Assessor Marking Guide

Programme Name	**Health and Fitness Coach (Personal Trainer) (Level 4)**	
Assessment Number	**01A2**	
Assessment Title	**Functional Anatomy and Energy Systems**	
Course Number	**Course 1**	**Version 2** **Level 4** **Credit 10**
Course Title	**Anatomy & Physiology**	

Internal feedback related to design of assessment tools should be submitted via the online Continuous Improvement Form (eCIF).

This assessment leads to the following graduate profile and learning outcomes.

NZQA GPO	Learning Outcome	Assessment Standard	Task #
GPO 2 Apply knowledge of anatomy and physiology to adapt and deliver safe and effective exercise programmes to individuals. (15 credits)	**1.1** Identify and describe the structure and function of major systems of the human body and their physiological responses (acute and chronic) to exercise *Contributes 3 GPO credits* **1.2** Differentiate clearly, the energy systems in use during different forms of exercise *Contributes 3 GPO credits*	Demonstrate a clear understanding of key body organ systems and their functions	All questions

NZQF Level 4 Descriptors	
Knowledge	• Broad operational and theoretical knowledge in a field of work or study
Skills	• Select and apply solutions to familiar and sometimes unfamiliar problems. • Select and apply a range of standard and nonstandard processes relevant to the field of work or study.
Application	• Self-management of learning and performance under broad guidance. • Some responsibility for performance of others.

ADMINISTRATION

Assessors are required to provide feedback to students:

- Constructive feedback to the student must be documented within assessment evidence. Including where resubmission is required.
- Notes on demonstrated performance and application of skills, knowledge, attributes; future improvement/development planning e.g., task management, study skills; relationship to other programme content and use in career.

Student evidence must be assessed against all specified criteria to meet learning outcomes.

- Any adaption in assessment methods must be documented and attached to the assessment by the assessor (where deemed necessary to be fair and transparent in relation to student's specified needs).

- Assessment Pack Cover should be dated and signed by assessor when the student has received the final result.
- Assessment opportunities must be indicated accurately.
  Where any practical criteria are not achieved, an additional practical sheet must be used for reassessment for all practical outcomes and attached to this assessment pack. Refer to Assessment opportunities policy for additional detail.
- The student must sign the post-assessment agreement after receiving final result.
- It is the Assessors responsibility to ensure all relevant documentation is included in the assessment prior to reporting and filing.
- Samples of assessments will be forwarded to internal and/or external parties for moderation as required.

Where appropriate **sample answers and or exemplars** may be included: Sample answers are a guide only providing an example of the sufficiency of quantitative and qualitative evidence the assessor could expect to see.

ASSESSMENT SCHEDULE *Give feedback to student on successes, for N add a note to the student on here or on their assessment evidence (e.g. in Turnitin) about how to improve for resubmission.*	
Task Evidence	**Achievement Criteria / Judgement**
1	1) Learner has described the impact of sport or training on the strength of bones. In their answer they have discussed bone remodelling and mechanical stress (minimum 50 words).
	2) For each of the following terms, the learner has provided a brief explanation as well as two example exercises: strain magnitude, strain velocity, and strain frequency.
	3) Learner has correctly identified a health condition related to poor bone health, described it, and outlined 3 risk factors that contribute to its development (minimum 75 words)
2	4) Learner has described the autonomic nervous system and the role it plays in exercise (minimum 50 words). Answer includes: a. identifying and describing the two divisions b. describing the response of each division to exercise.
	5) Learner has described the function of chemoreceptors and related it to exercise (minimum 50 words).
	6) Learner has a) identified the correct function of the nervous system that is adapting in this situation and b) briefly explained this process in their own words (minimum 50 words)
3	7) Learner has correctly identified the acute change/response that occurs during exercise and described the purpose of this in an exercise context for a. heart rate b. stroke volume c. ventilation rate d. blood pressure/distribution
	8) Learner has described the chronic change that endurance exercise has on the cardiovascular system. Answers mention changes to the heart muscle, blood vessels, and link to performance (minimum 80 words)
	9) Learner has described the chronic changes to the respiratory system. Answers should mention respiratory muscles, pulmonary capillaries, and the lungs (minimum 80 words).
4	10) Learner has correctly identified the prime mover for the following exercises: leg extensions, shoulder press, hip extension, bench press, pull ups, and leg curls

	11) Learner has correctly identified the correct type of contraction occurring during the following movements: upward portion of a squat, prone hold, pulling the bar down in a Lat Pull Down, Down phase of a hamstring curl, upward phase of bench press, wall sit, downward phase of a sit-up, standing on your toes for 10 sec
	12) Learner has identified and described two adaptations of the skeletal muscle fibres after training for 3 months. Answer is linked to muscle fibre types.
5	13) Learner has provided a description for the ATP-PC system including a. The need for oxygen b. Alternative names c. Fuel for the system d. How long we can use the system for e. The work:rest ratio
	14) Learner has provided a description for the glycolytic system including a. The need for oxygen b. Alternative names c. Fuel for the system d. How long we can use the system for e. The work:rest ratio
	15) Learner has identified and described an appropriate test for the glycolytic system. In their answer they have included the equipment used and a brief description of the testing protocol (80 – 100 words)
	16) Learner has identified and described an appropriate test for the aerobic system. In their answer they have included the equipment used and a brief description of the testing protocol (80 – 100 words)
	17) Learner has identified one (1) exercise, described how the exercise trains the energy system, and outlined an example protocol for the training mode for the following energy systems: a. ATP-PC b. Glycolytic c. Aerobic

Sample answers are provided below:

Task 1 – Skeletal system

1. How can the type of sport or training you do impact the strength of your bones? In your answer include the following: bone remodelling and mechanical stress. (Minimum 50 words)

Learners may include the following concepts in their answers and meet word count:

- Bone is a dynamic living tissue that must continue to remodel over time.
- Performing loaded exercises like dancing, running, or skipping are weight-bearing activities exercises where your bones need to support your weight
- When placed under mechanical stress bone becomes stronger over time as there is an increased rate of bone production
- Exercise must create stress on the bone to elicit a remodelling response – some exercises are not weight bearing at all, such as cycling or swimming, where some are highly stressful on the bones, such as running.

2. Provide a brief explanation (minimum 20 words each) of the terms strain magnitude, strain velocity, and strain frequency and provide at least two example exercises for each term.

Term	Explanation	Example exercise/sport
Strain magnitude	This term refers to the AMOUNT or how much stress/force/impact is placed on the bones. Typically, higher strain magnitude exercises include external loading of weight but not always	Weightlifting, contact sports, powerlifting, individual exercises such as barbell back squats, deadlifts, bench press etc may also be mentioned
Strain velocity	This term refers to the speed or rate at which impact is placed on the bones. Exercises that are high strain velocity include quick powerful movements.	Plyometrics, jumping, skipping, sprints, box jumps/depth jump, power movements
Strain frequency	This term refers to the frequency or number of repetitions of impact placed on the bones. High strain frequency exercises usually involve running	Anything where running is involved – most ball sports, downhill running, high repetitions of stepping movements, skipping

3. Identify a health condition related to poor bone health, describe it, and outline at least three risk factors for developing it. (Minimum 75 words)

Learners may identify osteopenia or osteoporosis and outline what occurs – bone degradation over time, loss in bone density, bone building is slower than bone breakdown etc. Some learners may identify other bone conditions not related to exercise, however

Risk factors include age (over 50), being female, lack of nutrition – specifically low calcium and vitamin D though other factors like low protein, iron, and vitamin A also contribute, lack of weight-bearing exercise specifically

Task 2 – Nervous system

4. Briefly describe the autonomic nervous system and explain the role it plays in exercise. In your answer (minimum 80 words):

a. Identify and describe the two divisions of this system
b. Describe how each division will respond to the stimulus of exercise

Example answer structure:

a. The autonomic nervous system is the system that we do not voluntarily control. The two divisions of the autonomic nervous system are sympathetic and parasympathetic nervous systems. The sympathetic nervous system is responsible for the "fight, flight, or fright" response – automatic responses to an external stimulus. The parasympathetic nervous system stimulates "rest and digest" responses in the body such as stimulating digestive organs and slowing heart rate.

b. Exercise (even thinking about performing exercise – such as standing at the start line of a race) stimulates the sympathetic nervous system to signal different body systems – such as the heart (increase heart rate) to pump more blood around the body and increasing rates of glycogen breakdown to access glucose. The parasympathetic nervous system is inhibited or down regulated during exercise.

Learners may discuss other organs that are stimulated by sympathetic nervous system activity during exercise such as:

- Cardiac output increases and vasodilation
- Increase in blood pressure
- Ventilation rate
- Increase in metabolic rate

5. Describe the function of peripheral chemoreceptors during exercise. In your answer explain what happens when we begin an exercise session (e.g., warming up on the treadmill before doing weights) and our oxygen requirements increase. (Minimum 50 words)

Chemoreceptors detect changes in the internal environment – in particular relating to oxygen levels in the blood.

When we start warming up, our muscles start to use more oxygen in order to perform aerobic metabolism – chemoreceptors found on the inside of large arteries (aorta and carotid artery) detect this change in oxygen levels and signal the brain to signal our respiratory and cardiovascular system to work harder to supply more oxygen to the muscles

6. Your client Sam has completed their first block of hypertrophy/strength training and has improved in strength dramatically over the first six weeks. Most of the gains they are experiencing are from neuromuscular adaptations.
    a. Identify which function of the nervous system you are witnessing
    b. Explain in your own words the physiological changes that are occurring – include at least two (2) points in your answer. (Minimum 50 words)

Use the following link to help you start your research:
https://www.ptdirect.com/training-design/anatomy-and-physiology/chronic-neuromuscular-adaptations-to-exercise

a) The function here is memory and learning.
b) The body is becoming more integrated and coordinated during this time – for example, we see an increase in the recruitment of additional motor units – this helps improve force production, we also see an increase in assisting muscles (synergistic muscles) helping the prime movers during a lift.

Students may include information from the following source, but it must be in their own words as much as possible:

Nerve–muscle connections	• Increased recruitment of additional motor units, which respond in a simultaneous fashion to improve force production. • There is an increased activation of synergistic muscles to assist force production for strength, power, speed and hypertrophy. • Neural pathways linking to target muscles become more efficient at transmitting the message (stimulus).
Timing of neural stimulus	• The timing of contractions becomes more co-ordinated, especially with power, speed and strength training, in order to meet the force generation required to move loads.
Summation of motor units	• The ability to summate (fire a lot of impulses in target muscles all at once) is improved with strength and power training because they require maximum activation of target muscles to create maximum force.
Neuromuscular fatigue	• Effective integration of multiple body segments to create explosive movements or lift heavy loads requires more neuromuscular involvement than any other training; hence strength, power, speed and hypertrophy training are the best types of training to improve the neuromuscular systems resistance to fatigue.

PT Direct. (2020). *Neuromuscular Adaptations to Exercise*. Ptdirect.com. https://www.ptdirect.com/training-design/anatomy-and-physiology/chronic-neuromuscular-adaptations-to-exercise

Task 3 – Cardiovascular and Respiratory systems

7. For the following measurements of the cardiovascular and respiratory systems, identify the **acute** change that occurs during exercise and briefly describe the purpose of this change

Factor	Effect of exercise
a) Heart rate	Heart rate will increase – this is to deliver more blood to muscles (containing oxygen, glucose etc)
b) Stroke volume	Increases – to be more efficient in delivering more blood per pump
c) Ventilation rate	Increases – enables better delivery of O2 and removal of CO2
d) Blood pressure and blood distribution.	Systolic increases, diastolic should remain the same – again to assist in delivery of blood to the correct areas, directs blood to the appropriate places. More blood distributed to muscles and less to areas like the digestive system (related to blood pressure)

8. Your client Aroha has been running 3 times a week, slowly building up her endurance capacity over the past 8 weeks. Describe the **chronic** changes that would have occurred to the anatomy and physiology of her cardiovascular system after this training block. Answers should include comments on the heart muscle, blood vessels, and overall performance. (Minimum 80 words)**.**

Aroha's heart will experience "cardiac hypertrophy" or increase in size of the heart muscle. This means her heart will be able to pump blood more efficiently. The heart will also become more elastic and able to expand and receive more blood, this will in turn increase stroke volume at rest and during exercise. The blood vessels will become more pliable allowing blood to flow easier. All of these changes combined will help improve performance over time as she is better at delivering blood, oxygen, and nutrients to the correct places.

9. Aroha is now wondering what kind of changes are occurring to her respiratory system. Describe the **chronic** changes that have been occurring to the anatomy and physiology of her respiratory system during this training block. Answers should include comments on respiratory muscles, capillaries in the lungs, and the lungs themselves (minimum 80 words)**.**

Aroha's respiratory system will exhibit the following changes over time: improved strength of respiratory muscles – able to take in bigger breaths and force out air more efficiently, better elasticity of the lungs which enables more air in and out, and also higher red blood cell counts (though this is technically CV system related). This will show up in an increase of pulmonary ventilation and pulmonary diffusion, meaning more air is getting into the lungs and more oxygen crossing into the blood.

Task 4 – Muscular system

10. Identify the prime mover (agonist) muscle/muscle groups for the following exercises:

Exercise	Prime mover (Answers below)
Leg extensions	Quadriceps, quads
Shoulder press	Deltoids (students may write anterior/medial also)
Hip extension	Gluteus maximus, gluteal group, glutes
Bench press	Pectoralis major
Pull ups	Latissimus Dorsi
Leg curls	Hamstrings, Biceps femoris, semi – tendinosus or membranosus

11. Identify the type of contraction occurring during the phase or exercise phase listed in the left column

Exercise (or exercise phase)	Type of contraction (answers below)
Upward portion of a squat	Concentric isotonic
Prone hold	isometric
Downward phase of a Lat Pull down	Concentric isotonic
Down phase of hamstring curl	Eccentric isotonic
Upward phase of a Bench press	Concentric isotonic
Wall sit	Isometric
Downward phase of a sit up	Eccentric isotonic
Standing on your toes for 10 sec	Isometric

12. Your client Aroha is now interested in preparing for a triathlon. Identify and describe two (2) adaptations you would expect to see within her skeletal muscle fibres after training this way for 3 or more months? Link your answer to the muscle fibre types.

The muscle fibres that would adapt from this type of training are the type 1 muscle fibres. They would develop more mitochondria and more capillaries which would mean more oxygen is delivered to the muscles and able to be used for fat oxidation.

Task 5 – Energy Systems

Example answer: ***Aerobic energy system***

The aerobic energy system requires oxygen to help break down fuel sources to release ATP. It is also known as the oxidative system because of it's need for oxygen to work. The fuels used by the aerobic system are glucose and fatty acids. We use the aerobic system all the time at low intensities, but when performing and moderate intensities the aerobic system will kick in at around the 2-minute mark, during this time you may notice a dip in performance output. The work:rest ratio for this system is 1:1 due to it usually being used at lower intensities. The aerobic system can last almost indefinitely as long as fuel sources such as glucose and fatty acids are available.

13. In your own words, describe the ATP-PC system including the following details:
    a. Whether they need oxygen
    b. Alternative names
    c. What fuels the system
    d. How long can we use this system for?
    e. What is the work to rest ratio for this system?

Description (points a – e above)
a) The ATP-PC system is anaerobic, therefore does not require oxygen. b) Alternative names for this system include phosphagen system or the phosphocreatine system. c) The fuel for this system is through the breakdown of creatine phosphate to donate a phosphate group to convert ADP → ATP. d) We are only able to do this for a short period of time (up to 15 seconds) e) The work:rest ratio for training this system is 1:10/12 – so if someone does a 10 second sprint, they will need to follow that with a 100 – 120 second rest. https://www.ptdirect.com/training-design/anatomy-and-physiology/the-atp-pc-system

14. In your own words, describe the glycolytic system including the following details:
    a. Whether they need oxygen
    b. Alternative names
    c. What fuels the system
    d. How long can we use this system for?
    e. What is the work to rest ratio for this system?

Description (points a – e above)
a) This system is anaerobic which means without oxygen. **b)** It is also known as the anaerobic lactic acid system or lactic energy system. **c)** It is fuelled primarily by glucose through glycolysis – which just means to break down glucose. During this process it produces more ATP than the ATP-PC system, but not as much as the aerobic. **d)** We can use it from around 15 seconds to 2 minutes, so most of the training we do in the gym will be using this energy system (weights, circuit training etc). **e)** The work:rest ratio for this can vary **i.** 1:6 if you are wanting to completely clear the bi-products **ii.** 1:3 if you want to teach the body to clear lactate iii. If you want to teach the body to tolerate lactate you might do a 1:1 ratio or 2:1 https://www.ptdirect.com/training-design/anatomy-and-physiology/the-anaerobic-glycolytic-system-fast-glycolysis?searchterm=glycolytic

Your client is interested in performing some different types of testing for their fitness, and you want to see which energy system they perform well with. Search for one fitness test for the energy systems below (Q14 and 15) and briefly describe it in the space below. In your answer include the equipment used and the testing protocol.

Here is an example answer for ATP-PC system

To perform the vertical jump test, you will need to use a “vertical jump tester” or a “Vertec®”. To set up, you will need to take the standing height of the subject. Get the subject to stand under the Vertec with one arm fully extended upward; set the lowest vane (0) of the Vertec to the height of the top of the subjects’ fingers when they are doing reaching upwards. You then instruct the subject to jump as high as they can swinging their arms and gently tapping the vanes. You can then read the top number that they hit, and this will correlate with their jump height in either inches or cm depending on the device.

15. For the glycolytic system – identify and describe an appropriate test (80 – 100 words)

Examples of tests that would be appropriate include but are not limited to anaerobic capacity tests such as:

- 30-second Wingate test
- 10 & 30-second tri-level anaerobic tests
- 500m rowing ergo test
- Cunningham-Faulkner test — maximal treadmill test at 20% gradient.
- Bosco Ergo Jump 60 sec Repetitive Jump Test
- 100-yard (10x10) Shuttle
- 300-yard Shuttle
- 60 Yard Shuttle (NFL)
- 45 Seconds Run
- 300m run

- 400m run
- 800m run

https://www.topendsports.com/testing/anaerobic-capacity.htm

16. For the aerobic system – identify and describe an appropriate test (minimum 80 words)

Examples of tests that would be appropriate include but are not limited to aerobic capacity tests such as:

- Maximal Aerobic Tests
- Continuous tests to exhaustion
- Multistage Shuttle Run Test (see also the similar 15m Bleep, Aero Test, and PACER test. Also called the beep, bleep test etc. - see variations)
- Yo-Yo Endurance Tests — a beep-type test with rest periods developed for intermittent sports.
- Maximal Oxygen Consumption Test (VO2max) — also VO2max tests for runners, cyclists and swimmers.
- Astrand Treadmill Test
- Bruce Protocol Test
- Balke Treadmill Test
- Vmax — simplified version of the VO2max test.
- University of Montreal Track Test — the precursor beep test.
- Maximal Aerobic Speed Run Test
- VAMEVAL Test — running around a track at increasing speeds
- Birtwell 40 metre Shuttle Run
- 1200m Shuttle Test — to and from a start line to 20, 40 and 60-m marks, 5 times without a break.

https://www.topendsports.com/testing/aerobic-about.htm

Learners will need to briefly describe the test including what equipment is used as well as a brief explanation of how to run the test with a client. See the example provided for ATP-PC.

17. Training the energy systems. For each energy system in the table below, research and describe different ways you could train your future clients to improve each energy system.

In your answers include:

- At least one (1) exercise
- Describe how the exercise trains the energy system
- Outline an example protocol for this type of training

Energy system	Description
Example (you cannot use this in your answer)	*(Track and field): 200m sprints, this trains the glycolytic system because it is a high intensity movement that lasts around 30 seconds. Clients will perform this at a work:rest ratio of 1:6, so if it takes 30 seconds to perform, then they rest 180 seconds (3 minutes) in between sets.*
a) ATP-PC	Clean and Jerk – this exercise trains the ATP-PC system because you typically perform this type of movement in a lower reps range. It is a powerful movement that requires quick access to energy. The work to rest ratio for this would be 1:10 – so a client may perform 3 reps (up to 15 seconds) and then rest for 150 seconds (2.5 minutes) before starting their next step.

b) Glycolytic system	To test lactic acid tolerance, you could set an exercise to be a work:rest ratio of 1:3 – they could work for 20 – 30 seconds going at a high intensity followed by 60 – 90 seconds rest (or at a reduced pace). Using a stationary bike would be a great use for training this system. They may repeat this 6 – 10 times depending on their training history
c) Aerobic	Interval training – running at a set pace for example if they have the goal of completing a 2.4km run in under 12 minutes they may want to train at that pace – this would be a speed of 12km/h. You could set intervals starting at 2 minutes at 12km/h on a treadmill, followed by 2 minutes walking pace (5km/h). Do this for a total of 6 sets. You can progress your client to longer running intervals until they can maintain that pace for 12 minutes at a time. This way they are training at a 1:1 work:rest ratio