OXYGEN ADVANTAGE
THEORY 1
The Oxygen Advantage

- Measurement appraisal called BOLT
- Unblock the nose by holding the breath
- Switch to nasal breathing on a permanent basis
- Address dysfunctional breathing patterns
- Simulation of high altitude training
TRAITS OF DYSFUNCTIONAL BREATHING

• Dysfunctional Breathing: no precise definition

Generally includes any disturbance to breathing including; hyperventilation/over breathing, unexplained breathlessness, breathing pattern disorder, irregularity of breathing.
NORMAL BREATHING VOLUME

• Hyperventilation- breathing in excess of metabolic requirements of the body at that time.
TRAITS OF DYSFUNCTIONAL BREATHING

• Breathing through the mouth
• Hearing breathing during rest
• Sigh regularly
• Regular sniffing
• Taking large breaths prior to talking
• Yawning with big breaths
• Upper chest movement
• Lots of visible movement
NORMAL BREATHING VOLUME

• 4 - 6 liters of air per minute during rest

MINUTE VOLUME

• 13 (±2) L/min (Chalupa et al, 2004)
• 15 L/min (Johnson et al, 1995)
• 14 (±6) L/min (Bowler et al, 1998)
• 13 (±4) L/min (Kassabian et al, 1982)

• Sleep Apnea
• 15 (±3) L/min (Radwan et al, 2001)
Breathing During Stress

- Faster
- Sigh more (irregular)
- Oral breathing
- Noticeable breathing
- Upper chest breathing
<table>
<thead>
<tr>
<th>BREATHING TO EVOKE RELAXATION</th>
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<tbody>
<tr>
<td>• Slow down</td>
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<tr>
<td>• Regular</td>
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<tr>
<td>• Nose breathing</td>
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<tr>
<td>• Soft breathing</td>
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<tr>
<td>• Diaphragm breathing</td>
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HOW SHOULD WE BREATHE?

• Breathing is light, quiet, effortless, soft, through the nose, diaphragmatic, rhythmic and gently paused on the exhale.

• This is how human beings breathed until the comforts of modern life changed everything, including our breathing.
HOW SHOULD WE BREATHE?

• If you took a run alongside an elite athlete in good health, would you expect her to be huffing and puffing like a train?
The regulation of breathing is determined by receptors in the brain which monitor the concentration of carbon dioxide along with the pH level and to a lesser extent oxygen in your blood.
PRIMARY STIMULUS TO BREATHE

- There is a large reserve of oxygen in the blood stream, such that oxygen levels must drop from 100mmHg to about 50mmHg before the brain stimulates breathing.
HOW SHOULD WE BREATHE?

• The threshold for the hypoxic ventilatory response is approximately 60mmHg (Loeschcke & Gertz, 1958), which is reached during exercise at an altitude of about 2500m (Ferretti et al., 1997; Cardus et al).

PRIMARY STIMULUS TO BREATHE

- **Peripheral chemoreceptors** (or carotid and aortic bodies) are so named because they are sensory extensions of the peripheral nervous system into blood vessels where they detect changes in chemical concentrations.
Peripheral chemoreceptors help maintain homeostasis in the cardiorespiratory system by monitoring concentrations of blood borne chemicals including low oxygen (hypoxia), high carbon dioxide (hypercapnia), and low glucose (hypoglycemia).
PRIMARY STIMULUS TO BREATHE

• If the levels are too low or too high, the chemoreceptors send a message to the respiratory centre located in the brain.
The brain stem is the most primitive part of the brain. It begins at the base of the skull and extends upwards 6-8 cm.

In the lower portion of the brain stem is the medulla containing the respiratory center with separate inspiratory and expiratory centers.

PRIMARY STIMULUS TO BREATHE

• Normal PCO2 is 40mmHg

• An increase of PCO2 above this level stimulates the medullary inspiratory center neurons to increase their rate of firing. This increases breathing to remove more CO2 from the blood through the lungs.

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. . Springer; 1994
The inspiratory center sends impulses down the spinal cord and through the phrenic nerve which innervates the diaphragm, intercostal nerves and external intercostal muscles, producing inspiration.

At some point the inspiratory center decreases firing, and the expiratory center begins firing.

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. Springer; 1994
On the other hand, a decrease in the PCO2 below 40mmHg causes the respiratory center neurons to reduce their rate of firing, to below normal-producing a decrease in rate and depth of breathing until PCO2 rises to normal.

However, breathing more than what the body requires over a 24 hour period conditions the body to increased breathing volume.
CARBON DIOXIDE
NOT JUST A
WASTE GAS!
pH CO₂ Link

- pH 0: acidic, cells die
- pH 6.8
- pH 7.365: normal
- pH 7.8: cells die
- pH 14: alkaline
**pH CO₂ Link**

- Normal pH is 7.365 which must remain within tightly defined parameters. If pH is too acidic and drops below 6.8, or too alkaline rising above 7.8, death can result.

Blood, Sweat, and Buffers: pH Regulation During Exercise Acid-Base Equilibria Experiment
Authors: Rachel Casiday and Regina Frey
Carbon dioxide forms bicarbonate through the following reaction:

\[ \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^- \]

CO2 disassociates into H+ and HCO3- constituting a major alkaline buffer which resists changes in acidity.
pH CO$_2$ Link

• If you offload carbon dioxide, you are left with an excess of bicarbonate ion and a deficiency of hydrogen ion.

• During short term hyperventilation- breathing volume subsequentially decreases to allow accumulation of carbon dioxide and normalisation of pH.
pH CO₂ Link

- However, when over breathing continues for hours/days, bicarbonate excess is compensated by renal excretion.

- Hypocapnia and pH shift are almost immediate; adjustment of bicarbonate takes time. (hours to days)

Thus the chronic hyperventilator's pH regulation is finely balanced: diminished acid (the consequence of hyperventilation) is balanced against the low level of blood bicarbonate maintained by renal excretion.

pH CO₂ Link

• In this equilibrium small amounts of over breathing induced by emotion can cause large falls of carbon dioxide and, consequently, more severe symptoms.

Bohr Effect

- In 1904, Christian Bohr, a Danish biochemist discovered that “the lower the partial pressure of carbon dioxide (CO2) in arterial blood (paCO2), the greater the affinity of hemoglobin for the oxygen it carries”
Bohr Effect

- That is, an increase in blood CO$_2$ concentration, which leads to a decrease in blood pH, will result in hemoglobin proteins releasing their load of oxygen.
Bohr Effect

• In other words, the lower the partial pressure of CO2 in arterial blood, the lower the amount of oxygen released by hemoglobin to cells for production of energy.

• This discovery was named ‘The Bohr Effect’.
pH CO₂ Link

• There is little difference between CO₂ in alveoli and arterial blood. The level of arterial blood depends entirely on alveolar CO₂.

• Alveolar CO₂ depends on breathing volume.
Bohr Effect

• By nasal breathing, CO$_2$ is higher, the oxygen that is inhaled is more efficiently distributed to fatigued tissues which should in theory improve health and athletic performance and recovery, with practice of the technique.
OXYHEMOGLOBIN DISSOCIATION CURVE

• Over breathing reduces the delivery of oxygen to tissues and organs.
OXYHEMOGLOBIN DISSOCIATION CURVE

- An exercising muscle is hot and generates carbon dioxide and it benefits from increased unloading of O2 from its capillaries.

A primary response to hyperventilation can reduce the oxygen available to the brain by one half.

Hyperventilation Syndrome

- Cardiovascular: palpitations, missed beats, tachycardia, sharp or dull atypical chest pain, ‘angina’, cold extremities, raynauds, blotchy flushing of blush area, capillary vasoconstriction.

- Neurological: dizziness, instability, faint feelings (but rarely fainting) headache, paraesthesiae- (numbness, deadness, uselessness, heaviness, pins and needles).

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. Springer; 1994
Hyperventilation Syndrome

- Respiratory: shortness of breath, irritable cough, tightness or oppression of chest, air hunger, inability to take a deep breath, excessive sighing, yawning, sniffing.
- Muscular: cramps, muscle pains - neck & shoulders, stiffness.
- Psychic: tension, anxiety, ‘unreal feelings’, panic, phobias, agoraphobia.
- Allergies.

Hyperventilation Syndrome

- Gastrointestinal: difficulty in swallowing, globus (having a lump in one's throat), dry mouth and throat, acid regurgitation, heart burn, flatulence, belching, air swallowing, abdominal discomfort, bloating.

- General: weakness, exhaustion, impaired concentration, impaired memory and performance, disturbed sleep, including nightmares, emotional sweating,

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. Springer; 1994
Hyperventilation Syndrome

- According to Lum, hyperventilation ‘fell between the two stools of medicine and psychiatry’

- The major reason why hyperventilation had not been fully recognised is that most clients were not taught how to change their breathing. Effective breathing retraining is required to demonstrate conclusively that hyperventilation is the cause of the clients' symptoms.

Hyperventilation Syndrome

Because these patients report symptoms in more than one system, they are often labelled as hypochondriacs. Historically, they are often told to relax and take a few deep breaths!

Timmons B.H., Ley R. Behavioral and Psychological Approaches to Breathing Disorders. 1st ed. Springer; 1994