Metabolic Adaptations to Steady State Exercise

- % Energy System Contribution
  - Phosphagen
  - Mitochondrial Respiration
  - Glycolytic-Lactic

- VO₂ (L/min)
  - Time (min)
  - 160 Watts
  - 120
  - 80
  - 40
Steady State Exercise

**Graph:**
- **X-axis:** Time (min)
- **Y-axis:** VO\(_2\) (L/min)
- **Title:** Oxygen Deficit
- **Legend:** Oxygen Consumed

**Graph:**
- **X-axis:** Time (min)
- **Y-axis:** VO\(_2\) (L/min)
- **Title:** VO\(_2\) Data Replay
- **Legend:**
  - GO
  - STOP

**Notes:**
- Dr. Robergs
- Fall, 2010
$VO_2 = (0.01184 \times \text{Watts}) + 0.699$

- **Power Output (Watts)**
  - 20
  - 40
  - 60
  - 80
  - 100
  - 120
  - 140
  - 160
  - 180

- **VO_2 (L/min)**
  - 0.5
  - 1.0
  - 1.5
  - 2.0
  - 2.5
  - 3.0

- **Heart Rate (beats/min)**
  - 40
  - 80
  - 120
  - 160

**Steady State Exercise**
Adaptations during steady state exercise, cont’d.

b. **VO$_2$ Drift**
For exercise intensities > 60% VO$_2$max, prolonged exercise (> 30 min) causes a slight continued increase in VO$_2$. *(increased temperature and circulating catecholamines)*

c. **CHO Catabolism**
Increases with an increase in exercise intensity, with an increasing reliance on muscle glycogen.

d. **Lipid Catabolism**
Decreases with an increase in exercise intensity. The majority of the source of FFA used during exercise is from intramuscular lipid droplets.
The lower the exercise intensity, the longer the time to muscle glycogen depletion.

Metabolic Energy Demand Is Quantified by Whole Body Oxygen Consumption (VO₂)
Treadmill Walking and Running

Speed $[\text{m/min}] = \frac{\text{belt length} [\text{m}] \times \text{belt revolutions} [\text{number}]}{\text{time} [\text{min}]}$

rise $= 2.15$ units; run $= 15$ units
$2.15 / 15 = 0.1433$
$= 14.33\%$

$treadmill angle (\sigma) ; \tan \sigma = \text{rise} / \text{run}$
$= 2.15 / 15.0$
$= 0.1433$
$\sigma = \text{inverse tan} (0.1433)$
$= 8.1568^\circ$

$treadmill angle \left( \right) = \sigma; \sin \sigma = \text{rise} / \text{hypotenuse}, \sigma = \text{inverse sin} \times (\text{rise} / \text{hypotenuse})$; $\tan \sigma = \text{rise} / \text{run}$

if $\sigma = 5^\circ$, then $\tan \sigma = 0.0875; \%\text{grade} = \tan \sigma \times 100 = 8.75\% = 1:11.43 \text{ slope ratio}$
Douglas Bag Collection of Expired Air

<table>
<thead>
<tr>
<th>VO2 units</th>
<th>System</th>
<th>Equation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(horizontal + vertical + resting)</td>
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<tr>
<td><strong>Treadmill Walking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mL/kg/min</td>
<td>metric</td>
<td></td>
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</tbody>
</table>

| **Treadmill Running** |              |                                                               |
| mL/kg/min | metric       |                                                               |
|            | imperial     |                                                               |
| mL/min    | (km/hr x 3.3333) + ((%grade/100) x km/hr x 15) + 3.5          |
|           | (mi/hr x 5.3668) + ((%grade/100) x mi/hr x 24.15) + 3.5      |

| **Cycle Ergometry** |              |                                                               |
| mL/min (ACSM)      | Watts        | 0 + (Watts x 12.238) + (3.5 x kg body mass)                   |
| ml/min (ACSM)      | kgm/min      | 0 + (kgm/min x 2) + (3.5 x kg body mass)                      |
| ml/min (Latin)     | Males        | 0 + ((Watts x 11.624) + 260) + (3.5 x kg body mass)          |
| ml/min (Latin)     | Females      | 0 + ((Watts x 9.7892) + 205) + (3.5 x kg body mass)          |

| **Arm Ergometry**  |              |                                                               |
| ml/min             | Watts        | 0 + (kgm/min x 18.364) + (3.5 x kg body mass)                 |
| ml/min             | kgm/min      | 0 + (kg/m X 3) + (3.5 x kg body mass)                         |

| **Bench Stepping** |              |                                                               |
| mL/kg/min          | metric       |                                                         |
| mL/kg/min          | imperial     |                                                         |
|                     | (steps/min x 0.35) + (step ht x steps/min x 0.02394) + 0  |
|                     | (steps/min x 0.35) + (step ht x steps/min x 0.06081) + 0 |

Exercise Increases Muscle and Whole Body Energy Demand In a Predictable Manner

1. Click on an exercise mode to call up the protocol controls on the left.
2. Manipulate the protocol controls to get the desired protocol.
3. Based on test content, remember you want a protocol with a consistent linear trend in predicted VO2, a VO2 slope that is not too large (< 5 mL/min/mmHg), and attains a VO2 that is sufficient to meet your subject’s anticipated fitness in approximately 8 to 10 min.