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THE IMPORTANCE OF OXYGEN CONCENTRATION (pO_2)

Dr. Walter Kempner is widely known today as the "Rice Diet doctor." However, in the 1930's, to a group of scientists who investigated the reactions of cells, he was known as "Oxygen Tension Kempner." His early work on oxygen tension (oxygen concentration or oxygen pressure) formed a basis for much of what he has accomplished since then.

Oxygen concentration in the arterial blood is normally between 85 and 120 mmHg. In discussing metabolism and oxygen concentration, Dr. Kempner often advises "cleaning your fireplace" or "getting larger, more effective lung bellows."

In the 1920's, Dr. Otto Warburg, the Nobel Prize winner often called the Father of Cellular Physiology, proposed the all-or-nothing law of cellular respiration: "The respiration of cells is independent of oxygen tension. Cells breathe maximally as long as any amount of oxygen, no matter of what tension or concentration, is present." His theory was derived from experiments with sea urchin eggs, red blood cells of birds, and bacteria, at 31-50 degrees Fahrenheit.

Dr. Kempner, after working at the Warburg Institute in Germany, came to Durham and continued research in this field. In the 1930's, he found that respiration of bacteria and of red blood cells of animals and humans *varies* greatly with changes in oxygen concentration. He conducted his experiments at 98.6 degrees Fahrenheit (body temperature) and in fluids whose compositions were similar to those in the human body. The effect of oxygen concentration is not a straight line phenomenon, but is similar to the hemoglobin oxygen dissociation curve (see Figure 1).

Dr. Kempner also showed that conditions of low oxygen concentration actually do occur in the body. He had made a model area of inflammation, producing small blisters on the skin with cantharidin plasters. He drew off fluid from the blisters and determined the concentration of the oxygen and of other substances such as lactic acid, bicarbonate, sugar, etc. in this fluid.

EFFECT OF VARIOUS OXYGEN CONCENTRATIONS ON RATE OF RESPIRATION
(1 mg. tubercle bacterio, 38° C)

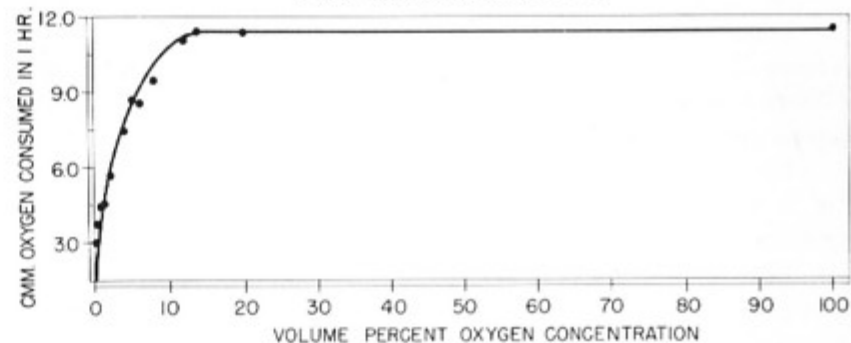


Figure 1

The oxygen decreased from values of 100 mmHg. to values as low as 16, 8 and 6 mmHg. after 65 hours of inflammation.

The oxygen concentration (pO_2) at the surface of any living cell is determined by the supply of oxygen to the tissue fluid surrounding the cell, and the amount used by that cell and the neighboring cells. The oxygen concentration in the tissue fluid depends on:

1. The oxygen (O_2) pressure (O_2 tension, O_2 concentration) in the air being breathed;
2. The degree to which the blood coming from the lungs has been saturated with O_2 ; e.g., with pneumonia or scarred lungs, the part of the blood going to the diseased or damaged lung will not take up much, if any, oxygen;
3. How much oxygenated blood is carried from the lung and arrives at the fluid surrounding the target tissue.

If there is any disturbance to the oxygen supply, the oxygen concentration in the tissue fluid will fall unless the body is able to compensate the deficiency, e.g., by increasing the number of red cells (the main oxygen carriers), or the volume of blood going to the tissue fluid. Disturbances in oxygen supply occur with high altitude, obesity, arteriosclerotic vascular disease, anemia, infection, etc.

Since fat needs oxygen in order to prevent it from becoming gangrenous, a lot of oxygen is wasted by heavy people. The lung volume may also be smaller, the chest wall heavier, and water retention in the lung membranes may affect diffusion. These factors play a

role in hypoventilation (decreased volume of air being moved) and in oxygen transfer from the air into the blood stream.

Once at the Warburg Institute for Cellular Physiology, Dr. Kempner discussed an early finding with a colleague who said: "There must be a mistake. What you have found is contrary to the laws of cellular physiology."

Dr. Kempner reported on the experiment the next morning to Dr. Warburg himself, adding, "I must have made a mistake. These findings are contrary to the laws of cellular physiology."

"Repeat your experiment a few times," Dr. Warburg said. "If you get the same results, the laws of cellular physiology have to be changed."

This is exactly what happened. It was Dr. Kempner's first overthrow of an established belief. He was to upset much other conventional wisdom:

- Cholesterol is independent of diet;
- Diabetics should avoid carbohydrates;
- Man needs 10-15 grams of salt and 50 grams of protein, preferably from animal sources, per day;
- Doctors should not attempt to lower the blood pressure of older people—"they need the high pressure to force the blood through narrow arteries";
- Large amounts of protein should be fed to kidney patients who lose large amounts of protein in their urine.

In marked obesity, low oxygen concentration is frequently an important complication. In narcolepsy* the oxygen concentration in the arterial blood is below normal. For example, patient N.S. (see 1955 Bulletin of the Kempner Foundation) came to Durham with narcolepsy and a weight of 462.5 pounds. He lost 150 pounds in 202 days on the Rice Diet. During this time, the oxygen concentration in his arterial blood increased from 65 to 85 mmHg. (85-120 is normal.) His narcolepsy disappeared.

We summarize data here on 250 obese out-patients without obvious heart or lung problems (i.e., cyanosis, twitching, periodic breathing, polycythemia or heart failure) in whom the initial oxygen concentration in the arterial blood was below 85 mmHg. The oxygen

* the Pickwickian syndrome: people fall asleep when talking, driving a car, or during normal activities like telephoning.

Table 1
CHANGES IN ARTERIAL OXYGEN TENSION (PO₂)
IN 105 PATIENTS TREATED WITH RICE/REDUCTION DIET

	NUMBER OF PATIENTS	PO ₂ BEFORE TREATMENT mmHg.	PO ₂ AFTER TREATMENT mmHg.	DIFFERENCE mmHg.
Increase in Arterial Oxygen Tension	87*	69.9	84.5	+14.6
Decrease in Arterial Oxygen Tension	18**	76.8	66.4	-10.4
Average Change in Arterial Oxygen Tension	105***	71.1	81.4	+10.3#

#paired t test: p < .0001 (Very highly significant)

* arterial carbon dioxide tension before treatment 37 mmHg.; after treatment 37 mmHg.; average weight loss 51 pounds in 102 days.

** arterial carbon dioxide tension before treatment 37 mmHg.; after treatment 38 mmHg.; average weight loss 45 pounds in 90 days.

*** arterial carbon dioxide tension before treatment 37 mmHg.; after treatment 37 mmHg.; average weight loss 50 pounds in 100 days.

