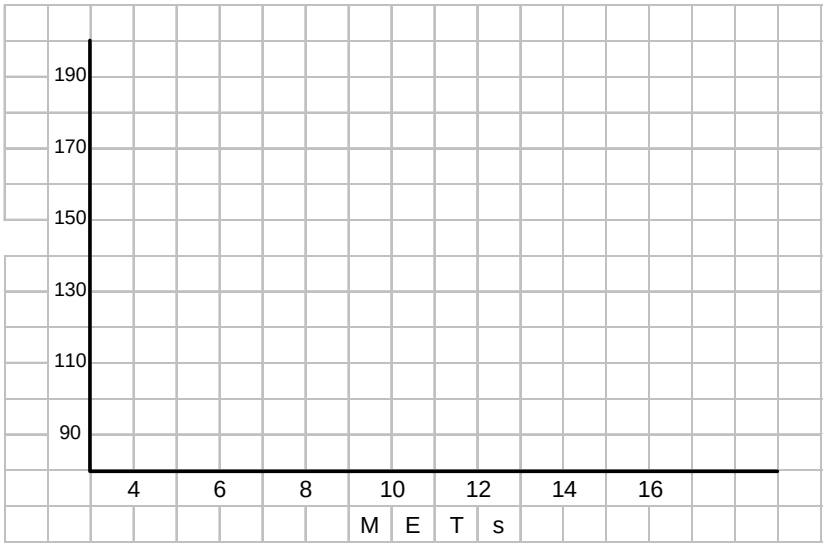
Bruce Protocol - Submaximal GXT

Name: _____ Age: _____ Resting BP: _____
Wt. kg: _____ Est. HR_{max}: _____ 85%HR_{max}: _____ Resting HR: _____

Stage	Min.	% Grade	MPH	METs	2min HR	3min HR	BP	RPE
1	0-3	10	1.7	4.7	_____	_____	_____	_____
2	3-6	12	2.5	7.0	_____	_____	_____	_____
3	6-9	14	3.4	10.1	_____	_____	_____	_____
4	9-12	16	4.2	12.9	_____	_____	_____	_____
5	12-15	18	5.0	15.0	_____	_____	_____	_____
6	15-18	20	5.5	16.9	_____	_____	_____	_____
7	18-21	22	6.0	19.1	_____	_____	_____	_____



Extrapolation Method

Instructions

1. Greet patient/client. Obtain consent (oral or written).
2. Record age and measure height and weight. Calculate and record estimated HRmax and 85% HRmax.
3. Obtain resting HR and BP scores.
4. Instruct the participant on how to walk on the treadmill.
   Hold onto railing; get feel of belt speed by putting one foot on the belt, keeping up with the belt speed.
   Step on, keeping eyes ahead and back straight; walk relaxed with arms swinging.
   Initially, person can hold on for balance, then use just finger or back of hand to touch railing lightly.
5. Begin the test protocol. Enter the belt speed and the treadmill incline for stage 1. Each stage is 3 minutes in length. Advance both the speed and the incline for the next stage.
6. Record your physiological variables are regular intervals.
   - Record HR at 2 min mark and at 2:55 minutes for each stage. The heart rate should have reached a steady state (the 2 and 3 min HR scores should be within 5 beats of one another).
   - Begin recording the BP at the 2 minute mark in each stage. This gives you enough time to redo it if you are not successful on your first attempt. Use Korotkoff sound IV for the diastolic value.
   - Record the RPE at the 2:45 mark of each stage. Continue to talk to the subject throughout the test.
7. The test is terminated when the subject reaches the 85%HR_{max} or if one of the 9 absolute stops is encountered. Know what these are.
8. When the test is terminated, begin an active cool-down by resetting the machine to a work intensity no higher than stage 1. Try a reset of 0% incline and speed of 3 mph. You will continue to monitor the HR, BP, and RPE until the subject recovers. A HR below 100 bpm is an arbitrary value you can use to gauge recovery.
9. The subject may now exit the treadmill and you can go extrapolate the VO_{2max} score.

Your VO_{2max} =_____

(1 MET = 3.5 ml · kg^{-1} · min^{-1})

VO_{2max} (ml · kg^{-1} · min^{-1}) 20-29 Years of age

	Low	Fair	Avg.	Good	High
W	<24	24-30	31-37	38-48	49+
M	<25	25-33	34-42	43-52	53+

Submaximal Exercise Tests

Submaximal exercise tests can be used to estimate VO_{2max}. These tests have been validated by examining: (a) the correlation between directly measured VO_{2max} and the VO_{2max} estimated from physiological responses to submaximal exercise (e.g. heart rate at a specified power output), or (b) the correlation between directly measured VO_{2max} and test performance (e.g. time to run 1 mile or time to volitional fatigue using a standard test protocol).

Maximal exercise testing is not a feasible method of assessing cardiorespiratory endurance for the majority of fitness practitioners. The basic aim of the submaximal test is to determine the relationship between a subject's heart rate response and VO_2 during progressive exercise and use that relationship to predict $VO_{2max.}$

To do this heart rate and exercise intensity must be plotted at two or more submaximal exercise stages. Several assumptions are understood when using the submaximal testing:

- a steady state HR is obtained during each exercise work rate
- a linear relationship exists between HR and oxygen uptake (or work rate if VO_2 is not being measured)
- the HR_{max} is uniform for a given age
- mechanical efficiency is the same for all persons

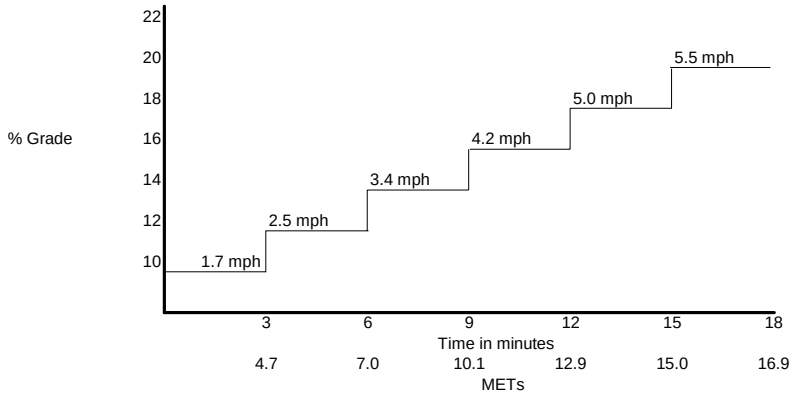
We understand that the assumptions are not fully met and this leads to errors in the predicted $VO_{2max.}$ However, submaximal testing does provide reasonably accurate reflections of an individual's fitness without the cost, time, risk, and effort on the part of the subject.

Why Use the Treadmill?

Advantages include:

can accommodate the least fit to the most fit participant
uses the natural activities of walking and running
tests are reproducible since the pace is set by the machine

Bruce Protocol



General Indications for Stopping a GXT in Apparently Healthy Adults*

1. Onset of angina or angina-like symptoms
2. Significant drop (20mmHg) in systolic blood pressure or a failure of the systolic blood pressure to rise with an increase in exercise intensity
3. Excessive rise in blood pressure:
   systolic >260 mm Hg or diastolic pressure > 115 mm Hg
4. Signs of poor perfusion: light-headedness, confusion, ataxia, pallor, cyanosis, nausea, or cold and clammy skin
5. Failure of heart rate to increase with increased exercise intensity
6. Noticeable change in heart rhythm
7. Subject requests to stop
8. Physical or verbal manifestations of severe fatigue
9. Failure of the testing equipment

* assumes that testing is non-diagnostic and is being performed without direct physician involvement or electrocardiographic monitoring.

Rating of Perceived Exertion (RPE scale)

The RPE scale is a valuable and reliable indicator in monitoring an individual's exercise tolerance. The RPE correlates highly with measured exercise heart rates and calculated oxygen consumption values. Both the cardiorespiratory training effect and threshold for blood lactate accumulation are achieved at a rating of "somewhat hard" or "hard" which corresponds to a rating of 13 to 16 on the original scale or 4 to 5 on the revised one.

Original scale		**Revised scale**	
6		0	nothing at all
7	very, very light	0.5	very, very weak
8		1	very weak
9	very light	2	weak
10		3	moderate
11	fairly light	4	somewhat strong
12		5	strong
13	somewhat hard	6	
14		7	very strong
15	hard	8	
16		9	
17	very hard	10	very, very strong
18		*	maximal
19	very, very hard		
20			

"During the exercise test we want you to pay close attention to how hard you feel the exercise work rate is. This feeling should reflect you total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort, and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath, or exercise intensity, but try to concentrate on your total, inner feeling of exertion. Try not to underestimate or overestimate your feeling of exertion; be as accurate as you can."

From: ACSM's Guidelines for Exercise Testing and Prescription, 5th edition.

Sequence of Testing and Activity Prescription

1. informed consent
2. health history
3. screening
4. resting CRF, body composition, and psychological tests
5. submaximal CRF
6. tests for low-back function
7. begin light activity program here
8. tests for muscular strength and endurance
9. maximal CRF
10. revise activity program; include games and sports here
11. periodic retest (and activity revision)

Steps to Administering a GXT

1. Greet patient/client.
2. Obtain consent (oral or written).
3. Record age and measure height and weight.
   Calculate and record estimated HRmax and 70% to 85% HRmax.
4. Obtain resting HR and BP
5. Instruct participant in how to do a step test.
   Step all the way up and all the way down.
   Keep pace with the metronome.
   OR
   Instruct participant on how to use the cycle ergometer.
   Adjust seat height so the knee is slightly flexed when the foot is at the bottom of the pedal swing and parallel to the floor.
   Keep pace with the metronome.
   Do not hold tightly onto the handlebars; release hold when blood pressure is taken.
   OR
   Instruct the participant on how to walk on the treadmill.
   Hold onto railing; get feel of belt speed by putting one foot on the belt, keeping up with the belt speed.
   Step on, keeping eyes ahead and back straight; walk relaxed with arms swinging.
   Initially, person can hold on for balance, then use just finger or back of hand to touch railing lightly.
6. Follow test protocol.
   Advise person to talk during the test about how he or she feels.
   Follow criteria to termination of the test.

Note: for fitness evaluations HR, BP, and RPE are the usual variables measured.
Adapted from Howley 1988.

Contraindications to Exercise Testing

Absolute contraindications:

1. A recent significant change in the resting ECG suggesting infarction or other acute cardiac event
2. Recent complicated myocardial infarction (unless patient is stable and pain-free)
3. Unstable angina
4. Uncontrolled ventricular arrhythmia
5. Uncontrolled atrial arrhythmia that compromises cardiac function
6. Third degree AV heart block without pacemaker
7. Acute congestive heart failure
8. Severe aortic stenosis
9. Suspected or known dissecting aneurysm
10. Active or suspected myocarditis or pericarditis
11. Thrombophlebitis or intracardiac thrombi
12. Recent systemic or pulmonary embolus
13. Acute infections
14. Significant emotional distress (psychosis)

Relative contraindications:

1. Resting diastolic blood pressure >115 mm Hg or resting systolic blood pressure >200 mm Hg
2. Moderate valvular heart disease
3. Known electrolyte abnormalities (hypokalemia, hypomagnesemia)
4. Fixed-rate pacemaker (rarely used)
5. Frequent or complex ventricular ectopy
6. Ventricular aneurysm
7. Uncontrolled metabolic disease (e.g. diabetes, thyrotoxicosis, or myxedema)
8. Chronic infectious disease (e.g. mononucleosis, hepatitis, AIDS)
9. Neuromuscular, musculoskeletal, rheumatoid disorders that are exacerbated by exercise
10. Advanced or complicated pregnancy

PEHD 210 – Concepts of Fitness Assessment and Exercise Prescription

Sources:

American College of Sports Medicine. (2000). ACSM's Guidelines for Exercise Testing and Prescription (6th ed.). Philadelphia: Lippincott Williams & Wilkins.

Howley, E.T. and Franks, B.D. (2003). *Health Fitness Instructor's Handbook*, (4th ed.). Champaign. IL: Human Kinetics.