal functions of humans and their parts.

SAMPLE SAMPLE

**Learning
Activity**

Question

LEARNING ACTIVITY TWO

There is a famous TV series called “Grey’s Anatomy”. The TV show is named after another famous person.

Who is this person and what is he famous for?

TEACHER / TRAINER GUIDANCE NOTES

His name is Dr. Henry Gray and he and another doctor wrote a comprehensive textbook on the human anatomy called “Gray’s Anatomy”.

SAMPLE SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY THREE

In this activity you are to locate three websites that you considered good sources of information on the human anatomy and physiology. Write down the website name and address in the space provided.

TEACHER / TRAINER GUIDANCE NOTES

There are numerous websites that the student or trainee can find on the internet. This will not only provide sources for the student or trainee, but also to practice their research skills.

SAMPLE SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY FOUR

In this activity you are to locate three websites that you considered good sources of information on the human anatomy and physiology and how they relate to fitness training, sports training and exercises . Write down the website name and address in the space provided.

TEACHER / TRAINER GUIDANCE NOTES

This is to fine tune their human anatomy and physiology information sources and have them more specific to fitness training. This will not only provide sources for the student or trainee, but also to practice their research skills.

SAMPLE SAMPLE



USE KNOWLEDGE OF ANATOMY AND PHYSIOLOGY IN DAY-TO-DAY PROFESSIONAL PRACTISE

Fitness clients will seek support from their fitness trainers/instructors for a wide range of reasons. They will talk about medical issues and with your strong knowledge of anatomy and physiology are able to understand and converse with the client and most importantly, have the skills to develop a fitness program and exercise sessions best suited for them.

Your clients may be truly impressed and feel in safe hands because you are demonstrating an understanding of how their body works, but remember that is why you are there and not to impress, but to ensure that they have a safe fitness program that actually suits them.

Having a good understanding of anatomy and physiology the professional fitness trainer then is confident in what to ask their client and what to look for both before, during and after a exercise session to maintain the clients' well-being. Examples here include blood pressure testing, pre-exercise health screening questionnaires and doctor referrals.

An experienced and professional fitness trainer relies on their anatomical and physiological skills all the time. Ask them and they will tell you that their anatomical and physiological skills are so much an ingrained part of what they do, that after a while it becomes second nature.

They will also say that all new clients have a different condition or problem to research and having anatomical and physiological skills can assist with improving their fitness and health. In other words, a fitness professional never stops learning.

Generally a fitness professional will have a sound knowledge of:

- ☆ The circulatory system
- ☆ The respiratory system
- ☆ The human skeleton and its joints
- ☆ The muscular system
- ☆ The life-course of the musculoskeletal system along with implications for 'specific populations'
- ☆ Energy systems
- ☆ The nervous system

**Learning
Activity**

Research

LEARNING ACTIVITY FIVE

In this activity you are to do some research and locate some information on the human body's circulation system. Tell us the parts of the circulation system and what each does. Compile this information in a report form and present the report to your teacher or trainer for review and discussion. Include in the report the information source(s) you used.

TEACHER / TRAINER GUIDANCE NOTES

The human circulation system is also known as the cardiovascular system. The reports will vary in content and complexity but should include the descriptions of the following:

- ☆ The heart and its parts being the right and left ventricles and right and left atriums
- ☆ Heart valves being the atrioventricular valves and the semilunar valves.
- ☆ The main arteries and veins, such as arteries and arterioles that carry oxygenated blood, capillaries carrying blood through the body parts and veins and venules carrying the blood back to the heart.
- ☆ Circulation pathways such as pulmonary circulation and systemic circulation
- ☆ Blood and blood cells such as red cell and white cells

The accuracy of the student's or trainee's submission can be checked using their list of information sources.

**Learning
Activity**

Research

LEARNING ACTIVITY SIX

In this activity you are to do some research and locate some information on the human body's respiratory system. Tell us the parts of the respiratory system and what each does. Compile this information in a report form and present the report to your teacher or trainer for review and discussion. Include in the report the information source(s) you used.

TEACHER / TRAINER GUIDANCE NOTES

The reports will vary in content and complexity but should include the descriptions of the following:

- ☆ Upper respiratory tract being the nose, mouth, sinuses and trachea
- ☆ Lower respiratory tract being the bronchial tubes, lungs and diaphragm

The accuracy of the student's or trainee's submission can be checked using their list of information sources.

**Learning
Activity**

Research

LEARNING ACTIVITY SEVEN

In this activity you are to do some research describing the type of tissue as listed below.

Connective***Muscle***

SAMPLE SAMPLE

Nervous

Epithelial

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Connective tissue—A body is made up of many parts and these are either separated or held together using connective tissue. There are three main types of connective tissue—fluid which is the blood plasma, loose connective tissue which includes lower layers of the skin and fat tissues and the dense connective tissues that include ligaments or tendons.

Cartilage and bone marrow are also looked at as being a type of connective tissue.

Muscle tissue—There are three different types of muscle tissue, including skeletal, cardiac and smooth. Cardiac muscle cells are located in the walls of the heart, smooth muscle tissue are located in walls of hollow visceral organs, such as the stomach or lungs (except the heart) and skeletal which are attached to the bones of the skeleton and include biceps and triceps.

Nervous tissue—Nervous tissue are those tissue cells found in the brain, the spinal cord and the peripheral nerve tissues that branch out throughout the body.

Epithelial tissue—Epithelial tissues line the cavities and surfaces of blood vessels and organs throughout the body. There are several types of epithelial tissues each with a different purpose.

For example, the epithelial tissues in a stomach are used to protect the stomach. Another type of epithelial tissue is used for absorption such as those found in the lungs and the intestine. Other epithelial tissues are used for the senses such as smell and taste and yet other epithelial tissues are used for lubrication and secretion such as in the sinuses and the vagina.

**Learning
Activity**

Research

LEARNING ACTIVITY EIGHT

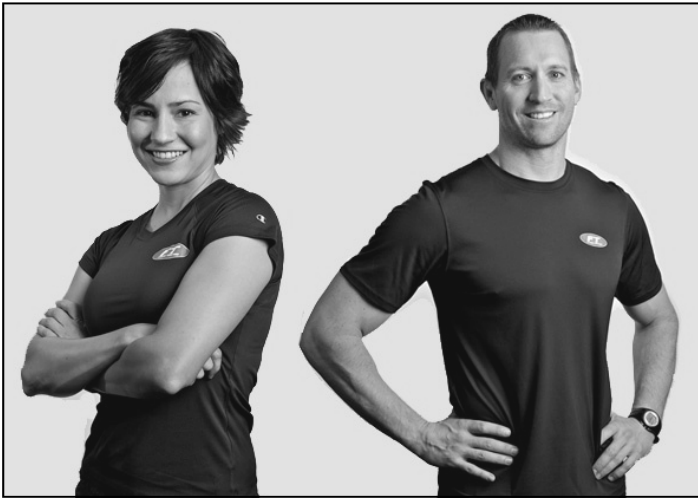
In Activity Five you described the human body's circulation or cardiovascular system. In this activity you are to tell us the role of blood in a human body.

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Blood is used in regulating the body's systems. It performs many functions within the body, including:

- ☆ Supplying oxygen to tissues
- ☆ Supplying nutrients to cells such as glucose, amino acids and fatty acids
- ☆ Removing waste such as carbon dioxide, urea and lactic acid
- ☆ Part of the body's immune system using white blood cells to carry antibodies
- ☆ Coagulation or blood clotting, which is one part of the body's self-repair mechanism
- ☆ Messenger functions, including the transport of hormones and the signalling of tissue damage
- ☆ Regulating body pH
- ☆ Regulating core body temperature
- ☆ Hydraulic functions, including the regulation blood pressure



DISCUSS/EXPLAIN HOW UNDERSTANDING OF ANATOMY AND PHYSIOLOGY CONTRIBUTE TO SAFE/OPTIMUM TECHNIQUE AND SKILL DEVELOPMENT

On the previous pages we mentioned how fitness professionals rely on their knowledge of anatomy and physiology and as a fitness instructor student, or trainee you will need to learn the same reliance.

By definition, a fitness professional possesses the knowledge, skills and abilities for safe and effective exercise and fitness program design, instruction and assistance for the purpose of reaching personal health and fitness goals.

This is not possible without anatomical and physiological knowledge, especially how it relates to fitness and fitness programs.

During your fitness career development you will be put into numerous situations where you will have to discuss and explain how and why an understanding of anatomy and physiology is important to safe and optimum development of fitness programs, especially those that focus on fitness skills and techniques.

So what are these situations?

Initially it will be with your teacher or trainer as you are going through your vocational qualification training in fitness training.

This may be:

- ☆ On the job training
- ☆ With other students/trainees (role play)
- ☆ Training qualification assessors

However, where it most counts is when you are sitting in front of a client and explaining their fitness program and how it is based on your understanding of anatomy and physiology and the effects it will have on their safe and optimum fitness program.

**Learning
Activity****LEARNING ACTIVITY NINE**

Below is a picture of a man holding the anatomical position. In this activity describe this position to us .

Task

**TEACHER / TRAINER GUIDANCE NOTES**

Anatomical position—The position with the body is erect with the arms at the sides and the palms forward.



SAMPLE SAMPLE

**Learning
Activity****LEARNING ACTIVITY TEN**

Here is our man again. There are some numbered arrows depicting a specific anatomical position direction. Tell us what the name of the direction is in anatomical terms.

Task

1 _____

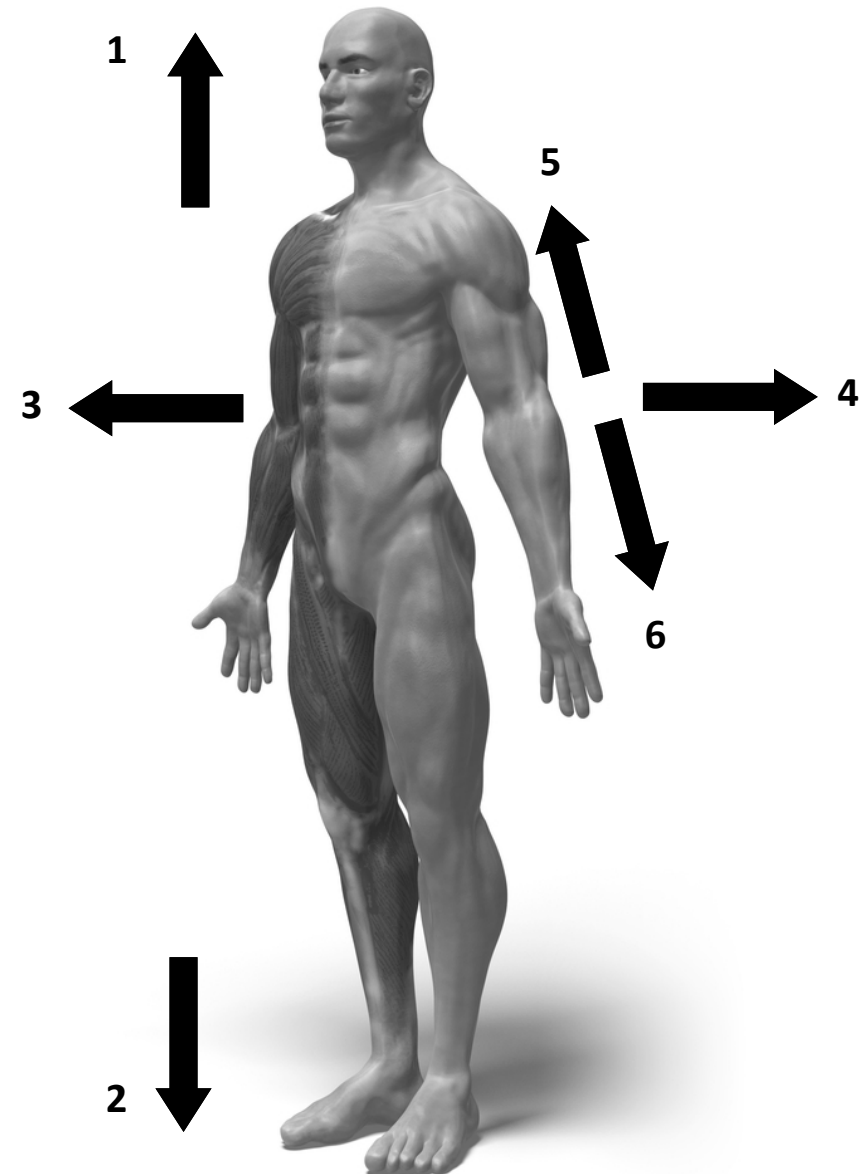
2 _____

3 _____

4 _____

5 _____

6 _____

**TEACHER / TRAINER GUIDANCE NOTES**

- 1—Superior
- 2—Inferior
- 3—Anterior
- 4—Posterior
- 5—Proximal
- 6—Distal

SAMPLE SAMPLE

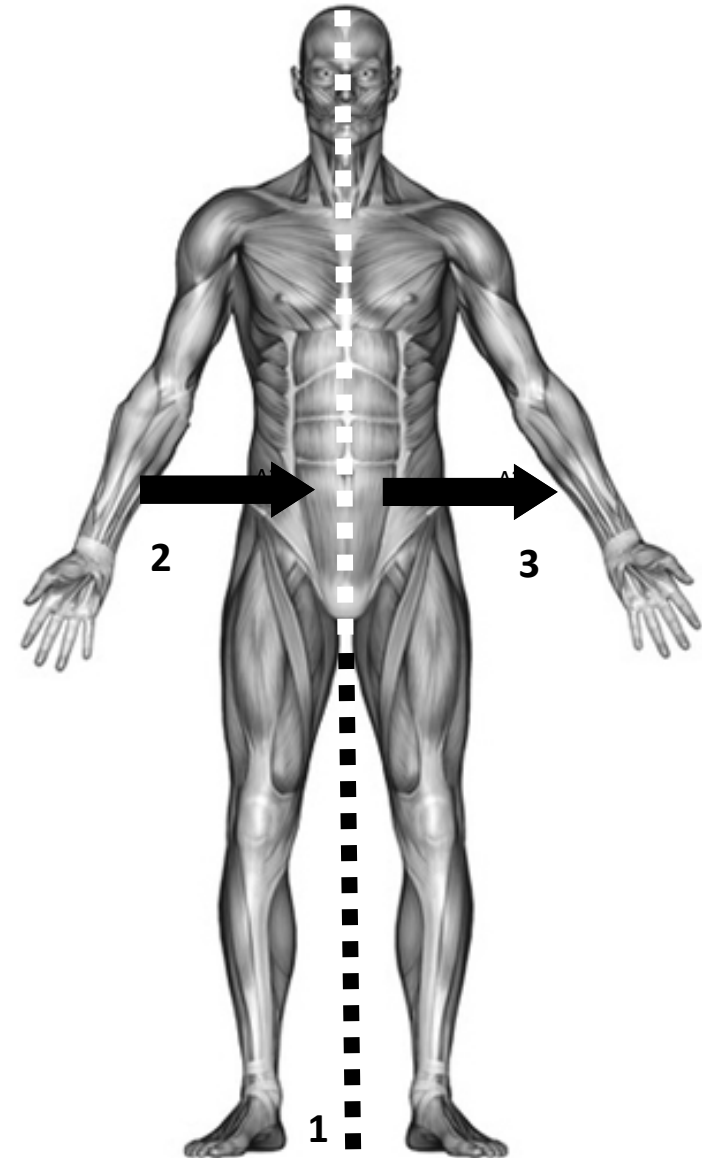
**Learning
Activity****LEARNING ACTIVITY ELEVEN****Task**

Here a new man. We have divided this man in two. There is a reason and looking at number 1, you will tell us what this is called in anatomical terms. There are some numbered arrows depicting a specific anatomical position direction. Tell us what the name of the direction is in anatomical terms.

- 1 _____
- 2 _____
- 3 _____

TEACHER / TRAINER GUIDANCE NOTES

- 1—Midline
2—Medial
3—Lateral



SAMPLE SAMPLE

**Learning
Activity****LEARNING ACTIVITY TWELVE**

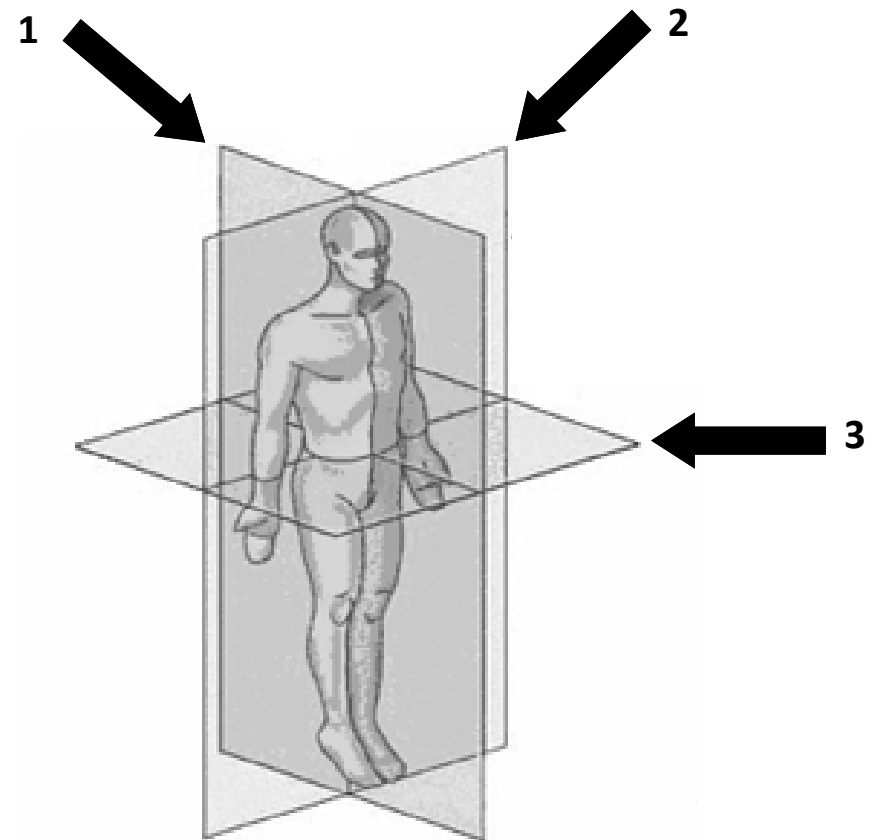
Below is a graphic that shows a man that has been hypothetically divided into 'planes of movement' as known in anatomical terms. Tell us what each plane is called.

Task

- 1 _____
- 2 _____
- 3 _____

TEACHER / TRAINER GUIDANCE NOTES

- 1—Sagittal
2—Frontal
3—Transverse or horizontal



SAMPLE SAMPLE

**Learning
Activity**

Task

LEARNING ACTIVITY THIRTEEN

Finally, still on anatomical terms tell us below what each of the anatomical terms mean.

Superficial***Deep******TEACHER / TRAINER GUIDANCE NOTES***

Superficial - nearer to the body's surface. Example, your skin is superficial to your bones.
Deep - further away to the body's surface. Example, your bones are deep to your skin.

SAMPLE SAMPLE



USE A WIDE RANGE OF ANATOMICAL TERMINOLOGY RELEVANT TO INJURY PREVENTION AND FITNESS OUTCOMES

As you would have noticed in the “Glossary of Terms” attached to these learning materials, there are a vast number of anatomical terms that commonly are used or referred to by a fitness professional.

As we know, anatomical terms of motion and location are the basis of describing human structure and function. When a fitness instructor or trainer understands the framework of movement, they are equipped with better tools for training their clients.

Developing a fitness program and selecting exercises requires an analysis of movement. Distinguishing various ranges of motion allows fitness instructors and trainers to identify which exercises best match the clients fitness goals.

An analysis of movement and distinguishing various ranges of motion also allows fitness instructors and trainers to pick exercises that clients can be assured will not cause them injury.

Generally there are two types of injuries that a client undergoing fitness training could be exposed to:

- ☆ Acute
- ☆ Chronic

Acute injuries are those that occur as a result of a fall, collision or sudden change of direction, such as in a twisted ankle. These types of injuries often result in an immediate cessation of the exercise session and may require medical attention.

Chronic injuries are those that gradually appear and are usually a result of overtraining, doing exercises that are not suited to the client's condition and so on. The pain associated with chronic injuries is generally low, however the effects of the injury can last a long time.

So a fitness professional that has an understanding the anatomical terms of motion and location can develop exercise programs with not only the clients fitness outcomes in mind, but also and just as important, a fitness program that has injury prevention in mind.

**Learning
Activity**

Task

LEARNING ACTIVITY FOURTEEN

When developing fitness programs you would need to put in place exercises that not only assist the client in reaching their fitness goals, but also prevent them doing exercises that could possibly lead to injury.

This is when you should have an understanding of anatomical terminality relating to major muscles and the functions of these major muscles during exercising.

In this activity we want you to tell us what the following muscle function terms mean and then on the following diagram tell us the functions of each as pointed to by the numbered arrows.

Agonist***Prime mover***

SAMPLE SAMPLE

Antagonist**Synergist****Fixator****TEACHER / TRAINER GUIDANCE NOTES**

Agonist—The agonist in a movement is the muscle(s) that provides the major force to complete the movement. They are also called the prime mover.

Antagonist—This muscle movement opposes the agonist because it is not needed to provide the major force. Because Agonists and antagonist muscles are in pairs, these muscles switch back and forth from agonistic movements to antagonistic movements.

Synergist muscle—A synergist muscle is a muscle which works jointly with another muscle to generate movement and work with the so-called agonists or prime movers which surround a joint. Sometimes known as a fixator muscle.

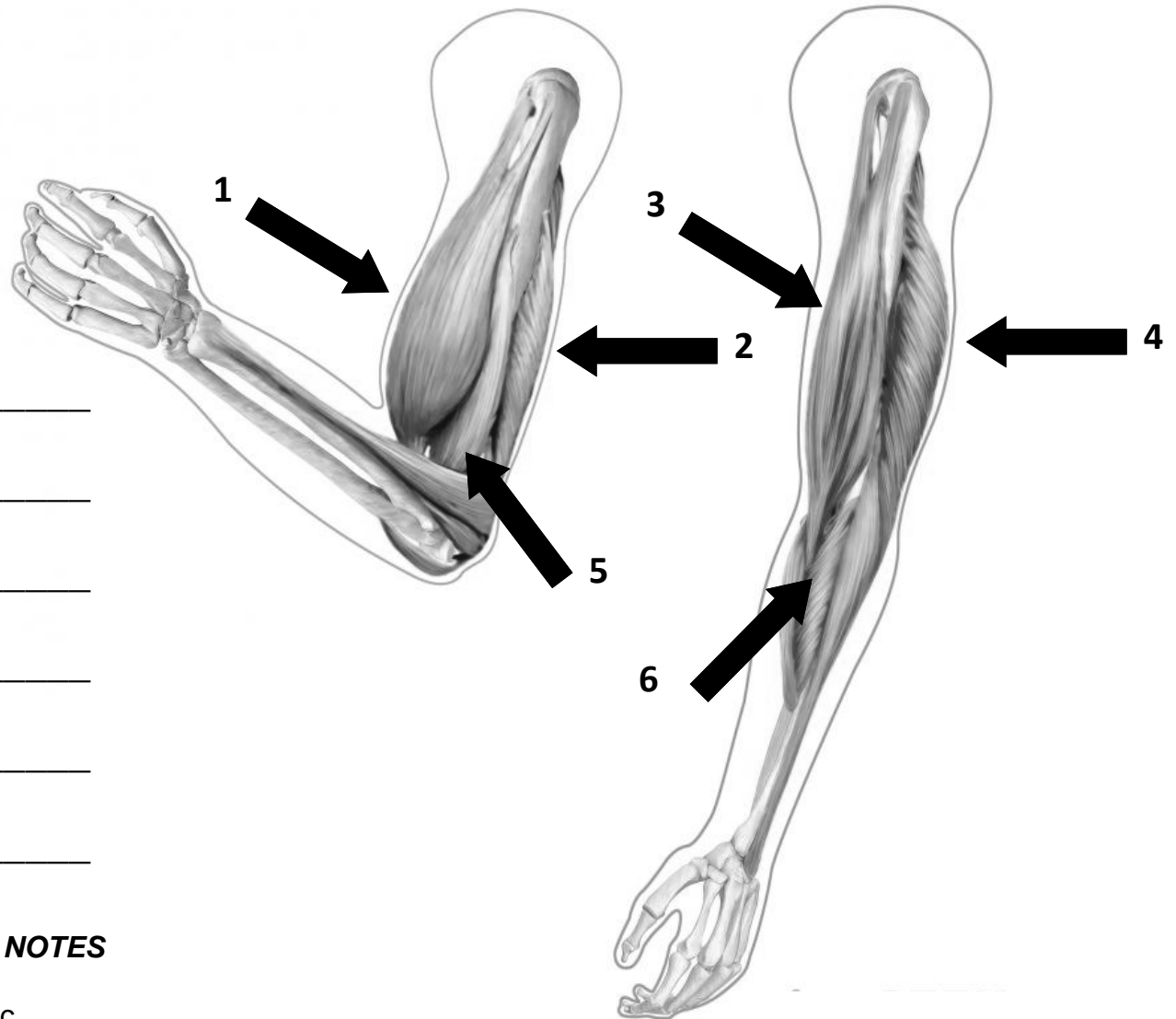
Fixator—A fixator is a stabiliser that acts to eliminate the unwanted movement of a prime mover muscle's origin, mainly joints such as the shoulder or hip joints.

SAMPLE SAMPLE

- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____
- 6 _____

TEACHER / TRAINER GUIDANCE NOTES

- 1—Prime mover contracted agonistic
- 2—Relaxed antagonist
- 3—Relaxed antagonist
- 4—Prime mover contracted agonistic
- 5—Synergist muscle
- 6—Synergist muscle





IDENTIFY HOW ANATOMICAL STRUCTURES RESPOND TO PHYSICAL ACTIVITY

When a client begins to exercise their body must immediately adjust to the change in activity level.

The body's energy production must increase to meet demand and this results in changes to the body's energy system and fuel source occurring throughout the exercise in order to maintain the required level of activity.

There are two main types of exercises:

- 1) Anaerobic—exercises not needing air
- 2) Aerobic—exercises needing air

Types of anaerobic include weightlifting and other resistance exercises as well as short high intensity exercises, such as sprinting, interval training, stair climbing, skipping and jumping.

Types of aerobic exercises include walking, running, dancing, swimming, bicycling, rowing and racket sports.

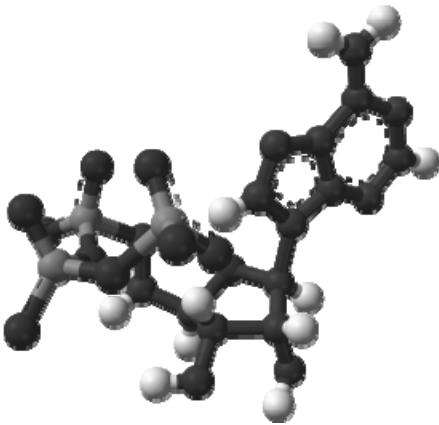
The anatomical structures of the human body respond differently to each type—anaerobic and aerobic.

Aerobic exercise or physical activity that requires a high level oxygen involves extended periods of exercise at levels below a muscle's maximal contraction strength and uses a high percentage of Type I muscle fibres.

Type 1 muscles (also known as slow twitch muscles) are identified by slow contraction times and a high resistance to fatigue.

Anaerobic exercises or physical activity needing low levels of oxygen, involves high intensity muscle contractions for short periods of time, utilising primarily Type II muscle fibres.

Type II muscles are also known as fast twitch muscle fibres and are characterised by high force/power/speed uses and low endurance.



ENERGY SYSTEMS

Aerobic and anaerobic exercises use different energy systems in the body.

The anaerobic energy system provides energy in the absence of oxygen.

This system is used to provide energy when the aerobic system (where there is sufficient available oxygen) is insufficient. There are two systems within anaerobic metabolism:

- ☆ ATP-PC system
- ☆ Lactic acid system

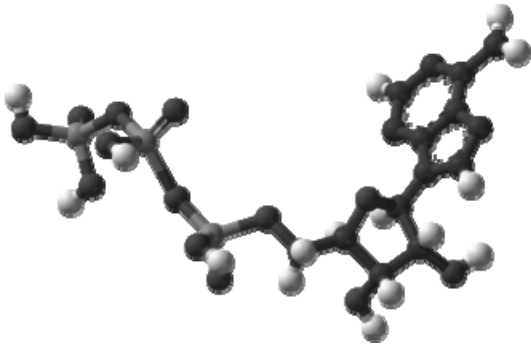
ATP (adenosine triphosphate) is a high energy molecule and the energy in ATP is obtained from the breakdown of foods. A muscle cell has very little ATP and only enough to last for about three seconds.

ATP is required for the biochemical reactions involved in any muscle contraction. As the work of the muscle increases, more and more ATP gets consumed and must be replaced in order for the muscle to keep moving.

Chemically, ATP is an 'adenine nucleotide' bound to three phosphates. There is a lot of energy stored in the bond between the second and third phosphate groups that can be used to fuel chemical reactions.

When a cell needs energy especially during anaerobic exercises, it breaks this chemical bond to form 'adenosine diphosphate' (ADP) and a free phosphate molecule.

The phosphate group is removed from creatine phosphate by an enzyme called 'creatine kinase' and is transferred to ADP to form ATP. The cell turns ATP into ADP, and the phosphagen rapidly turns the ADP back into ATP and this is how ATP is regenerated during a workout. As the muscle continues to work, the creatine phosphate levels begin to decrease. Together, the ATP levels and creatine phosphate levels are called the 'phosphagen energy system'. The phosphagen system can supply the energy needs of working muscle at a high rate, but only for 8 to 10 seconds.



In the lactic acid energy system, muscles also have big reserves of a complex carbohydrate called 'glycogen' which is a chemical chain of glucose molecules. A cell splits glycogen into glucose. Then the cell uses anaerobic metabolism (anaerobic means 'without oxygen' to make ATP and a by-product called 'lactic acid' from the glucose.

Numerous chemical reactions take place to make ATP under this process, so it supplies ATP at a slower rate than the phosphagen energy system. The system can still act rapidly and produce enough ATP to last about 90 seconds. This system does not need oxygen, which is important because the rapidly contracting muscle in anaerobic exercising squeezes off its own blood vessels, depriving itself of oxygen-rich blood that is made available during aerobic exercising.

There is a definite limit to anaerobic energy systems because of the lactic acid. Lactic acid builds up in the muscle tissue and causes the fatigue and soreness clients feel in the exercising muscles.

During aerobic exercising the body responds to supply working muscles with oxygen and this causes the glucose to be completely broken down into carbon dioxide and water in a process called 'aerobic respiration'.

The glucose can come from three different places:

- ☆ Glycogen supplies in the muscles
- ☆ Breakdown of the liver's glycogen into glucose and sends the glucose to the working muscle through the bloodstream
- ☆ Absorption of glucose from food in the intestine, which gets to working muscle through the bloodstream

Aerobic respiration can also use fatty acids from fat reserves in muscle and the body to produce ATP.

Aerobic respiration would use carbohydrates first and then fats and then protein (that is converted to amino acids). These are called 'substrates' of the energy system. Aerobic respiration takes even more chemical reactions to produce ATP than either of the previous systems. Aerobic respiration produces ATP at the slowest rate of the three systems but it can continue to supply the muscles ATP for several hours or longer, so long as the fuel supply lasts.



MUSCLE HYPERTROPHY

Muscle hypertrophy is an increase in muscle mass due to an increase in muscle cell size.

Body builders are a good example of exhibiting muscle hypertrophy.

There are two types of muscle hypertrophy:

- 1) Myofibrillar hypertrophy
- 2) Sarcoplasmic hypertrophy

Myofibrillar hypertrophy is when the muscle mass is increased by using exercises that increase the size of the muscle fibres, where as sarcoplasmic hypertrophy is where exercises are used that increase the size of the muscle cells.

Heavy weight lifting is used for myofibrillar hypertrophy and this also leads to increased muscular strength and lighter weight lifting exercises are used for sarcoplasmic hypertrophy but at the expense of increased muscular strength.

Earlier we learned that the body's energy systems would create energy by using carbohydrates first or the body's stored fat cells fats or even protein that is converted to amino acids.

In muscle hypertrophy, especially myofibrillar hypertrophy, there is a high need for amino acids so a diet of high in protein is used to assist the body in converting the required protein into amino acids.

**Learning
Activity**

Task

LEARNING ACTIVITY FIFTEEN

In this Section we learned about the two main energy systems of the body. What were they called?

1 _____

2 _____

TEACHER / TRAINER GUIDANCE NOTES

- ☆ ATP-PC system
- ☆ Lactic acid system

SAMPLE SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY SIXTEEN

It is important to understand that there is a relationship as to how your body responds the more the clients exercise and the higher the intensity.

We learned earlier about how the body develops energy using the body's energy systems.

There is also a relationship between the body's cardiovascular system and exercising.

What is the general benefit to the body's cardiovascular system and exercising?

There is also a relationship between the body's ventilator system and exercising.

What is the general benefit to the body's ventilator system and exercising?

TEACHER / TRAINER GUIDANCE NOTES

Cardiovascular— Your heart rate increases with physical activity to supply more oxygenated blood to your muscles. The fitter you are, the more efficiently your heart can do this, allowing you to work out longer and harder. As a side effect, this increased efficiency will also reduce your resting heart rate. Your blood pressure will also decrease as a result of new blood vessels forming.

Ventilator— As your muscles call for more oxygen your breathing rate increases. Once the muscles surrounding your lungs cannot move any faster, you've reached what's called your VO2 max—your maximum capacity of oxygen use. The higher your VO2 max, the fitter you are.

**Learning
Activity**

Task

LEARNING ACTIVITY SEVENTEEN

In this activity you are to find someone to help you. It could be a friend, a fellow worker, fellow student/trainee, possibly your teacher or trainer.

Print out the page of the Glossary that has the 'Movement Terminology and Muscle Actions' and give this page to the person you have recruited to help you. You are not allowed to have a copy of this page in this activity.

They are to go down the list 'Movement Terminology and Muscle Actions' and ask you what each one means without you having any reference materials.

They are to keep score as to how many you answered correctly.

If you got three or more wrong, review the Glossary and then in a couple of days repeat the same exercise. This activity is to reinforce and help you retain the information relating to Movement Terminology and Muscle Actions'. Good luck!!

TEACHER / TRAINER GUIDANCE NOTES

This activity is to reinforce and help the student or trainee retain the information relating to Movement Terminology and Muscle Actions'. This is required as part of their 'Knowledge Evidence' requirement in this unit of competency.

**Learning
Activity**

Research

LEARNING ACTIVITY EIGHTEEN

In this Section we learned about 'Muscle Hypertrophy'.

To better understand Muscle Hypertrophy is to have a strong understanding of the human body's muscle groups.

In Activity Five you told us about the types and classifications of the human body's muscle tissue.

In this activity we want you to do some research and tell us what the human body's major muscle groups are.

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Answers might vary depending on the source of information the student or trainee has used. However most submissions would likely include:

Quadriceps
Hamstrings
Calves
Chest
Back and neck
Shoulders
Triceps
Biceps
Forearms
Trapezius
Abs
Wrist and hands
Hip and pelvis

SAMPLE SAMPLE

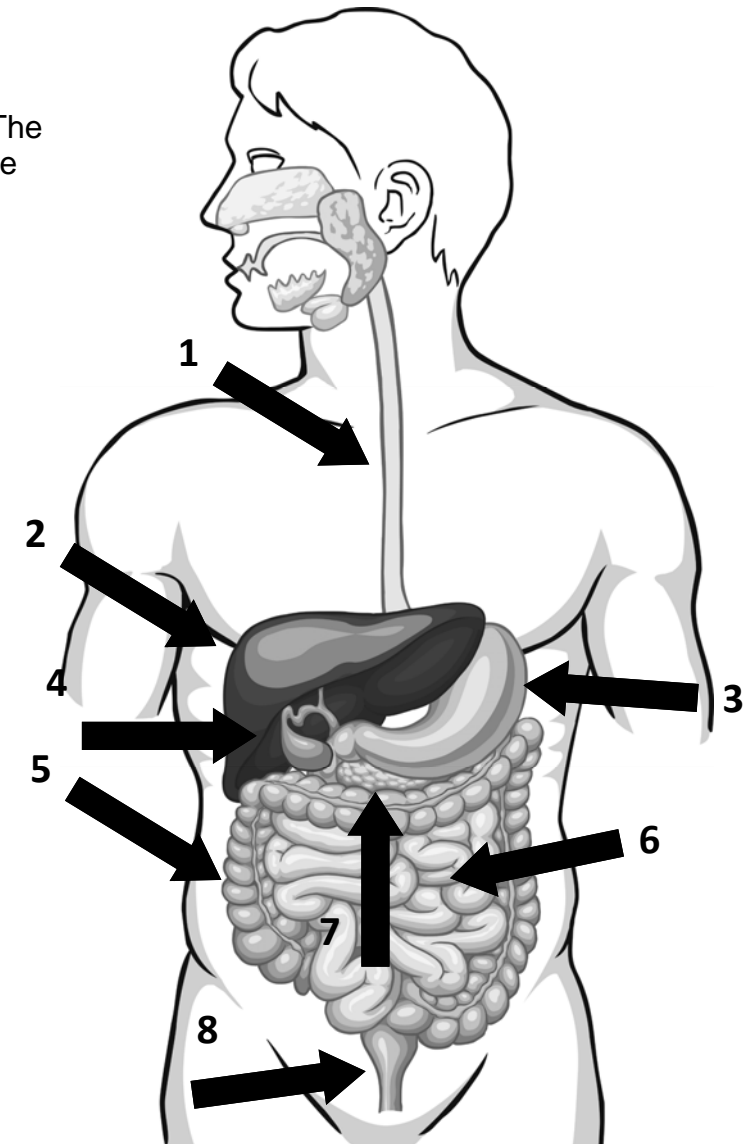
**Learning
Activity**

Task

LEARNING ACTIVITY NINETEEN

This is a two part activity. Another body structure is the digestive system. The first part of the activity is to tell us the parts of the digestive system using the diagram to the right.

- 1 _____
- 2 _____
- 3 _____
- 4 _____
- 5 _____
- 6 _____
- 7 _____
- 8 _____

**TEACHER / TRAINER GUIDANCE NOTES**

1—Esophagus 2—Liver 3—Stomach 4—Gall bladder
5—Large intestine 6—Small intestine 7—Pancreas
8—Rectum

The next part of this activity is to tell us how the digestive system benefits from exercise and what negative effects there are on the digestive system from exercise.

Benefits***Negative effects******TEACHER / TRAINER GUIDANCE NOTES***

Benefits—Exercise can help to improve the efficiency of the digestive process and help you to maintain a healthy weight, As well as help to reduce heartburn. Light exercise that increases breathing and heart rate can help to produce more efficient bowel movements.

Negative effects—Exercise such as running can cause digestive disorders. Disorders such as nausea and diarrhea are common in runners who train hard. Acute gastritis and gastro-oesophageal reflux symptoms are also common in runners.



APPLY A SOUND UNDERSTANDING OF INJURY PREVENTION TECHNIQUES TO FITNESS INSTRUCTION AND PROGRAMMING

As a fitness professional you have the responsibility that any fitness program you develop for a client as well as the activities will include activities that are considered safe and not likely to cause injury to the client.

This means that as a fitness professional you need to develop injury prevention strategies and embed those strategies into each fitness program.

The most common and arguably the most important injuries strategy is the warm-up and cool-down as well as what activities are used.

In any earlier section we learned about dynamic warm up activities and cool-down stretching activities. Both are used to prevent injuries.

Using the advice or guidance from health professionals is also an important strategy in injury preventions especially those that need to have clearance from their doctor to exercise.

Having client's (especially unconditioned clients) ease into a fitness program will prevent injury. They will build strength and endurance which will allow them to increase the intensity.

Proper recovery periods is also important. Each client will have their own needs and limitations and these needs and limitations will need to be considered closely when developing injury prevention strategies.

The trainer should know the client's trouble spots such as lower back problems, arthritis in certain joints and so on.

The trainer can work on these areas to build strength, but in a way that does not increase the problem.

Cross training can help avoid injuries. This means vary the exercise from session to session and this avoids overworking a specific part of the body allowing it to recovery.

Clear instructions are always needed to prevent injury. The fitness trainer must be assured that the client knows how to do the exercises properly as well as how to use fitness machines correctly.

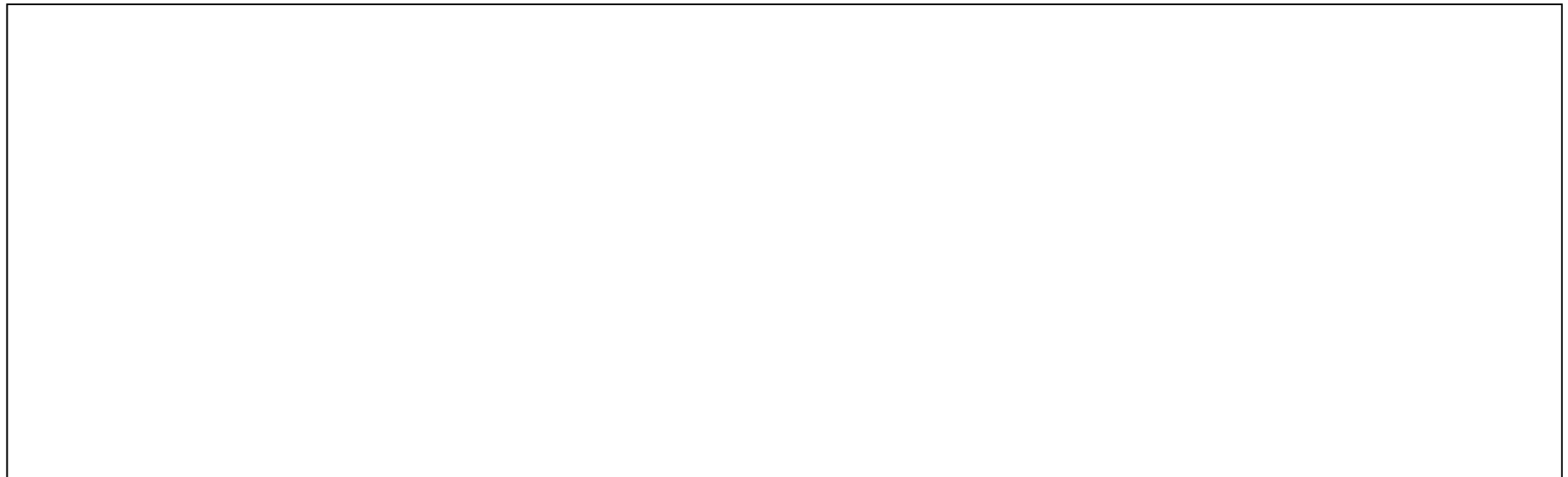
**Learning
Activity**

Research

LEARNING ACTIVITY TWENTY

As part of a properly developed fitness program is the use of exercises that ensure ideal postural alignment.

First define what it means to have ideal postural alignment and keep in mind it does not mean merely having a straight back.

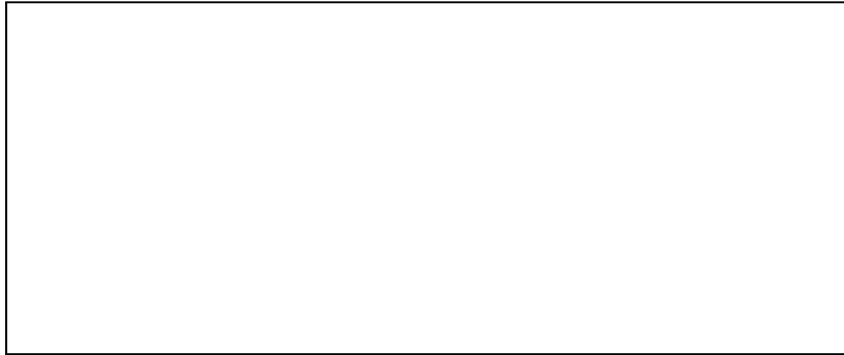
***TEACHER / TRAINER GUIDANCE NOTES***

Ideal postural alignment can be determined by drawing an imaginary line through a body standing sideways and connecting the ear lobe, anterior shoulder, lumbar spine, posterior hip, anterior knee and anterior ankle.

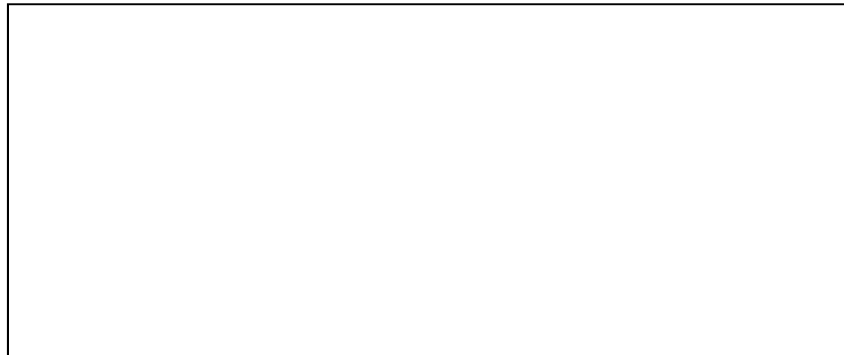
SAMPLE SAMPLE

Next we have shown some diagrams that are considered pathological postures. Do some research and tell us what each pathological posture is called and what defines this posture.

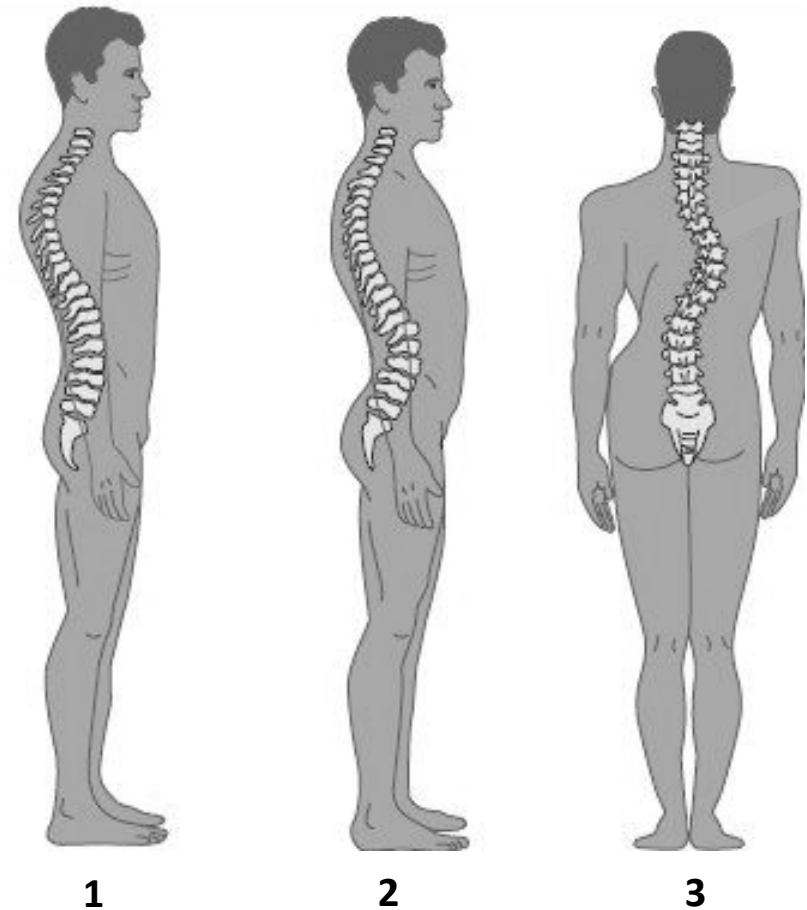
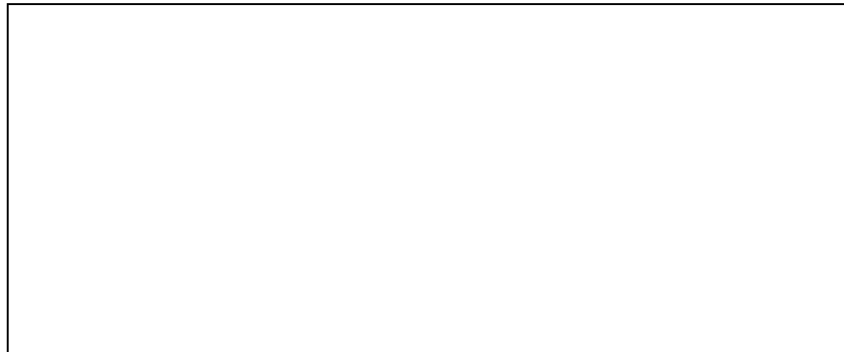
1



2



3



TEACHER / TRAINER GUIDANCE NOTES

1—**kyphosis** : abnormal posterior curvature of the thoracic spine (humped-back condition)

2—**lordosis** : abnormal anterior curvature of the lumbar spine (sway-back condition)

3—**scoliosis** : abnormal lateral curvature of the spine (S-shaped curve)

**Learning
Activity**

Research

LEARNING ACTIVITY TWENTY ONE

Persons that lead a predominately sedentary lifestyle often will develop muscle imbalances that cause postural issues.

In the activity we want you to do some research and describe three of the most common types of muscles imbalances.

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Answers may vary slightly depending on the source of information used, however it is likely that the submissions would have suggested the following muscle imbalances:

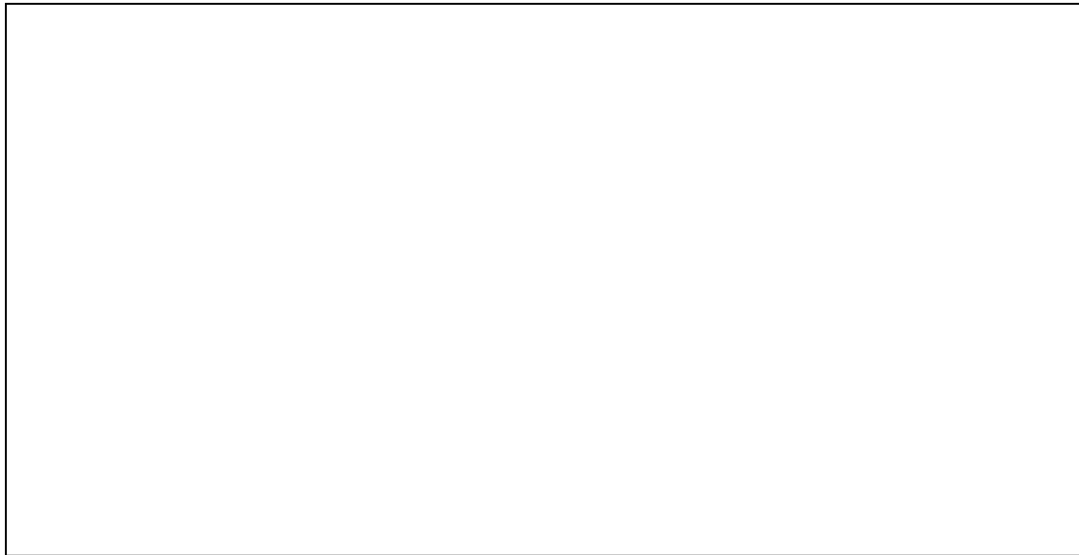
- 1—Tight hip flexors are a major cause of many posture problems caused from being in a seated position for long periods of time.
- 2—Chronic hamstring tightness are again caused from being in a seated position for long periods of time.
- 3—Middle upper back (lower and middle trapezius and rhomboids) become lengthened and weak, while the primary muscles on the front which oppose shoulder retraction (pecs and anterior deltoids) become tight. This is known as the forward shoulder condition.

**Learning
Activity**

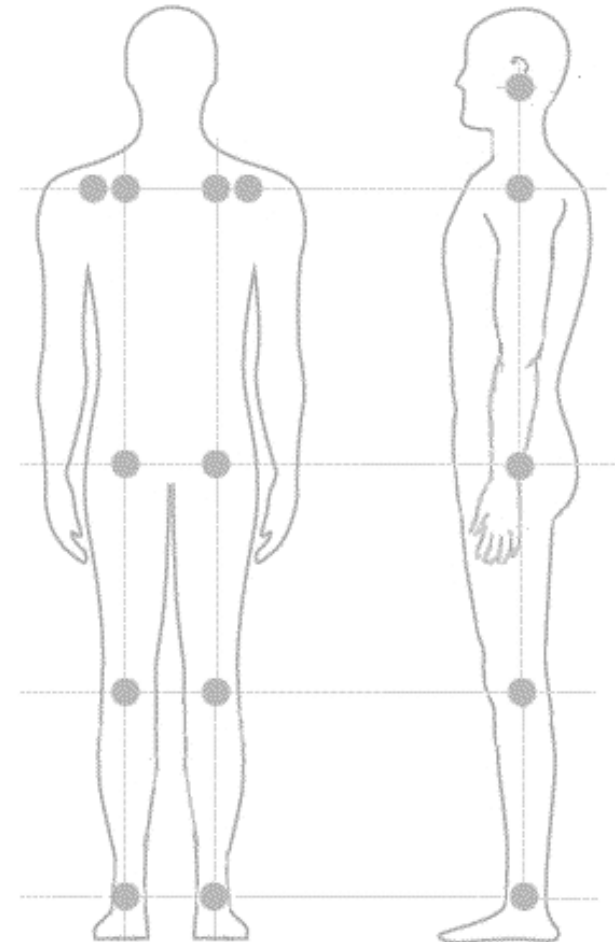
Question

LEARNING ACTIVITY TWENTY TWO

When it comes to ideal postural alignment what is the diagram suggesting?

**TEACHER / TRAINER GUIDANCE NOTES**

It is suggesting that the top of the spine, shoulder, hip, knee and ankle joints are all aligned both vertically and horizontally.



Section Two

Apply knowledge to Own Professional Practice

SAMPLE SAMPLE

*This is not a complete document.
SAMPLE ONLY*

INCORPORATING ANATOMY AND PHYSIOLOGY PRINCIPLES INTO FITNESS PROGRAMMING

SECTION TWO – APPLY KNOWLEDGE TO OWN PROFESSIONAL PRACTICE

INTRODUCTION

The saying...“You never stop learning”, is one that can be clearly applied to a person learning about the science of human anatomy and physiology.

This is especially true when it comes to fitness training and applying knowledge to fitness programming.

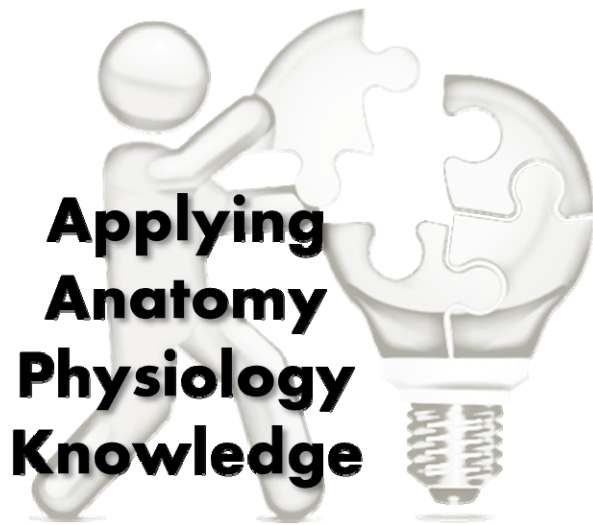
In this section you will learn the reasons of continually developing your knowledge of the human anatomy and applying new knowledge to your fitness programming.

The activities in this section also continues to introduce you to numerous other areas of human anatomy and its application to fitness programming.

SECTION LEARNING OBJECTIVES

At the completion of this section you will learn information relating to:

- ☆ Assessing ways that the knowledge of anatomy and physiology used in the instruction and providing fitness advice
- ☆ Identifying current and emerging knowledge of anatomy and physiology as and how this relates to the development of a fitness career
- ☆ Modifying fitness programming approaches as the knowledge of anatomy and physiology increases



ASSESS WAYS IN WHICH KNOWLEDGE OF ANATOMY AND PHYSIOLOGY MAY BE USED, ADAPTED OR CHALLENGED IN INSTRUCTION AND PROVISION OF FITNESS ADVICE

Using your knowledge of anatomy and physiology gives you the ability to create exercises that use the proper muscles at the proper times. Understanding anatomy ensures that you design exercises that provide proper angles and ranges of motion for clients that have different body alignments and to recognise imbalances in strength and stability of muscle groups that will need to be worked on.

The more you know and understand the body, the better you will be at creating successful programming. Anatomy is not limited to the muscles and bones of the body; you will also want to have a significant knowledge of how the cardiovascular system works to understand how exercise affects the oxygenation of the blood and therefore the working muscles.

A subset of anatomy is the science of kinesiology or human kinetics. This is the study of human movement and having an understanding of human kinetics will provide you with the foundation to understand movement patterns. Recognising when a client has irregularities in movement you are then able to develop fitness programs to adjust postures and provide more efficient use of the body.

Based on your knowledge of anatomy you understand that bones are living tissues. They become stronger and increase in density and strength as clients exercise regularly. In addition, regular exercise maintains muscle strength, balance and coordination; thus preventing falls and associated fractures.

Understanding the human nervous system you understand how and why a client's fitness improves as the central nervous system changes the way it controls and coordinates the body movements.

Nutrition knowledge is also a must as your clients will inevitably need to know what they should consume before and after an exercise session to get the most out of fitness program. For example, you may have to work with diabetics or those that are border-line and blood sugar highs and lows may be a challenge for both them and you. An understanding of the bodies energy systems and a program designed to manage or address these challenges are essential if you are to recognise the early signs of these problems and keep your clients safe.

**Learning
Activity**

Research

LEARNING ACTIVITY ONE

Part of understanding human anatomy is the structure levels of body organisation.

In this activity we want you to tell us what the structures of body organisations are, what role each plays as well as examples of each.

Write out this activity in a report form and present the completed report to your teacher or trainer for review and discussion.

TEACHER / TRAINER GUIDANCE NOTES

The submissions will vary.

They however should cover the levels of organisation in the correct order, which is:

- 1) Cells
- 2) Tissues
- 3) Organs
- 4) Organ systems
- 5) Organisms

Cells—They are the basic unit of structure and function in living things. They serve a specific function within the organism and examples include blood cells, nerve cells and bone cells.

Tissues—These are made up of cells that are similar in structure and function and which work together to perform a specific activity. Humans have 4 basic tissues: connective, epithelial, muscle, and nerve.

Organs—Made up of tissues that work together to perform a specific activity such as the brain, heart, skin and so on.

Organ systems—Groups of two or more tissues that work together to perform a specific function for the organism and include circulatory, digestive, endocrine, excretory (urinary), immune (lymphatic), integumentary, muscular, nervous, reproductive, respiratory, and skeletal.

Organisms—Entire living things that can carry out all basic life processes. Meaning they can take in materials, release energy from food, release wastes, grow, respond to the environment and reproduce. This is the human body.

**Learning
Activity**

Question

LEARNING ACTIVITY TWO

An important part of fitness instruction is understanding the mechanics of breathing.

The general definition of breathing mechanics is the action of breathing in and out due to pressure changes within the thorax in comparison with the outside.

What is the human thorax?

TEACHER / TRAINER GUIDANCE NOTES

The thorax is the part of the body of a human between the neck and the abdomen, including the cavity enclosed by the ribs, breastbone and dorsal vertebrae and containing the chief organs of circulation and respiration; in other words the chest.

SAMPLE SAMPLE

**Learning
Activity**

Task

LEARNING ACTIVITY THREE

Still on the subject of the mechanics of breathing, below are parts of the human body that play a part in the mechanics of breathing.

Describe each parts and tell us what role each plays in the mechanics of breathing.

Intercostal muscles***Diaphragm******Chemoreceptors***

SAMPLE SAMPLE

Medulla oblongata***Stretch receptors******Pulmonary Alveolus***

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Intercostal muscles—these are several groups of muscles that run between the ribs, and help form and move the chest wall. The intercostal muscles are mainly involved in the mechanical aspect of breathing. These muscles help expand and shrink the size of the chest cavity to facilitate breathing.

Diaphragm—the diaphragm separates the thoracic cavity containing the heart and lungs, from the abdominal cavity and performs an important function in breathing. As the diaphragm contracts, the volume of the thoracic cavity increases and air is drawn into the lungs.

Chemoreceptors—it is a receptor in the blood stream that monitors or detects the levels of oxygen or carbon dioxide in the blood. If oxygen is low the breathing increases

Medulla oblongata—the continuation of the spinal cord within the skull, forming the lowest part of the brainstem and containing control centres for the heart and lungs.

Stretch receptors—a sensory receptor that responds to the stretching or enlarging of the lung and sends a impulse to the medulla oblongata when the limits have been reached.

Pulmonary alveolus—small air sacs in the lungs of a human which are located at the ends of the air passageways in the lungs. They absorb the oxygen from the air breathed in and transfer the oxygen to the red blood cells and then absorbs the carbon dioxide and transfers carbon dioxide to the air being breathed out.

**Learning
Activity**

Task

LEARNING ACTIVITY FOUR

Still on the subject of the mechanics of breathing, there is a term called 'respiratory volumes'.

In the area below tell us what respiratory volume is.

TEACHER / TRAINER GUIDANCE NOTES

Respiratory volume is defined as tidal volume and residual volume. Tidal volume is the volume of air inhaled in a single, normal breath. Residual volume: the volume of air remaining in the lungs after a maximal exhalation.

The two other types of residual respiratory volumes are inspiratory reserve volume which is the amount of extra air inhaled (above tidal volume) during a deep breath and expiratory reserve volume which is the amount of extra air exhaled (above tidal volume) during a forceful breath out.

**Learning
Activity**

Question

LEARNING ACTIVITY FIVE

And finally on the subject of the mechanics of breathing, there is a term called 'gaseous exchange'.

What does that mean?

TEACHER / TRAINER GUIDANCE NOTES

The main function of the respiratory system is gaseous exchange. This refers to the process of Oxygen and Carbon Dioxide moving between the lungs and blood. This is done using the pulmonary alveolus and the capillaries which are the smallest of all blood vessels and form the connection between veins and arteries.

SAMPLE SAMPLE



Emerging Anatomy Physiology Knowledge

IDENTIFY CURRENT AND EMERGING KNOWLEDGE OF ANATOMY AND PHYSIOLOGY RELEVANT TO DEVELOPMENT OF OWN PROFESSIONAL PRACTICE

When a person decides on a career...no matter what industry, there is a sharp learning curve in the beginning when they are starting to develop their skills.

Fitness is the same. Learning anatomy and physiology is essential and can be daunting at the beginning.

Because a fitness professional is advising and instructing people on how to have a fit and healthy body, they need to know how the human body works, what types of exercises to use and how they affect the various bodily systems.

But as a person starting off a fitness career, they will notice that their knowledge base is increasing and they are learning new and innovative ways to use their knowledge including their knowledge in the human anatomy.

They will also notice that they will be learning new information as they are being increasingly exposed to the many types of clients, with varying fitness goals, preferences, and limitations.

This is especially true when a fitness instructor or trainer is developing a client base that are clients within a certain 'specific population group'. The needs and limitations of these clients are those that designing fitness programs is challenging and may require building up their anatomical and physiological knowledge in more specific areas.

Another example is bodybuilding. Knowing anatomy and physiology, especially in areas of hypertrophy and body composition is essential if the instructor is involved with bodybuilding clients.

Also, as a fitness professional's practice develops and grows, there is a very likely chance that they will have significant interaction with a wide variety of medical and health professionals. Anatomical and physiological knowledge is essential to have a productive interaction with medical and health professionals.

Also, the advice and guidance from medical and health professionals often adds to the fitness professional's anatomical and physiological knowledge base.

**Learning
Activity**

Question

LEARNING ACTIVITY SIX

Over the last few Activities we reviewed the mechanics of breathing. When you relate the mechanics of breathing to fitness training you will hear a term VO_2 and VO_2 max and why this is important in fitness training. What does this mean?

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

VO₂ stands for 'volume of oxygen' consumed by the body and VO₂ max is the maximum rate of oxygen consumption as measured during incremental aerobic type exercise. The oxygen the body takes in is used to convert food into energy known as ATP.

When exercising, the muscles are working harder than normal and as a result, they require more energy than normal. Since the ATP energy used by the muscles is generated with the aid of oxygen, it means there is a need for more oxygen intake. Therefore, increased exercise intensity ultimately corresponds to an increased VO₂. This is the reason that a person's breathing gets progressively faster and deeper as the exercise intensity increases, basically the body is trying to provide more oxygen to the working muscles so that they can generate enough ATP energy to keep the muscles moving.

**Learning
Activity**

Question

LEARNING ACTIVITY SEVEN

As a fitness instructor or trainer you will need to have an understanding of the thermoregulation of the human body. What is thermoregulation?

TEACHER / TRAINER GUIDANCE NOTES

Thermoregulation is the bodily process that allows the human body to maintain its core internal temperature. In humans that core temperature is 36.5°F.

SAMPLE SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY EIGHT

How does the body stay cool when exercising?

TEACHER / TRAINER GUIDANCE NOTES

Sweating is one of the first methods your body will use to control your temperature. Sweat cools your skin as it evaporates. This helps lower your internal temperature.

The central nervous system may instruct the capillaries under the surface of your skin to dilate, or open and this is called vasodilatation or enlarged capillaries which increases blood flow at the skin surface. This lets your body release heat through radiation.

**Learning
Activity**

Research

LEARNING ACTIVITY NINE

How does the body stay warm?

TEACHER / TRAINER GUIDANCE NOTES

Your nervous system can lower sweat production to help maintain the heat your body generates and the nervous system may signal your capillaries to constrict or become narrower. This decreases blood flow under the skin and reduces heat loss.

Another way is 'thermogenesis' and this is when your body's muscles, organs and brain produce heat when your core temperature is sinking. This process is called thermogenesis. Muscles are especially effective at thermogenesis. They can produce large quantities of heat quickly. Shivering is one way muscles generate heat.

And finally there is hormonal thermogenesis. Your body can activate the thyroid gland if you are getting too cold. This releases hormones that increase your metabolism. An increased metabolism increases the energy your body creates and the amount of heat your body is able to make.

SAMPLE SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY TEN

Tell us below what steps a fitness instructor or trainer should take when relating thermoregulation to fitness training.

TEACHER / TRAINER GUIDANCE NOTES

The fitness instructor or trainer should be aware of the environmental conditions where the exercising is taking place. If it is indoors the rooms temperatures in most fitness facilities is set at an optimum temperature conducive to high intensity aerobic training.

If it is outdoors the temperature could be quite hot and if so the fitness condition level of the client should be taken into account and the exercising closely monitored so as not to have the client overheat when exercising.

Because the body uses sweat to keep cool, the body needs to take in water to replace the water being expelled by sweating, This is called 'rehydration'.



MODIFY APPROACH TO FITNESS PROGRAMMING ACTIVITIES AND ADVICE AS REQUIRED

Except for the obvious differences between a male and a female body, the anatomical structures of all clients are the same.

As your anatomical and physiological knowledge increases and the opportunities to apply that knowledge increases you will find that how you initially developed fitness programs may change over time.

Your approach to developing fitness programs becomes more confident and more focused, generally due to your stronger anatomical and physiological knowledge.

As your experience increases and your client base grows you will find your stronger anatomical and physiological knowledge allows you to create more personalised fitness programs, where as in the past you may have had a more generalist approach.

Also, other more experienced fitness trainers often share their new experiences, methods and approaches and these should always be noted and considered as you progress through your fitness career.

SAMPLE SAMPLE

SAMPLE

**Learning
Activity**

Research

LEARNING ACTIVITY ELEVEN

In this activity we want you to do some research and tell us below what a 'reflex arch' is.

TEACHER / TRAINER GUIDANCE NOTES

Reflex arcs are nerve impulses that are not sent from the brain, instead originate within the spinal cord.

When the safety of the human body demands a very quick response, the nerve impulses may be passed directly from a sensory neuron (nerves that send signals relating to sight, sounds, feelings, etc.), via a relay neurone, to a motor neurone (nerves that sends signals to muscles) for instant, unthinking action. This is a reflex action.

A reflex arc is the nerve pathway which makes such a fast, automatic response possible. Example of reflex actions are if you touch something hot, the hand is immediately pulled back or if you start to lose your balance, muscles start to react to place your body upright again.

**Learning
Activity**

Research

LEARNING ACTIVITY TWELVE

In this activity we want you to do some research and tell us what a 'stretch reflex' is and how does it work in a fitness application.

SAMPLE SAMPLE

TEACHER / TRAINER GUIDANCE NOTES

Reflex arcs are used when a muscle is being stretched and to avoid it being stretched too far the nerves send out impulses to cause tell the body to stop stretching and causes the muscle to contract to a safe length.

This is called 'stretch reflex'.

When the muscle is stretched, so is the muscle spindle (sensory nerves at the ends of the muscles). The muscle spindle records the change in length (and how fast) and sends signals to the spine which convey this information. This triggers the stretch reflex which attempts to resist the change in muscle length by causing the stretched muscle to contract.

This basic function of the muscle spindle helps to maintain muscle tone and to protect the body from injury.

One of the reasons for holding a stretch for a prolonged period of time is that as you hold the muscle in a stretched position, the muscle spindle becomes accustomed to the new length and reduces its signalling. Gradually, you can train your stretch receptors to allow greater lengthening of the muscles.

Section Three

Maintain and Update Knowledge of Anatomy Principles

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SAMPLE ONLY

SAMPLE SAMPLE

SELF ASSESSMENT

Self assessment is where you ask yourself certain questions to ensure you have understood what you have learned while reading this manual and completing the learning activities.

This unit requires you the student or trainee at the completion of your training to have a certain level of 'Required Knowledge' in which you would be need to have acquired and in which you will be assessed on.

This self assessment section reviews this required knowledge by way of questions and if you are able to say YES to all of them you can be confident your assessment will be satisfactory.

- ☆ Do you remember what the term anatomy and physiology refer to, as well as why knowledge in these areas will be an important asset in developing a career in the fitness industry?
- ☆ Can you recall the various reasons why a fitness professional should develop and continue to constantly maintain a strong knowledge of anatomy and physiology during their career as a fitness instructor?
- ☆ Are you able to explain the situations earlier in your fitness career that will become a large part of acquiring and using knowledge of anatomy and physiology?
- ☆ Do you know the differences between the following types of injuries a client may sustain;
 - a) Acute?
 - b) Chronic?
- ☆ Can you describe what the two main types of exercise are, as well as how the following types of muscle hypertrophy differ;
 - a) Myofibrillar hypertrophy?
 - b) Sarcoplasmic hypertrophy?
- ☆ Are you able to understand in what ways a fitness instructor may make considerations regarding injury preventing techniques in the following areas of a clients instruction and programming:
 - a) Warm ups/Cool downs?
 - b) Unconditioned clients?
 - c) Recovery periods?
 - d) Clients troubles spots?
- ☆ Do you remember what the term 'Kinetics' refers to, as well as how having a knowledge of it can assist in creating fitness programs for clients in order to improve posture and increase effectiveness in their programs?

- ☆ Can you recall why it is important that a fitness instructor attempts to learn as quickly as possible in the earlier stages of their career to develop a comprehensive knowledge base of anatomy and physiology?
- ☆ Are you able to explain why a fitness trainers program for clients will improve over time when they apply their on-going knowledge of anatomy and physiology?
- ☆ Do you know which registration bodies fitness professionals generally align themselves with and what types of professional development courses do they encourage members to attend?

If there were any questions that you were unable to confidently say YES to, we encourage you to review the information again in this manual and if needed seek the assistance of your teacher or trainer.

Glossary

Anatomical and Physiology Terminology

SAMPLE SAMPLE

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ANATOMICAL TERMINOLOGY

- ☆ **Anatomical position** – the position with the body standing erect, feet together, with the arms at the side, the palms forwards and thumbs facing outwards.
- ☆ **Anatomical position** - **Superior** – the part is above another or closer to head (cranial)
Vs.
- ☆ **Anatomical position** - **Inferior** – the part is below another or towards the feet (caudal)
- ☆ **Anatomical position** - **Proximal** – used to describe a part that is closer to the trunk of the body or closer to another specified point of reference than another part (the elbow is proximal to the wrist)
Vs.
- ☆ **Anatomical position** - **Distal** – a particular body part is farther from the trunk or farther from another specified point of reference than another part (fingers are distal to the wrist)
- ☆ **Anatomical position** - **Lateral** – towards the side with respect to the imaginary midline dividing the body into equal right and left sides (the ears are lateral to the eyes)
Vs.
- ☆ **Anatomical position** - **Medial** – relates to the imaginary midline dividing the body into equal right and left halves (the nose is medial to the eyes)
- ☆ **Anatomical position** - **Superficial** – means situated near the surface.
Vs.
- ☆ **Anatomical position** - **Deep** – used to describe parts that are more internal
- ☆ **Planes of movement** – sagittal (divides the body into left and right sections), frontal (divides the body into anterior and posterior sections), horizontal (divides the body into superior and inferior sections)

MOVEMENT TERMINOLOGY AND MUSCLE ACTIONS

- ☆ **Flexion** – bending movement at a joint
- ☆ **Extension** – straightening out: making a flexed part straight
- ☆ **Abduction** – movement away from the body axis
- ☆ **Adduction** – movement toward the midline
- ☆ **Pronation** – turning the palm posteriorly, or downward
- ☆ **Supination** – turning the palm upward
- ☆ **Dorsiflexion** – bending the foot so the toes move upward toward the shin
- ☆ **Plantarflexion** – bending the foot so the toes move downward
- ☆ **Circumduction** – the proximal end is fixed while the distal end moves in a circle
- ☆ **Inversion** – turning inward
- ☆ **Eversion** – turning outward

STRUCTURAL LEVELS OF BODY ORGANISATION

Cells

- ☆ Are the basic unit of structure and function in living things
- ☆ May serve a purpose function within the organism
- ☆ Examples – blood cells, nerve cells, bone cells, etc.

Tissues

- ☆ Made up of cells that are similar in structure and function and which work together to perform a specific activity
- ☆ Examples – blood, nerves, bones, etc.

Organs

- ☆ Made up of tissues that work together to perform a specific activity
- ☆ Examples – heart, brain, skin, etc.

Organ systems

- ☆ Groups of two or more tissues that work together to perform a specific function for the organism
- ☆ Examples – circulatory system, nervous system, skeletal system, etc

Organisms

- ☆ Entire living things that can carry out all basic life processes. Such as; take in materials, release energy, release waste, grow, respond to environment and reproduce
- ☆ Example – humans, plants, animals, bacteria

FUNCTIONS OF MAJOR MUSCLES DURING EXERCISE AND MOVEMENT

- ☆ **Agonist** – a muscle that causes motion
- ☆ **Prime mover** – group of agonist muscles that have the major responsibility for movement
- ☆ **Antagonist** – a muscle that can move the joint opposite to the movement produced by the agonist muscle
- ☆ **Synergist** – a muscle that assists another muscle to accomplish a movement with added force and to reduce undesirable or unnecessary movement
- ☆ **Fixator** – these are synergist muscles that immobilise a bone or muscle's origin

TYPES OF MUSCLE CONTRACTIONS

- ☆ **Isotonic** – muscle contractions generate force by changing the length of the muscle which enable movement and can be either *concentric* (causes muscles to shorten, thereby generating force, as when lifting a weight) or *eccentric* (cause muscles to elongate in response to a greater opposing force, as when slowly lowering a weight)
- ☆ **Isokinetic** – muscle contractions such as isotonic, but that change length during the contraction at a constant speed. Used mostly at rehabilitation centre or specialist sport training facilities
- ☆ **Isometric** – contractions generate force without changing the length of the muscle, as when holding a weight in one position for a period of time

TISSUE TYPES

- ☆ **Connective** – protect, support and binds body parts together
- ☆ **Muscle** – produce movement of parts or whole of body
- ☆ **Nervous** – receive stimuli and coordinates bodily functions
- ☆ **Epithelial** – lines body cavities and covers body surfaces

BODY SYSTEMS

- ☆ **Cardiovascular** – The heart pumps blood and blood vessels transport it. Blood carries oxygen, carbon dioxide, nutrients, waste and more throughout the body (heart, blood vessels)
- ☆ **Musculoskeletal** – made up of the following;
 - ◆ Muscular system maintains posture and produces movement. Produces heat. (skeletal muscles)
 - ◆ Skeletal system supports and protects the body's organs. Provides a framework muscles use. Bones also store minerals and create blood cells (Bones, joints)
- ☆ **Nervous** – Control system of the body, responds to internal and external changes and activates muscles and glands (brain, spinal cord, nerves)
- ☆ **Digestive** – Breaks down food to be absorbed and eliminates indigestible waste (oral cavity, esophagus, liver, stomach, small intestine, large intestine, rectum, anus)
- ☆ **Respiratory** – Removes carbon dioxide and continually supplies blood with oxygen. Gaseous exchanges occur in the respiratory system which are the lungs. (nasal cavity, pharynx, larynx, trachea, bronchus, lungs)

STRUCTURE AND FUNCTION OF MUSCLES

Muscles types and classification:

- ☆ **Cardiac**; muscle tissue forms the bulk of the wall of the heart. It is striated(containing alternating light and dark bands, striation) Contraction is not under conscious control, or involuntary.
- ☆ **Smooth**; muscles located in the walls of hollow internal structures such as blood vessels, stomach intestines, bladder. Non-striated (smooth) and contractions usually involuntary.
- ☆ **Skeletal**; attached to bones. They are striated, (alternating light and dark bands, striation) Are able to be contracted or relaxed by conscious control, or voluntary.

Global and local muscular systems:

- ☆ **Local muscles**; are usually deeper and closer to the joint. Are attached directly to the joint capsules and do lengthen very little, primary role is to stabilise the joint during movement.
- ☆ **Global muscles**; more superficial and tend to be larger in size. Primary role is to move the joints. Responsible for transferring and balancing external loads and for bigger movements.

Major muscle groups:

- ☆ **Abdominal** – Location – stomach – Function – sitting up, postural alignment
- ☆ **Biceps** – Location – front of upper arm – Function – lifting, pulling
- ☆ **Deltoids** – Location – top of shoulder – Function – Overhead lifting
- ☆ **Erector Spinae** – Location – Low back – Function – postural alignment
- ☆ **Gastrocnemius & Soleus** – Location - back of lower leg – Function – push off for walking, standing on tiptoes
- ☆ **Gluteus** – Location – buttocks – Function – climbing stairs, walking, standing up
- ☆ **Hamstrings** – Location – thigh-back – Function – walking
- ☆ **Latissimus Dorsi & Rhomboids** – Location – back, lats are the large triangular muscle in the midback. Rhomboids are between the shoulder blades – Function – postural alignment, pulling open a door
- ☆ **Obliques** – Location – side of body – Function – rotation and side flexion of body
- ☆ **Pectoralis** – Location – front of chest – Function – push up from lying position, push open a door
- ☆ **Quadriceps** – Location – Thigh, front – Function – climbing stairs, walking, standing up
- ☆ **Trapezius** – Location – large muscle in upper and mid-back – Function – moves head sideways
- ☆ **Triceps** – Location – back of upper arm – Function – pushing

Contractibility and activation:

- ☆ **Contractibility**; enables a muscle to become shorter or thicker, and this ability, along with interaction with other muscles, produces movement of internal and external body parts.
- ☆ **Activation**; an approach to identify and treat muscular imbalances through therapy. Primarily promotes increased mobility, flexibility and posture.

STRUCTURE AND FUNCTION OF NERVOUS SYSTEM

Nerves and nerve impulses:

- ☆ **Nerves**; bundles of fibres in the body that transmit impulses or sensation to the brain or spinal cord and impulses these to the muscles and organs.

Reflex arcs and relationship to stretching

- ☆ **Reflex arcs**; Reflex arcs are nerve impulses that are not sent from the brain, instead originate within the spinal cord.

STRUCTURE AND FUNCTION OF SKELETAL SYSTEM

Types of bones:

- ☆ **Short bones**; approx. cube-shaped. Length is similar to width/depth/diameter. Examples, hands/wrists (carpel bones), feet/ankles (tarsal bones)
- ☆ **Long bones**; longer than they are wide. Shaft like, main part(long) with variety of endings (extremities) depending on the joints formed at either/both ends of the long bone. Examples, leg bone (femur), arm bone (humerus)
- ☆ **Sesamoid bones**; develop in some tendons in locations where there is considerable friction, tension and physical stress. Common areas are in palm of hand or soles of feet. Most are un-named, but the kneecap (patella) is one example.
- ☆ **Flat bones**; thin shaped and may provide mechanical protection to soft tissues beneath or enclosed by them. Examples, bones protecting the brain (Cranial) bones protecting muscle attachments such as shoulder (scapulae)
- ☆ **Irregular bones**; more complicated shapes that are due to the functions they fulfil. Example, bones that support the body as well as the spinal cord. Vertebrae or back bones (Axis bone, ect)

Major bones:

- ☆ **Clavicle**—A doubly curved short bone that connects the upper arm (at the shoulder) to the body, right above the first rib. Also known as the collar bone.
- ☆ **Cranium**—The cranium is also referred to as the skull. The cranium supports the structures of the face and protects the head from injury.
- ☆ **Femur**—The thigh bone, extending from the hip to the knee. It is the largest and strongest bone of the body.
- ☆ **Fibula**—The fibula is located on the outer side of the lower leg. It is smaller than the tibia and attaches below the tibia and forms the outer part of the ankle joint.
- ☆ **Humerus**—The upper arm bone. The longest and largest bone of the upper body.
- ☆ **Ilium**—The Ilium is the uppermost and largest bone of the pelvis. It is often referred to as the hip bone.
- ☆ **Mandible**—The mandible forms the lower jaw and holds the lower teeth in place.
- ☆ **Patella**—A flat triangular bone located at the front of the knee joint. Also called kneecap. Protects and covers the knee joint.
- ☆ **Radius**—The radius is located on the thumb side of the forearm. The radius is the forearm bone of the hand.
- ☆ **Ribs**—The ribs are long curved bones which, along with the sternum, form a ribcage. They enable the lungs to expand and they also protect the lungs, heart and other internal organs.
- ☆ **Sacrum**—The sacrum is a large bone that is located at the base of the spine and at the upper back part of the pelvis where it is inserted between the two hip bones, or two Iliums.
- ☆ **Scapula**—The bone, located on the upper back that connects the humerus with the clavicle. Often referred to as the shoulder blade.
- ☆ **Sternum**—A long flat bone in the middle of the chest. Supports the clavicle. The sternum along with the ribs form the rib cage that protects the heart, lungs and major blood vessels from damage.
- ☆ **Tibia**—The tibia is the second largest bone in the body. The tibia is located on the inside of the lower leg. It connects the knee with the ankle bones. It is also known as the shin bone.
- ☆ **Ulna**—The ulna is located on the little finger side of the forearm. The ulna is the forearm bone of the elbow.

Bony landmarks:

Meaning 1—The body landmarks are bony areas that show at the surface of the body. They are called landmarks because they don't change much between different body types. It's the muscle and fat tissue that shows the most dramatic changes.

The landmarks include:

- ☆ Skull
- ☆ Clavicle
- ☆ Scapula
- ☆ Sternum
- ☆ Humerus
- ☆ Radius and ulna
- ☆ Spine
- ☆ Ribs
- ☆ Hand and wrists
- ☆ Sacrum / coccyx (also known as the tailbone)
- ☆ Pelvis
- ☆ Femur
- ☆ Tibia and fibula
- ☆ Ankle and foot

Meaning 2—A groove or prominence on a bone that serves as a guide to the location of other body structures. These structures allow for the passage of blood vessels and nerves, for joints between bones or for the attachments of ligament, muscles and tendons.

Major joints

- ☆ **Fibrous joints (immoveable)** - This type of joint is held together by only a ligament. An example is the lower arm's ulna and radius are held together with a fibrous joint. The parts of the skull is another example and these fibrous joints are called 'sutures'. Another final example are teeth. The teeth are held into their jaw sockets by way of a fibrous ligament.
- ☆ **Cartilaginous (partially moveable)** - These joints occur where the connection between the articulating bones is made up of cartilage for example, between vertebrae in the spine.
- ☆ **Synovial (freely moveable)** - Synovial joints are most common type of joint within the human body. They are highly moveable and all have a synovial capsule (socket) surrounding the entire joint, a synovial membrane (the inner layer of the socket) which secretes synovial fluid (a lubricating liquid) and cartilage which pads the ends of the articulating bones.

STRUCTURE AND FUNCTION OF CARDIOVASCULAR SYSTEM

Heart and blood vessel anatomy:

- ☆ The heart and blood vessels make up the cardiovascular system. A heart works as a pump that pushes blood to the organs, tissues, and cells of a body. Blood is carried from the heart to the rest of the body through a complex network of arteries, arterioles and capillaries. Blood is returned to the heart through venules and veins.

Circulation pathways:

- ☆ Twenty major arteries make a path through tissues, where they branch into smaller vessels called arterioles. Arterioles further branch into capillaries, the true deliverers of oxygen and nutrients to the cells.
- ☆ Once the capillaries deliver oxygen and nutrients and pick up carbon dioxide and other waste, they move the blood back through wider vessels called venules. Venules eventually join to form veins, which deliver the blood back to the heart to pick up oxygen
- ☆ The one-way system carries blood to all parts of a body. This process of blood flow within the body is called circulation. Arteries carry oxygen-rich blood away from the heart and veins carry oxygen-poor blood back to the heart.
- ☆ In pulmonary circulation, though, the roles are switched. It is the pulmonary artery that brings oxygen-poor blood into the lungs and the pulmonary vein that brings oxygen-rich blood back to your heart.

Role of blood:

- ☆ Blood delivers oxygen and nutrients to every cell and removes the carbon dioxide and waste products made by those cells.

STRUCTURE AND FUNCTION OF RESPIRATORY SYSTEM

Mechanics of breathing:

- ☆ The general definition of breathing mechanics is the action of breathing in and out due to pressure changes within the thorax in comparison with the outside.

Respiratory volumes:

- ☆ Respiratory volume is defined as tidal volume and residual volume. Tidal volume is the volume of air inhaled in a single, normal breath. Residual volume: the volume of air remaining in the lungs after a maximal exhalation.
- ☆ The two other types of residual respiratory volumes are inspiratory reserve volume which is the amount of extra air inhaled (above tidal volume) during a deep breath and expiratory reserve volume which is the amount of extra air exhaled (above tidal volume) during a forceful breath out.

ENERGY SYSTEMS, PATHWAYS AND SUBSTRATES

- ☆ Aerobic and anaerobic exercises use different energy systems in the body. The anaerobic energy system provides energy in the absence of oxygen. This system is used to provide energy when the aerobic system (where there is sufficient available oxygen) is insufficient. There are two systems within anaerobic metabolism:
 - ◆ ATP-PC system
 - ◆ Lactic acid system
- ☆ Aerobic respiration would use carbohydrates first, then fats and then protein (that is converted to amino acids). These are called 'substrates' of the energy system.

THERMOREGULATION OF THE HUMAN BODY

- ☆ Thermoregulation is the bodily process that allows the human body to maintain its core internal temperature. In humans that core temperature is 36.5°F.

POSTURAL ALIGNMENT AND PATHOLOGICAL POSTURES

- ☆ **Postural alignment** can be determined by drawing an imaginary line through a body standing sideways and connecting the ear lobe, anterior shoulder, lumbar spine, posterior hip, anterior knee and anterior ankle.
- ☆ **Pathological postures** include:
 - 1—**kyphosis** : abnormal posterior curvature of the thoracic spine (humped-back condition)
 - 2—**lordosis** : abnormal anterior curvature of the lumbar spine (sway-back condition)
 - 3—**scoliosis** : abnormal lateral curvature of the spine (S-shaped curve)

NOTES

SAMPLE SAMPLE