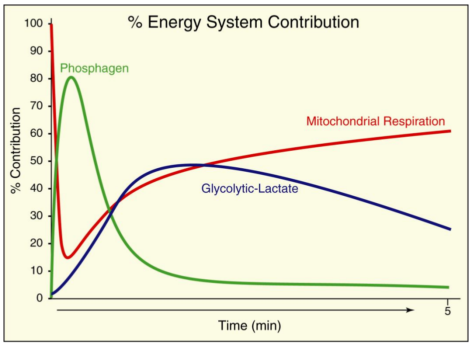
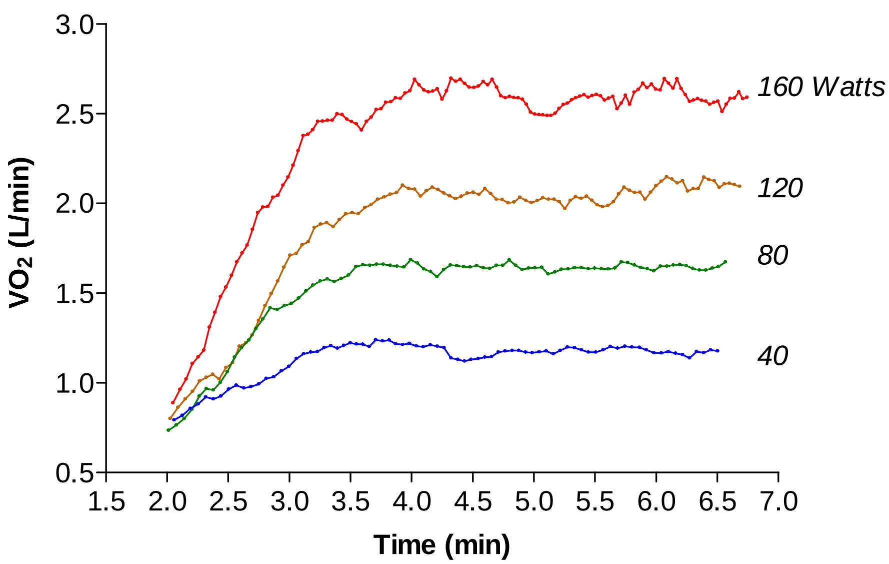
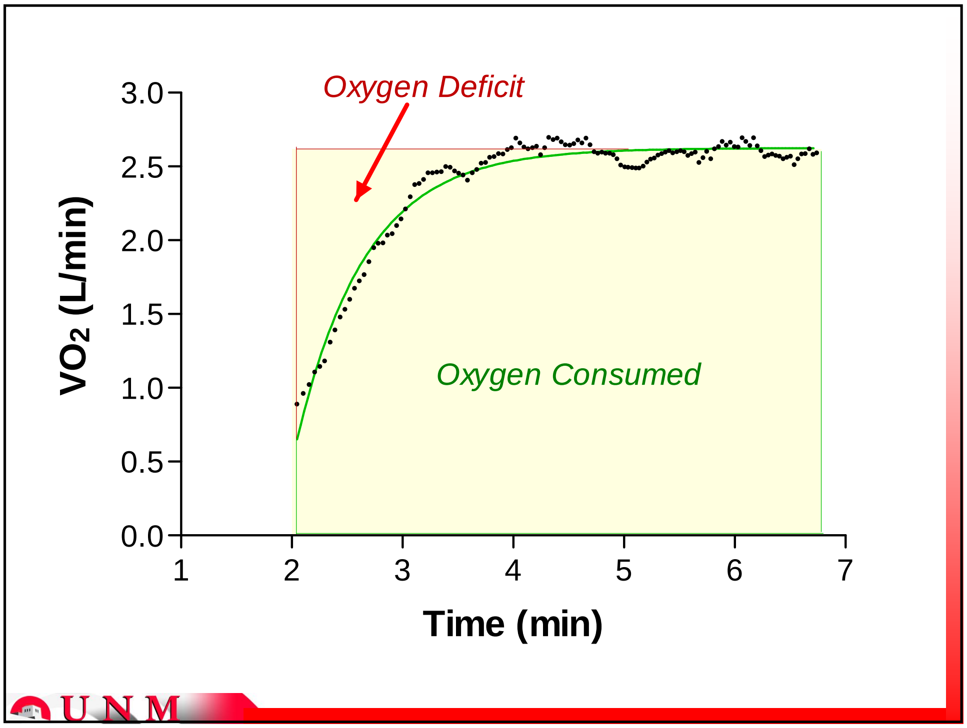
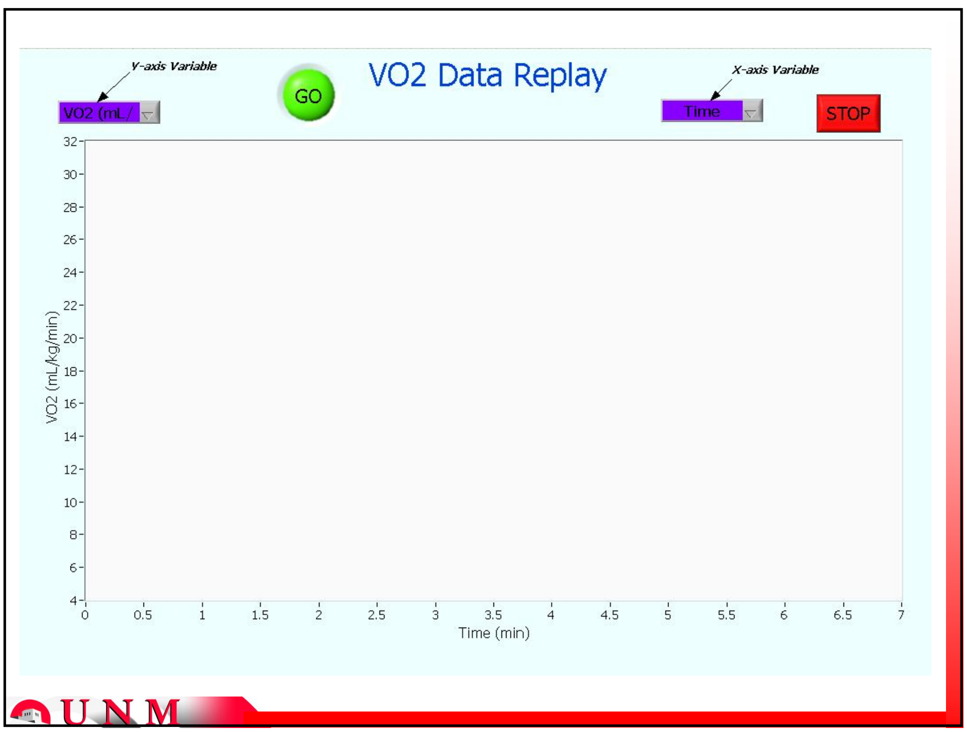
Metabolic Adaptations to Steady State Exercise



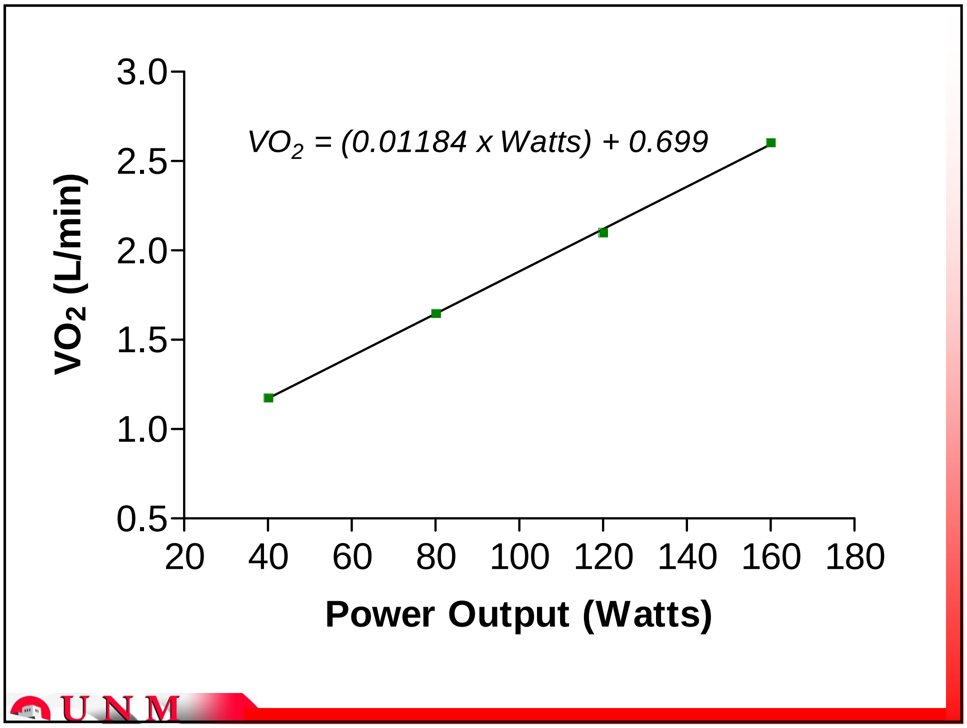




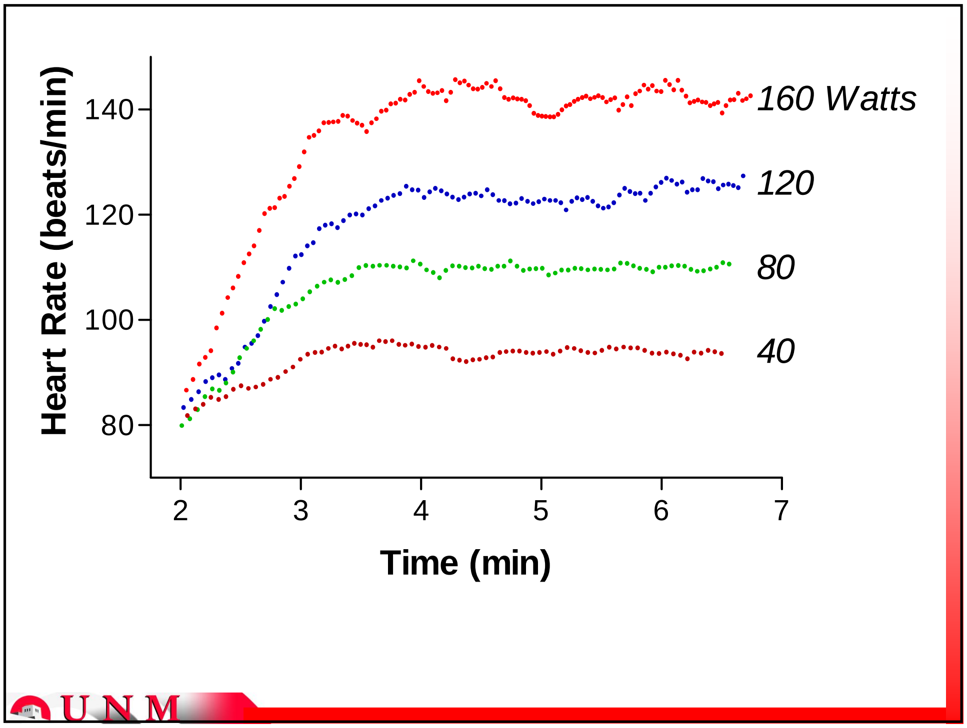
Oxygen Deficit
Oxygen Consumed
VO2 (L/min)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
Time (min)
UNM



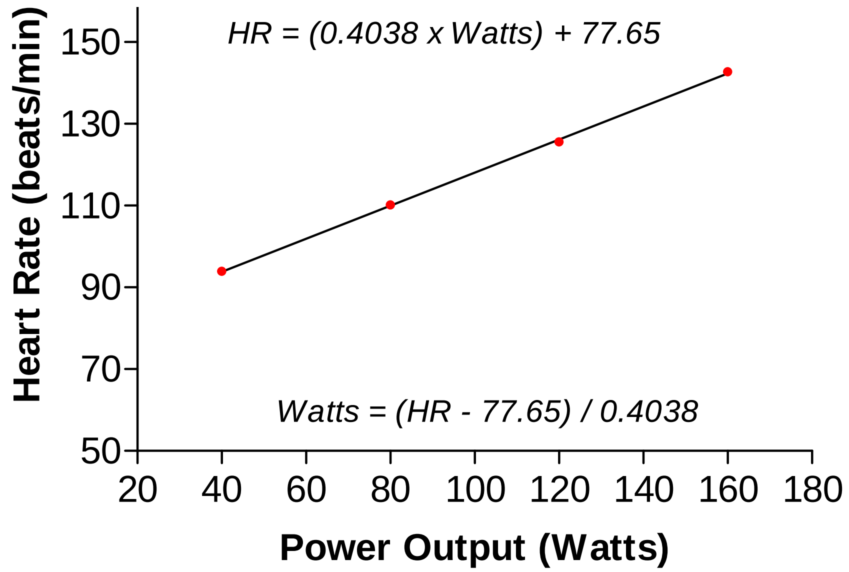
Y-axis Variable
VO2 (mL/
GO
VO2 Data Replay
X-axis Variable
Time
STOP
VO2 (mL/kg/min)
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
Time (min)
UNM



VO2 = (0.01184 x Watts) + 0.699
VO2 (L/min)
3.0
2.5
2.0
1.5
1.0
0.5
20 40 60 80 100 120 140 160 180
Power Output (Watts)
UNM



Heart Rate (beats/min)
140
120
100
80
160 Watts
120
80
40
2 3 4 5 6 7
Time (min)
UNM



Adaptations during steady state exercise, cont'd.

b. VO_2 Drift

For exercise intensities > 60% VO_2max, prolonged exercise (> 30 min) causes a slight continued increase in VO_2. *(increased temperature and circulating catecholamines)*

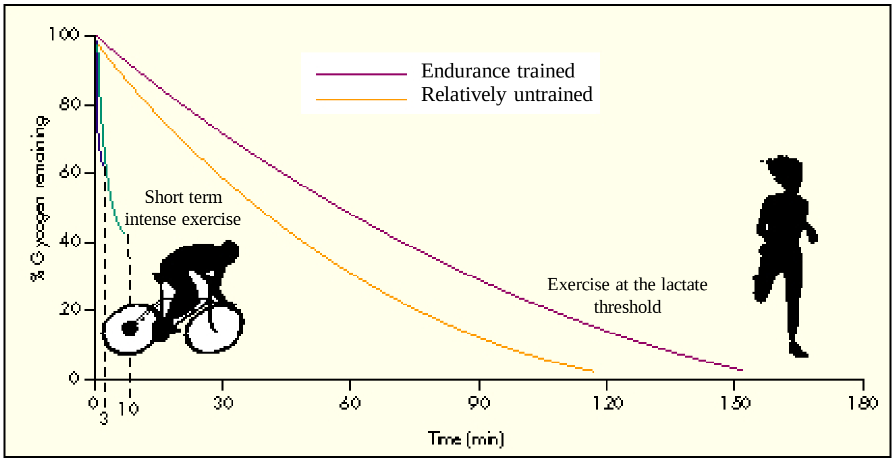
c. CHO Catabolism

Increases with an increase is exercise intensity, with an increasing reliance on muscle glycogen.

d. Lipid Catabolism

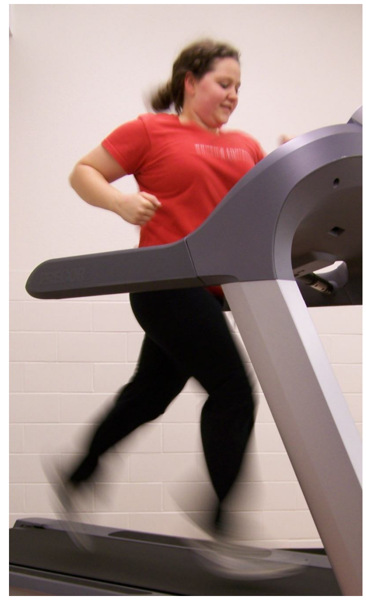
Decreases with an increase is exercise intensity. The majority of the source of FFA used during exercise is from intramuscular lipid droplets.

The lower the exercise intensity, the longer the time to muscle glycogen depletion.



Metabolic Energy Demand Is Quantified by Whole Body Oxygen Consumption (VO_2)

Treadmill Walking and Running



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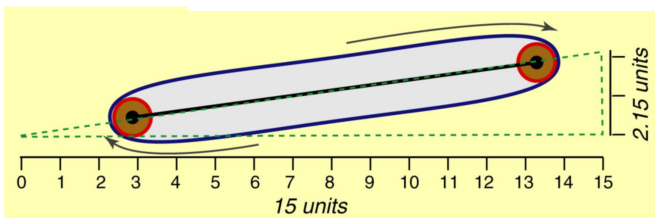
$$\text{Speed}\,[m/\min] = \frac{\text{belt length}\,[m] \times \text{belt revolutions}\,[number]}{\text{time}\,[\min]}$$



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

treadmill angle (σ) ; tan σ = rise / run
= 2.15 / 15.0
= 0.1433
σ = inverse tan (0.1433)
= 8.1568°

%grade	tan σ	Angle (°)
1	0.01	0.57
2	0.02	1.15
3	0.03	1.72
4	0.04	2.29
5	0.05	2.86
6	0.06	3.43
7	0.07	4.00
8	0.08	4.57
9	0.09	5.14
10	0.10	5.70
11	0.11	6.08
12	0.12	6.84
13	0.13	7.40
14	0.14	7.97
15	0.15	8.53
16	0.16	9.09
17	0.17	9.65
18	0.18	10.20
19	0.19	10.76
20	0.20	11.31

treadmill angle $[°] = \sigma$; $\sin\sigma = rise/hypotenuse$; $\sigma = \text{inverse}\sin \times (rise/hypotenuse)$;
$\tan\sigma = rise/run$
if $\sigma = 5°$; then $\tan\sigma = 0.0875$; %grade $= \tan\sigma \times 100 = 8.75\% = 1{:}11.43$ slope ratio

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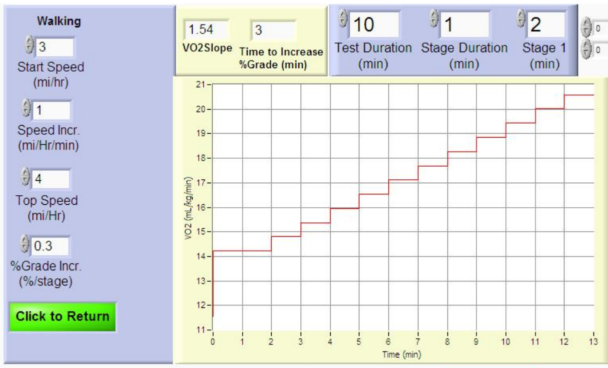
Douglas Bag Collection of Expired Air

VO2 units	System	Equation
		(horizontal + vertical + resting)
Treadmill Walking		
mL/kg/min	metric	(km/hr x 1.6667) + ((%grade/100) x km/hr x 30) + 3.5
mL/kg/min	imperial	(mi/hr x 2.6834) + ((%grade/100) x mi/hr x 48.3) + 3.5
Treadmill Running		
mL/kg/min	metric	(km/hr x 3.3333) + ((%grade/100) x km/hr x 15) + 3.5
mL/kg/min	imperial	(mi/hr x 5.3668) + ((%grade/100) x mi/hr x 24.15) + 3.5
Cycle Ergometry		
mL/min (ACSM)	Watts	0 + (Watts x 12.236) + (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 18.354) + (3.5 x kg body mass)
mL/min	metric	0 + (kgm/min x 3) + (3.5 x kg body mass)
Bench Stepping		
mL/kg/min	metric	(steps/min x 0.35) + (step ht cms x steps/min x 0.02394) + 0
mL/kg/min	imperial	(steps/min x 0.35) + (step ht inches x steps/min x 0.06081) + 0

ACSM equations from ACSM. Guidelines for exercise testing and prescription. 4th Edition. Lea & Febiger, Philadelphia, 1991.

Latin equations from Latin RW, Berg KE, Smith P, Tolle R, Woodby-Brown S. Validation of a cycle ergometry equation for predicting steady-rate VO2. ***Med Sci Sports Exerc*** 1993;25(8):970-4.

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



Time	Speed	%Grade	rev/min	kg Load	Watts	estVO2
0	3	0	0	0	0	11.54
2	4	0	0	0	0	14.22
3	4	0.3	0	0	0	14.8
4	4	0.6	0	0	0	15.38
5	4	0.9	0	0	0	15.96
6	4	1.2	0	0	0	16.54
7	4	1.5	0	0	0	17.11
8	4	1.8	0	0	0	17.69
9	4	2.1	0	0	0	18.27
10	4	2.4	0	0	0	18.85
11	4	2.7	0	0	0	19.43
12	4	3	0	0	0	20.01
13	4	3.3	0	0	0	20.59
14	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

Print This Page Quit

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 text content, remember you want a protocol with a consistent linear trend in predicted VO2, a VO2 slope that is not too large (< 5 mL/kg/min/min), and attains a VO2 that is sufficient to meet your subject's anticipated fitness in approximately 8 to 10 min.

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