I. Learning Objective
   a. Understand the concept of lactate threshold and its importance in predicting endurance and performance
   b. Learn the process of measuring lactate threshold by lactate analysis and noninvasive respiratory gas analysis

II. Definitions
   a. Lactate: an ion that remains after lactic acid disassociates a proton
   b. Lactate threshold: point during exercise of increasing intensity at which the rate of lactate production exceeds the rate of lactate clearance; point preceding an increase in lactate of >1mM with increases in intensity
   c. Onset of blood lactate accumulation (OBLA): point at which blood lactate levels reach 4.0mM during an exercise bout with increasing intensity

III. Background:
   a. Lactic acid and lactate are often used synonymously—and incorrectly. Lactate is the anion of the lactic acid molecule once it has released its proton. Within the cytoplasm and blood, lactic acid typically takes the form of lactate and H⁺. Thus, for this lab lactate will be used.
   b. Lactate is constantly produced, even in the condition of rest. For years, it was thought to be a waste product of glycolysis that caused muscle fatigue and soreness. However, lactate can be used as a fuel source like other carbon-containing compounds.
   c. As exercise intensity increases, blood lactate concentrations increase due to a number of factors, including both increased production and reduced removal. With the increase in exercise intensity, the demand for ATP increases, which can overwhelm the ability of the mitochondria to meet the need aerobically. The point where lactate production exceeds clearance is referred to as the lactate deflection point.
   d. Over the years, many methods have been developed to define and describe the lactate deflection point from an incremental tests that corresponds to endurance performance. This point can be crucial because it indicates when the individual switches from mostly aerobic metabolism to mostly anaerobic metabolism—which may hasten fatigue. As exercise intensity increases, blood lactate concentrations demonstrate an accelerated increases above resting levels. The point at which blood lactate concentrations increase nonlinearly is the lactate threshold.
   e. Endurance performance depends on an athlete’s ability to perform for extended periods of time at the highest possible intensity without experiencing the effects of fatigue and lactate accumulation. This depends on lactate threshold because they occur at a certain percentage of VO₂max and determine the point at which lactate concentrations begin to rise. LT occurs at different percentages of VO₂max for trained and untrained individuals.
   f. The clearly defined methods for determine the lactate deflection point are the OBLA and lactate threshold. OBLA is defined as the workload associated with 4 mmol·L⁻¹ during an incremental exercise test. Lactate threshold is considered to be the workload where a nonlinear increase of >1 mmol·L⁻¹ is observed in a successive workload. It is thought that OBLA typically occurs at a higher intensity and percentage of VO₂max than LT and thus LT better predicts performance lasting 60-75 minutes where OBLA better predicts those lasting 20-40 minutes.
IV. Lab Activity (Pending availability of Lactate meter)

a. Resting Lactate:
   i. Have participant sit for 3 minutes prior to taking a resting blood sample
   ii. While wearing gloves, clean the subjects’ fingertip with an alcohol swab. Wait for the alcohol to evaporate so that the blood is not mixed with the alcohol during sampling
   iii. With a lancet, prick the swabbed finger and pulse-squeeze to obtain a drop of blood.
   iv. Place the lactate analyzer strip in contact with the drop of blood to begin measurement. Capillary action should draw a blood sample into a reservoir in the strip.
   v. Wipe any remaining blood off of the finger with sterile gauze and apply a bandage if necessary
   vi. Record data on the group data sheet.
b. Blood Lactate during Cycle Test
   i. Allow the participant to sit for about 3 minutes on the bike to attain resting steady state.
   ii. Instructor will demonstrate procedure for taking blood samples for the lactate analyzer.
      1. See “Resting Lactate” above
   iii. Measure the participants resting heart rate
   iv. Have the participant pedal at 75 rpm at an initial resistance of 0.5kg and then increase it by 0.5kg every 3 minutes
   v. At each stage, collect the following data during the last 30 seconds of the stage:
      1. Power
         a. Remember the power formula
            i. Power = force x velocity
            ii. Power on bike = resistance (kg) x (rpm x 6 m-rev⁻¹)
      2. HR
      3. RPE
   vi. During the last minute of each stage collect a lactate sample. Be prepared with gauze, strips and analyzer to obtain the blood sample as quickly as possible.
   vii. Be observant of the exercising participant to monitor for signs and symptoms indicating that the test should be terminated.
   viii. Cool down is important in order to keep the subject moving to avoid blood pooling in the lower extremities and potential syncope.
   ix. Continue to monitor the participant’s physical appearance and symptoms during the cool-down period
   x. Record the data from each stage and complete the individual data sheet.
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<th>Stage Time</th>
<th>Resistance</th>
<th>Power</th>
<th>HR</th>
<th>RPE</th>
<th>Lactate</th>
<th>RPM</th>
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Participant 2 Name:___________  Age:_________  Ht:_______cm  Wt:______kg
Resting HR:___________  Resting BP:___________

Blood Lactate during Cycle Test

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Lab Questions:

1) Prepare a data table showing resting lactate values for your class. (attach to lab report)

2) Did resting lactate differ by sex? Why might this be the case?

3) What do these values say about lactate production at rest?

4) What could explain a resting lactate value of >2.0 mM?

5) Prepare a graph illustrating the relationship between blood lactate concentration and work rate. (Print and attach to lab report)
6) Prepare a graph illustrating the relationship between HR and work rate. (attach to lab report)

7) At what workload, HR, and %HRmax does the subject reach his or her lactate threshold (LT)? OBLA? Ventilatory threshold? (Hint: a table would work best.)

8) Does the LT occur at the same workload as the ventilatory threshold? Why or why not?

9) What causes the abrupt increase in blood lactate accumulation, indicated by LT, that occurs during dynamic exercise in an incremental test?

10) Explain the importance of LT for performance prediction.