DPE
AEROBIC FITNESS

COURSE SUPPLEMENT

Course Director: CPT HECTOR TOVAR

Aerobic Fitness Course Supplement

Cardio-respiratory Endurance (Aerobic Fitness)

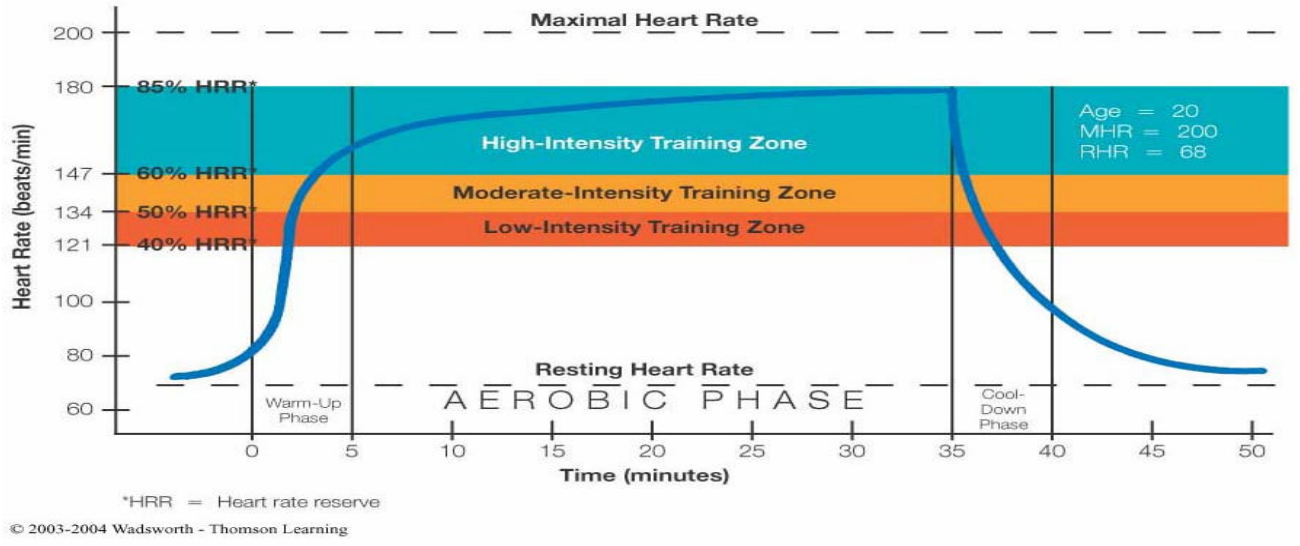
The word *aerobic* means "in the presence of oxygen". Aerobic fitness is the efficiency with which the body delivers oxygen and nutrients needed for muscular activity and transports waste products from the cells of the body. The amount of O_2 that the human body is able to utilize per minute of physical activity is called *Oxygen Uptake* (VO_2). A person's maximum oxygen uptake (VO_2 Max) is considered the "Gold Standard" for measuring and assessing aerobic fitness.

Determining your Maximum Heart Rate, Resting Heart Rate, and training Heart Rate

Heart Rate, oxygen uptake, and workload have a linear relationship. Therefore, heart rate is considered an excellent means for estimating exercise intensity.

1. Determining *Resting Heart Rate* (RHR). The best time to take your Resting Heart Rate is prior to rising out of bed in the morning. For untrained people resting heart rates are generally between 70 - 80 bpm. Trained athletes usually have a RHR between 40 - 50 bpm. Women have a RHR of about 10 beats more than men.
2. Estimating *Maximum Heart Rate* (MHR) Age predicted estimation: 220 - Age = MHR. Age predicted estimation of maximum heart rate has limitations. (MHR will vary between individuals of the same age.) Another way to "estimate" MHR is via lab and field methods by progressively increasing exercise intensity to a point where you can no longer continue exercising. After a warm-up of about 15 minutes, the person does an activity that progressively increases intensity. These include a max heart rate treadmill protocol or running hill repeats. The MHR can then be recorded from a HR monitor.
3. Determining *Heart Rate Reserve* (HRR). Heart rate reserve takes one's resting heart rate into consideration. HRR = MHR ─ RHR
4. Determining *Training Heart Rate* (THR). The Heart Rate per minute one should reach while exercising. Research has found that improvement in aerobic fitness is directly related to the intensity of exercise. Exercising between 60% - 90% of MHR or HRR is generally prescribed for THR.

   (____% x HRR) + RHR = THR



Maximal Oxygen Uptake/VO_2 Max

Aerobic fitness is determined by the maximal amount of O_2 that the human body is able to utilize per minute of physical activity. The maximum rate of oxygen consumption per minute is referred to as that persons *VO_2 max* and is considered to be one of the best indicators of a person's level of

aerobic fitness. VO_2 max can increase from about 5 to 30% with regular aerobic training. Training causes an increase in VO_2 max but, more importantly, training influences energy supply making it more aerobic for increasing workloads. This means that lactic acid is formed at a workload corresponding to a higher percentage of VO_2 max.

CLASSIFICATION	FEMALE	MALE
Average, college-aged	35	45
World-class athlete	65	75
Highest recorded	74	94

Principle of Training (PROVIRRBS)

Progression: Gradual increase in intensity and/or time
Regularity: Exercise often (look at FITT)
Overload: Exercise must exceed normal demands
Variety: Reduces boredom
Individuality: Each person is unique in their exercise needs
Recovery: Physiological "gains/adaptations" occur when you rest
Realism: Know your capabilities and work diligently to reach your goals
Balance: Maximize all the components of Fitness
Specificity: Focused training on your desired goal

Variables of Training (FITT)

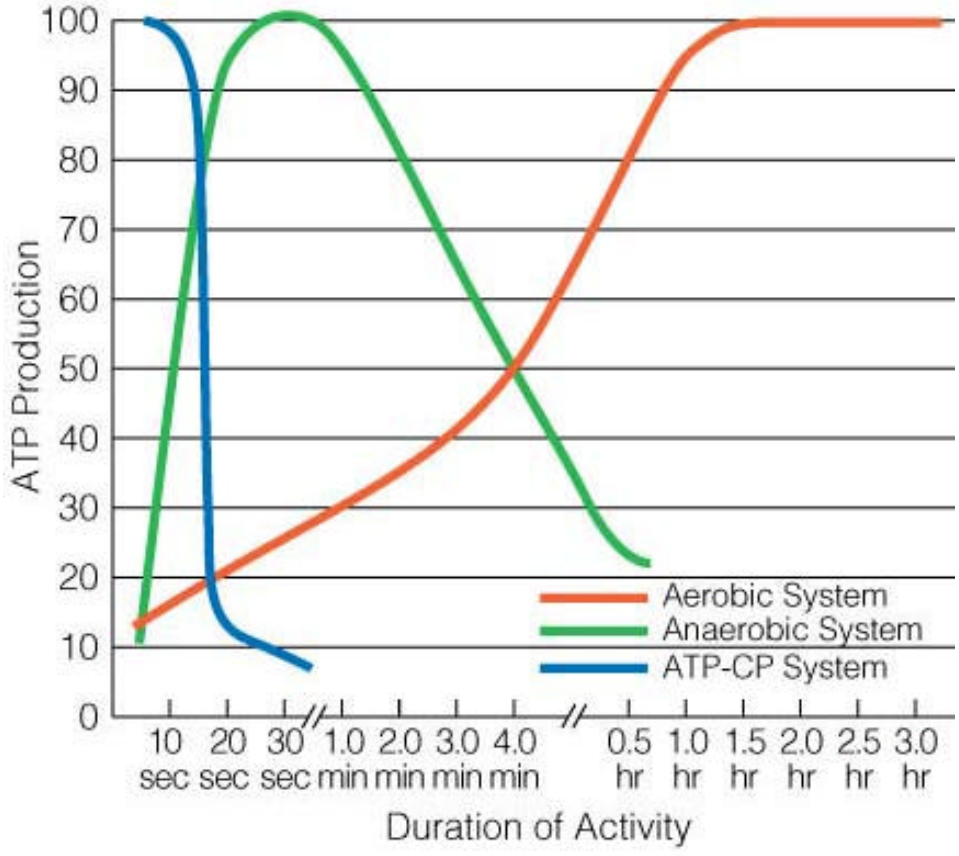
	Frequency	Intensity	Time	Type
Flexibility	5-6x/wk	Mild discomfort	10-30 sec/rep 3-5 rep/stretch	PNF Static
Cardio-Respiratory	3-5x/wk	50-85%maxHR 60-90%HRR	20+ minutes Inversely related to intensity	Run, cycle, swim, walk, row, dance

Energy Systems/Sources

1. Immediate Sources of Energy (*ATP-CP*).
   10-15 Seconds high explosive/high power activities: all out sprint
   Without oxygen from high energy phosphate compound: creatine phosphate or CP.

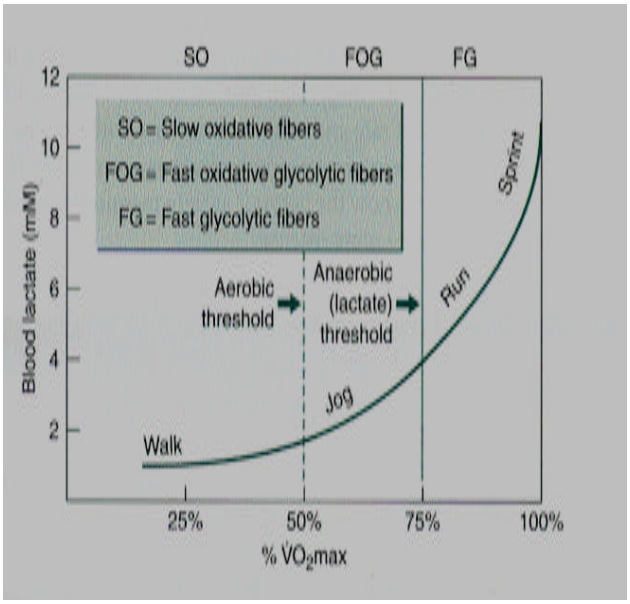
2. Short Term Sources of Energy (*Anaerobic Glycolysis*).
   < 90 seconds, break down muscle glycogen (stored glucose)
   Does not require oxygen
   Produces lactic acid.

3. Long Term Sources of Energy *(Aerobic Glycolysis).*
   The primary fuels are muscle glycogen, blood glucose, plasma free fatty acids, and intramuscular fats. These fuels are broken down primarily within the mitochondria, where oxygen is present.

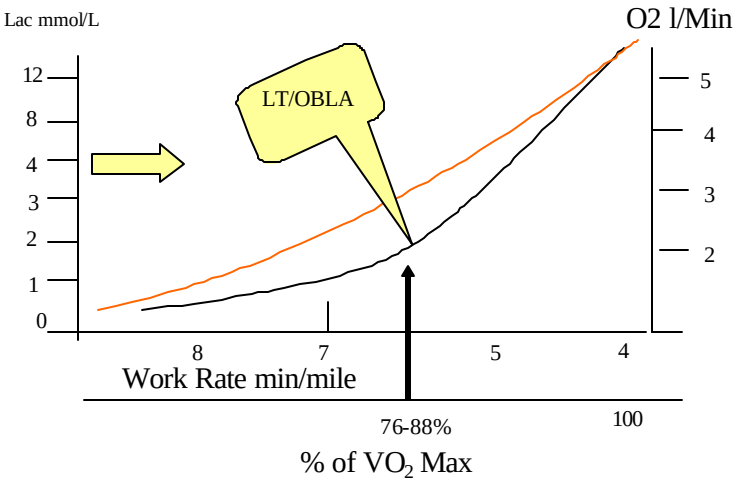


Onset of Blood Lactic Acid/Lactate Threshold

Onset of *Blood Lactic Acid* (O.B.L.A.) or *Lactate Threshold* (LT*)* is the point at which lactic acid begins to accumulate in the blood faster than it is removed from circulation. The burning sensation and fatigue experienced because of an over abundance of lactic acid does not mark the point at which we begin to produce lactic acid, but marks the point at which we can no longer efficiently get rid of it. The exercise intensity that produces the OBLA/LT is usually expressed as a percentage of the VO_2 max. This normally occurs between 55% and 65% of the maximal oxygen uptake in healthy, untrained people and is often over 85% in highly trained endurance athletes. Given two people with an identical VO_2 max and assuming all other factors are equal, the one who can exercise at the higher percentage of the VO_2 max without accumulating large amounts of lactic acid in the blood will outperform the other individual.



Lactate Threshold



Disadvantages of Excessive Lactate Accumulation

1. Causes acidosis in and around muscles and decreases the aerobic endurance. (The aerobic enzyme system is sabotaged by acidosis.)
2. Causes damage to the muscle cell membrane.
3. Disturbs coordination.
4. Increases the risks of injury. Micro-ruptures in muscle tissue can lead to more serious injury.
5. Disturbs the creatine phosphate system. The reformation of CP is delayed in acidic muscles.
6. Limits fat oxidation.

Estimating OBLA/Lactate Threshold:
220 - Age = MHR
MHR x 85% = Estimated HR at OBLA/LT

Long Term (Chronic) Adaptations to Aerobic Training

Decrease in Resting Heart Rate. With training, the heart increases in strength and can produce more forceful contractions, causing a greater amount of blood pumped with each beat. The volume of blood pumped from the left ventricle during each contraction is called Stroke Volume (SV). Since the heart can pump more blood with each beat (increased SV), it is able to beat at a slower rate and get more rest between beats. Resting heart rates are frequently decreased by 10-20 beats per minute after 6-8 weeks of training. (RHR is influenced by genetics).

1. Lower Heart Rate at a given workload (VO_2 submax)
2. Decrease in Heart Rate Recovery Time
3. Increase in Number and Size of Surface Area of Functional Capillaries
4. Increase in the Number and Size of the Mitochondria
5. Increase in the Ability to Mobilize and Utilize Fat
6. Increase in the Oxygen-Carrying Capacity
7. Higher Maximal Oxygen Uptake
8. Improved Blood Lipid Profile
9. Decrease in Resting Blood Pressure.
10. Musculoskelatal Benefits

a. Increased muscular strength
b. Increased capillary density in muscle
c. Strengthened tendons, ligaments and joints
d. Counteracted osteoporosis
e. Increased muscle hypertrophy
f. Increased glycogen stores in muscle

11. Miscellaneous Benefits
    a. Enhanced tolerance to heat
    b. Increased release of endorphins (Endorphins are morphine like substances)
    c. Improved sense of well being
    d. Improved sleep pattern
    e. Improved digestion
    f. Improved sweating response

Injury Prevention

Blisters - Properly fitted shoes and socks that stay in place can prevent blisters. Treatment is to puncture the bubble with a sterile needle and drain. Cover with gauze/bandage.

Muscle soreness - Start at low levels of intensity and progress slowly thorough warm up and cool down. Massage and warm baths after exercise helps relieve soreness.

Muscle cramps - Involuntary muscle contraction may be due to a salt and potassium imbalance in the muscle. Treatment is stretching, warming up properly, and replacing salt and potassium.

Lower Back Pain - Results from poor flexibility, weak abdominal and back muscles, and poor posture. Correct with stretches and strengthening exercises.

Knee Problems - Caused or aggravated by the endurance conditioning program (overuse). Wear proper footwear and run on soft, even surfaces.

Shin Splints - Results probably from a lowered arch, irritated membranes, and or the tearing of muscle from bone. Use taping, rest, stretching, ice, proper footwear, running on soft surfaces, and strengthening exercises to heal.

Achilles Tendon injuries - A trouble in distance runners resulting from improper footwear. Treatment is reduced activity, ice, rest, and proper warm up.

Environmental Considerations

Exercising in the Heat

1. Factors to Modify Heat Tolerance
    a. Gradually acclimatize - Continued exposure to heat results in gradual adaptation and heat can be tolerated more effectively. Full acclimatization generally occurs in 10 days of heat exposure.
    b. Drink plenty of water before, during, and after. Fluid loss in excess of 4%-5% body mass compromises cardiovascular function and work capacity. Fluid replacement should match fluid loss.
    c. The body is cooled by evaporation. Wear the least amount of clothing as possible. In humid weather, the evaporation process is limited.
    d. Electrolytes lost through sweating can be replaced by adding a small amount of salt to food or by consuming a sport drink containing electrolytes. Salt tablets are not recommended.
    e. When possible, avoid running during the hottest times of the day. During the morning may be best.

Exercising in the Cold

1. Factors to avoid exposure

a. Dress in layers. Hands, feet, and head are particularly sensitive to cold.
b. Avoid profuse sweating.
c. Avoid wind and wind chill factor.
d. Considerable water can be lost from the respiratory passages when exercising in the cold due to incoming air which must be warmed. Humidification occurs at the expense of water from respiratory passages.

Training at high altitude

The percentage of oxygen at higher altitude is the same as that at sea level. However, the atmospheric pressure is less so the pressure exerted by oxygen at higher altitude is proportionately less than at sea level. Therefore, it is more difficult to deliver oxygen to the working muscles of the body. The body will acclimatize after several weeks but performance is still compromised.

1. Effects of Training at higher altitudes
   a. More red blood cells
   b. Increase in Hemoglobin
   c. Increase in Cardiac Output
   d. Increase in Blood Volume

Running Basics

1. Running Mechanics

Overall action - smooth, relaxed, ease of movement and rhythmic
Head - relaxed and erect
Shoulders - relaxed and down
Arm Swing - relaxed, fluid, counteract hip rotation
Hands - relaxed, cupped, down near abdomen.
Pronation or Supination - The pronated foot has a low arch, and the foot turns outward, upward and away from the midline of the body. The supinated foot has a high arch, and the foot turns inward, downward and toward the midline of the body. The heel rolls out with pronation and rolls in with supination. The knee rotates inward with pronation and outward with supination. Over pronated runners require a supportive shoe to reduce excessive movement of the foot. Over supinative runners require a softer soled shoe to improve shock absorption. When pronation and supination are not controlled, injury can occur in the foot, ankle, hip and lower back.

Different Running Strategies

Long Slow Distance (LSD) and Recovery. A continuous run at a steady state (70-75% HRR), longer than the race distance up to the ½ marathon, and slower than the race pace. Time or distance depends on race distance.

Tempo. Runs of 1-5 miles depending on race distance performed at Lactate Threshold (80-85% HRR).

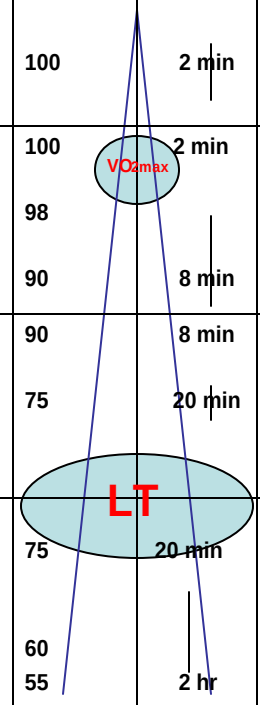
Speed/Intervals. Runs of 200 meters up to 2 miles depending on race distance performed higher than lactate threshold (> 85 % HRR).

Sample running training program for different distance races:

Goal Distance	Day 1	Day 2	Day 3	Day 4	Day 5
2 MILE RUN	2-3 miles @ >75 % HRR	Tempo 2-4 miles @ 80-85 % HRR	2-3 miles @ >75 % HRR	Speed/Intervals: 1-2 miles:4-8x 400 meters at > 85 % HRR	2-6 miles @ 70-75% HRR
10K RACE	4-6 miles @ >75 % HRR	Tempo 3-5 miles @ 80-85 % HRR	4-6 miles @ >75 % HRR	Speed: 2-3 miles at > 85 % HRR	8-10 miles @ 70-75% HRR
1/2 MARATHON	5-7 miles @ >75 % HRR	Tempo 4-5 miles @ 80-85 % HRR	5-7 miles @ >75 % HRR	Speed: 3-5 miles at > 85 % HRR	13-15 miles @ 70-75% HRR
MARATHON	8-10 miles @ >75 % HRR	Tempo 6-8 miles @ 80-85 % HRR	7-9 miles @ >75 % HRR	Speed: 4-6 miles at > 85 % HRR	18-20 miles @ 70-75% HRR

Primary training zones of performance during running

Physiological Adaptations	Blood Lactate	% max heart rate	%VO2 max	Training Int. Run Time	System	Terms	Training Int. Dist.	Race Pace
Strength & Speed ST & FT Development Inc. Neural Recruitment Improved Blood Buffering Tolerance to acidosis stress	+ 9 mmol 8 mmol	100 95	130 100	30 s 2 min	Anaerobic Capacity	Short Interv. Repet. Short Speed	200 m 1000 m	800 1500
Speed St & FT fiber development Some inc. in neural dev. Some inc. in blood buffering Increased glycolytic enzymes	8 mmol 7 mmol 5 mmol	95 90	100 98 90	2 min 8 min	Aerobic Capacity	Long Interval Long Speed	800 m 3000 m	3000 5000 10000
Stamina St & Ft Type IIa development Inc. Heart Chamber size Inc. stroke volume & blood volume Inc. oxidative/glycolytic enzymes	5 mmol 4 mmol 3.5 mmol	90 80	90 75	8 min 20 min	Anaerobic Condition	Tempo Pace Mara. Steady State	Mara. Race pace 15-20 min	Mara.
Endurance ST Fiber Development Inc. Blood Volume Inc. connective tissue development Inc. muscle fuel storage Inc. oxidative/glycolytic enzymes Increased capillarization	3.5 mmol 2 mmol	80 70	75 60 55	20 min 2 hr	Aerobic Condition	Over distance Base work	All Longer Distances	



Martin, D. & Coe, P. 1997. *Better training for distance runners*.

Introduction to Cycling

Sizing and Riding Positions

1. 1-2 inches clearance over top tube
2. 4 inches clearance for ATB
3. Seat height - slight bend in the knee on downstroke
4. Other sizing considerations
    a. Crankarms
    b. Handlebar stems
    c. Saddle - fore and aft
    d. Seat posts
    e. Top tube

Riding Techniques

Pedaling Cadence

Measured in revolutions per minute (RPM)
Cadence for fitness riding should be between 80 - 100 RPM. (Count revolutions at top of stroke for 30 sec. x 2.)
Pedal in a circular motion.
ATB - May be more difficult to maintain this cadence because of terrain.

Shifting

Continue pedaling, ease up slightly.
Avoid Chain Cross Over - friction, stress.
Can get the same ratio with another combination.
18 speed has 16 "usable gears".
Anticipate hills and varying terrain.

Braking

Apply rear brakes first.
Brake before entering turns.
Front brake has more stopping power but use gradual pressure.

Cornering

Keep inside pedal up and weight on outside pedal.
ATB - advanced technique - skidding/hopping.

Climbing

If possible, remain seated.
Shift to easier gear before hill.
ATB - Lean forward but keep most weight on the seat to avoid skidding in loose terrain.

Descending

Stay in control.
Get into higher gear.
Be in position to apply brakes, if needed.
ATB - lower seat, stand on pedals. Sit way back on steep hills. Use brakes as needed but do not overuse. Skidding and lack of control results for over braking.

Drafting

Cuts wind resistance.
Stay within 12 inches (2-3 for advanced) of leader.
Use hand signals to communicate.

No abrupt movements
Take turns being the leader.
ATB - not really a factor, unless on open, smooth terrain.

Rough Terrain

Pick a line.
Stay in control of speed.
Stand on pedals, distribute weight.
Avoid braking on loose rock gravel - ride it out.

Training Notes

Concentrate on cadence and be aware of THR.
Start slow and build a good mileage base
Build strength and speed - intervals
Specificity
Rest
Plan your off season - cross training, weight training, XCS, skating
Proper nutrition
Set goals.

Pre-ride Check

Tire Inflation
Seat Height
Handlebars
Brakes
Crank Arms
Wheel Rotation
Shifting - All Gears Are Functional
Quick Releases On Tires Are Tight

Safety Considerations

1. Always wear a helmet and gloves.
2. Make sure bike is in proper working order.
3. On road:
    a. Ride single file on far right of road.
    b. Watch for glass/debris. Signal other cyclists.
    c. Be visible and predictable.
    d. Use hand signals.
    e. Obey all traffic rules.
4. On trail:
    a. Know your ability. Stay in control.
    b. Stay on trails.
    c. Watch out for hikers.
    d. Learn to dismount. Control falls.

Competitive Cycling

1. Road Bike Races
    a. Criteriums - Races of varying distances which are usually done on flat level ground. Categorized by ability (novice through advanced). Other factors include tight turns and bumping. Drafting is legal and is very exciting for spectators.
    b. Time Trials - "Race against the clock". Cyclists start at intervals (usually one minute). Drafting is illegal.

c. Road Races - Can be done in stages. ("Tour de France") A combination of criteriums and time trials.
d. Century - 100 mile road race. A cyclist's equivalent of a runner's marathon. Also, Double Century 200 miles.
e. Track Racing - Highly specialized. Races are held on an oval, banked track (velodrome). Unique bikes: no brakes, one "high" gear. Different races: matched pairs, pursuit, tandem.

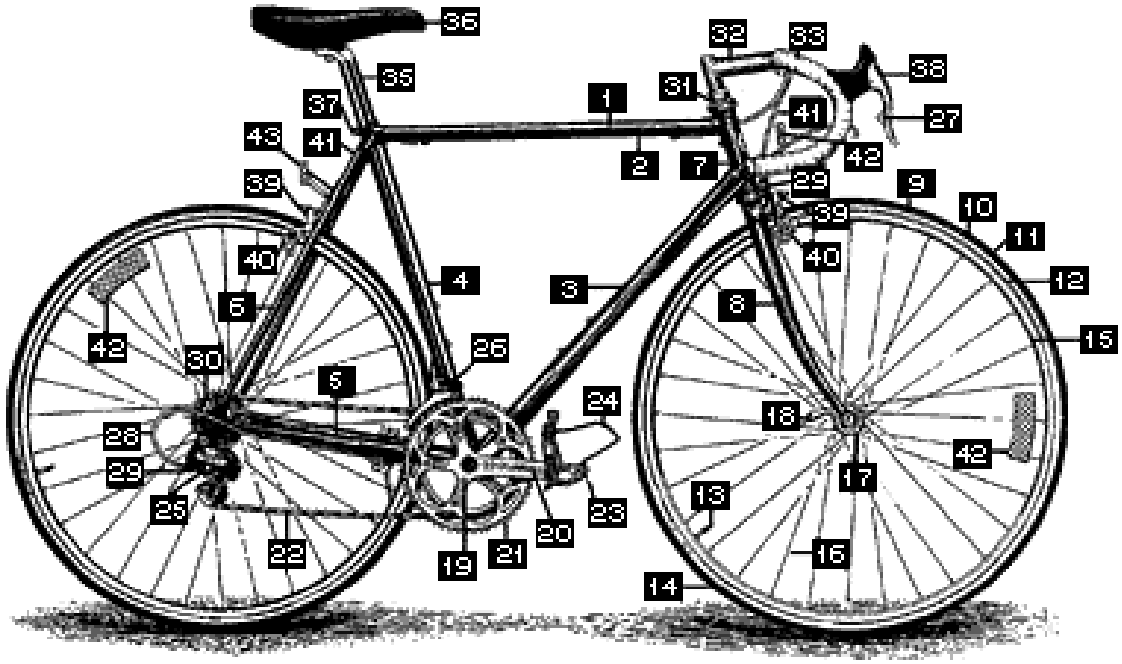
2. Triathlons and Biathlons/Duathlons - Usually swim, bike, run (triathlon) and run, bike, run (biathlon). There are both draft legal and illegal races.

3. Mountain Bike Races
   a. Cross Country - The races usually consists of varying terrain.
   b. Down hill - Requires bikes with front and rear suspension. Riders wear protective gear.

BIKE ANATOMY

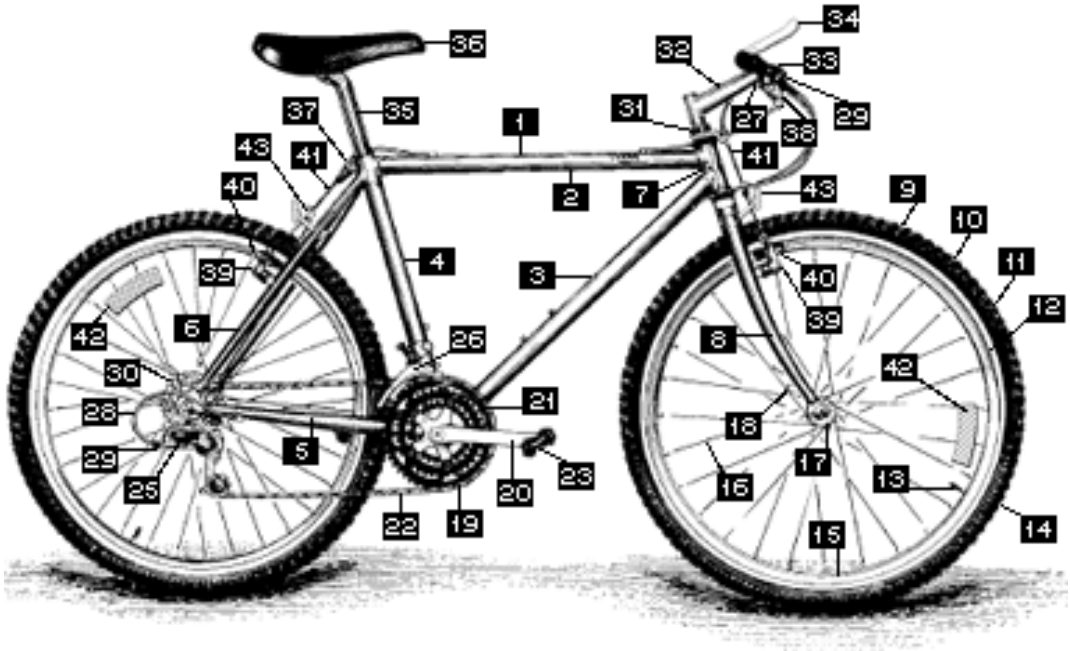
(Road Bike & Mountain Bike)

See Pictures and Diagrams Below



1. frame
2. top tube
3. down tube
4. seat tube
5. chain stay
6. seat stay
7. head tube
8. fork
9. wheel
10. tire
16. spokes
17. hub
18. quick release
19. bottom bracket
20. crank
21. chain rings
22. chain
23. pedal
24. toeclip/strap
25. rear derailleur
31. headset
32. stem
33. handlebars
34. bar-end extension
35. seat post
36. saddle
37. seat binder
38. brake lever
39. brake
40. brake shoe

11. tread
12. sidewall
13. valve stem
14. tube (inside tire)
15. rim
26. front derailleur
27. shifter
28. shifter cable
29. adjusting barrel
30. free wheel/rear cluster/cassette
41. brake cable
42. reflector
43. brake cable hanger



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