VCE Physical Education
Units 3 and 4, 2025–2029

Clarification of content: Lactate Inflection Point (LIP)

Introduction

This supplementary material has been developed to guide teachers as to the approach to Lactate Inflection Point as part of VCE Physical Education (2025–2029).

The information provided specifically relates to VCE Physical Education.

Unit 3 Area of Study 2: How does the body produce energy?, This includes key knowledge of:

* the 3 energy systems (ATP-CP, anaerobic glycolysis and aerobic), including their fuels (chemical and food); rate and yield of each system; their contribution at rest and varying intensities; and recovery rates associated with active and passive recovery
* the interplay of energy systems in relation to the intensity and duration of physical activity, sport and exercise
* muscular fatigue mechanisms, including fuel depletion, accumulation of metabolic by-products and thermoregulatory fatigue linked to varied sport and exercise intensities and durations

Unit 4 Area of Study 2: How is training implemented effectively to improve performance? This includes key knowledge of:

* chronic adaptations of the cardiovascular, respiratory and muscular systems to aerobic, anaerobic and resistance training that produce improvements in:
* VO2 max
* lactate inflection point (LIP)
* speed and force of muscular contraction
* lactate tolerance.

Important considerations in teaching the concept of Lactate Inflection Point (LIP) clarification

**The following information should be considered when delivering the key knowledge and key skills related to LIP:**

1. The LIP reflects the last point where lactate entry into and removal from the blood are balanced. It is identified as the final exercise intensity or oxygen uptake value at which blood lactate concentration is relatively stable during a maximal aerobic test. The LIP of an individual represents the maximal intensity at which blood lactate is in steady state.
2. There are a number of different terms used by exercise physiologists and sports scientists to describe the inflection. These include anaerobic threshold, lactate threshold, onset of blood lactate accumulation (OBLA), maximal lactate steady state, ventilatory threshold, individual anaerobic threshold and LIP. For the purposes of VCE Physical Education the term LIP will be used.
3. The common goal of testing protocols and calculation methods to determine blood lactate levels is to identify the intensity at which lactate production exceeds lactate removal.
4. At exercise intensities beyond an individual’s LIP, blood lactate concentration increases exponentially. Exercise intensities beyond the LIP are associated with a more rapid onset of fatigue due to an increased contribution form anaerobic energy pathways to meet the ATP demands of exercise. The higher the exercise intensity performed above the inflection point, the more rapid the predicted onset of fatigue and this is believed to result from accumulation of the by-products of anaerobic metabolism, but not lactate itself.
5. Lactate is formed in the cell’s cytoplasm when a pyruvate molecule is not transferred into the mitochondria. In this scenario an enzyme converts pyruvate into lactate. Lactate is produced even in a rested state under fully aerobic conditions.
6. Lactate removal from the cell cytoplasm occurs via different mechanisms. Lactate can be re-converted to pyruvate for immediate oxidation in the mitochondria. Lactate can also be transported out of the cell into the blood. Most blood lactate is oxidised by other muscles (particularly cardiac muscle and slow twitch muscle fibres). Some of the blood lactate is converted to glucose or glycogen in the liver.
7. Lactate production in the cell increases in direct proportion to increases in work-rate. However, blood lactate concentrations remain relatively stable during sub-maximal work-rates, as the body is able to remove it at a similar rate to its appearance in the blood.
8. Blood lactate concentration inflects when the lactate that enters the blood is greater than the lactate removed (through oxidation for energy production or conversion to glucose or glycogen).
9. The cause of the LIP is speculative but coincides with a number of changes within the body such as a sudden surge in adrenaline, recruitment of fast twitch fibres to maintain the required speed or power output, and a decline in the rate at which enzymes are able to oxidise fatty acids and pyruvate in the mitochondria. A diversion of blood from lactate removal sites such as the liver may also contribute to the LIP. Insufficient oxygen supply (hypoxia) has not been shown to cause the LIP.
10. Individuals with a greater proportion of slow twitch fibres relative to fast twitch fibres have a greater ability to oxidise fatty acids in mitochondria, and in turn will have a higher LIP.
11. LIP tests provide guidance as to the training intensity required to improve endurance performance and predict the speed or power output an athlete is able to sustain for a prolonged period of time. In events exceeding 10–15 minutes duration, the relative importance of LIP to endurance performance increases. Research indicates that LIP is frequently a better predictor of performance than VO2 max.in events of extended duration.
12. An individual’s LIP can be raised by regular endurance training. Training near the LIP is an adequate training stimulus for an untrained individual, but a higher intensity is necessary for endurance-trained athletes. Most of the improvements in the LIP progressively occur over 8 to 12 weeks of training, but small changes may accrue beyond this period.
13. An individual’s LIP varies depending on their training status. LIP in untrained individuals typically occurs between 55 to 70% of VO2 max. In well-trained individuals the LIP typically occurs between 75–90% of VO2 max. Therefore with appropriate training the lactate inflection training point will occur at higher absolute exercise intensity (VO2, speed, watts) and a higher relative exercise intensity (%VO2 max.) in a more trained versus untrained athlete.
14. The adaptations that lead to an improvement in the LIP are localised to the specific muscle cells used in chronic exercise training. Greater mitochondria mass and an increased capability to oxidise fat and carbohydrate in response to endurance training and lead to an improvement in LIP.

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Figure 1. This diagram depicts the LIP detected during a maximal aerobic test. This LIP value will vary depending on the person’s fitness, the environmental conditions, the nutritional status, genetics, type of training and the intensity of the exercise. Note the LIP is also measured using other modes of exercise such as cycling and rowing. In these sports the LIP is assessed by the power output (watts).

Conclusion

LIP is a much debated and complex concept. For the purposes of VCE Physical Education (2018–2024) it is expected that students should be able to:

* define the term LIP
* identify the LIP on a graph
* understand why lactate accumulates beyond LIP
* describe the impact of exercise intensities beyond LIP on fatigue
* identify the differences in LIP between a trained and an untrained athlete
* describe how training can improve LIP.

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