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Lowest Barometric Pressure Compatible with Life in an Atmosphere of 100 Per Cent Oxygen.

H. F. HAILMAN. (Introduced by E. Gellhorn.)
From the Department of Physiology, University of Illinois College of Medicine, Chicago.

Armstrong[1] has stated that life is impossible at an altitude where the barometric pressure equals 87 mm Hg even in an atmosphere of 100% oxygen. He explains this conclusion by assuming the water vapor tension in the lungs to be 47 mm Hg and the carbon dioxide tension to be 40 mm Hg. Hence, at an altitude where the barometric pressure corresponds to 87 mm Hg no oxygen would be able to enter the alveoli of the lungs even though one were breathing pure oxygen. However, it is generally known that hypernea occurring at high altitude considerably reduces the carbon dioxide tension in the alveoli. Moreover, the water vapor tension, too, tends to fall during hyperventilation.[2] These observations suggest that the theoretical minimal barometric pressure compatible with life in an atmosphere of 100% oxygen is lower than given by Armstrong. The present investigation aims to show that this is true.

Ten male rats weighing approximately 250 g were subjected to decreased barometric pressure in an atmosphere of 100% oxygen. The barometric pressure was reduced by a vacuum pump which permitted a constant flow of oxygen. In the first 5 minutes the pressure was gradually lowered to 180 mm Hg, in the next 5 minutes to 90 mm Hg and thereafter by 5 mm Hg every 4 minutes until gasping occurred. Soda lime was placed in the chamber to absorb carbon dioxide. The rate of reducing the pressure was controlled by an outside manometer connected to the decompression chamber, while the lower values of pressure were read from a closed manometer placed directly in the chamber. The experiment was terminated when gasping occurred; restoration to normal atmospheric pressure revived the animals in several minutes.

TABLE I.
Barometric Pressure at Which Respiratory Failure Occurred in Rats in an Atmosphere of 100% Oxygen.

Rat	Group A	Group B (allowed to hyperventilate for an additional 20 min)
1	60	50
2	65	70
3	65	55
4	65	60
5	75	50
6	65	65
7	70	65
8	65	65
9	60	60
10	60	

In a second group (9 animals) the same procedure as above was carried out except that the animals were kept for 20 minutes at a pressure varying between 75 and 90 mm Hg, depending on the pressure at which the greatest degree of hyperpnea occurred. After this period the decompression was carried on to the gasping state as in the first experimental group. This was done to allow additional time for reducing the carbon dioxide and water vapor tensions.

As shown in the accompanying table, the average barometric pressure at which gasping occurred in an atmosphere of pure oxygen was 65 mm Hg with variations between 60 and 75 mm Hg. In the second group permitted to hyperventilate for an additional 20 minutes the average pressure for gasping was 60 mm Hg with variations between 50 and 70 mm.

Observations of Bert[3] and Selladurai and Wright[4] suggest that at a partial pressure of about 10 mm Hg of oxygen in the alveoli

[1] Armstrong, H. G., *Principles and Practice of Aviation Medicine*, Baltimore, 1939, Williams and Wilkins Co.

[2] Christie, R. V., and Loomis, A. L., *J. Physiol.*, 1932, **77**, 35.

[3] Bert, P., *La Presson Barometrique*, 1878.

[4] Selladurai, S., and Wright, S., *Quart. J. Exp. Physiol.*, 1932, **22**, 233.

death occurs. If this value of 10 mm Hg for oxygen is subtracted from 50 mm Hg, the lowest barometric pressure at which gasping was found to occur in an atmosphere of pure oxygen, 40 mm Hg remain for the partial pressures of carbon dioxide and water vapor. It is evident that these pressures must fall considerably below the values given by Armstrong. The fall in the partial pressure of carbon dioxide is due, as is well known, to the hyperventilation occurring during anoxia and the fall in water vapor tension is probably the result of two factors: (a) lowering of body temperature as a result of anoxia[5] and (b) the lack of equilibrium between alveolar air and blood as a result of the increased ventilation.[2]

Summary. Two groups of male rats were subjected to a progressive reduction in barometric pressure while in an atmosphere of pure oxygen in order to discover the pressure at which respiratory failure occurred. The first group gave an average value of 65 mm Hg with variations between 60 and 75 mm Hg, and the second group, allowed to hyperventilate for an additional 20 minutes, gave an average value of 60 mm Hg with variations between 50 and 70 mm Hg. The difference between the two groups shows that the additional hyperventilation had a slight effect on reducing the atmospheric pressure at which respiratory failure occurred in this experiment. These results indicate that the partial pressures of carbon dioxide and water vapor fall lower than previously assumed and therefore life is possible at a higher altitude in the presence of pure oxygen than heretofore believed.

5 Gellhorn, E., *Am. J. Physiol.*, 1937, **120**, 190.

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Effects of Yeast Extracts and Phenylmercuric Nitrate on Yeast Respiration and Growth.

ELTON S. COOK AND CORNELIUS W. KREKE. (Introduced by S. Tashiro.)

From the Research Laboratories of the Institutum Divi Thomae, Cincinnati, Ohio.

In earlier papers it has been pointed out that yeast extracts having the property of increasing respiration are able to offset the toxicity of phenylmercuric nitrate and of *n*-butyl-*p*-hydroxybenzoate for molds[1] and to overcome the depressant effects of phenylmercuric nitrate on skin respiration without loss of inhibitory power for *S. aureus* in the concentrations employed.[2] We had also found that, with certain fractions from yeast, ability to stimulate the oxygen uptake of yeast paralleled ability to increase yeast proliferation.[3]

In continuation of our studies on respiration depression as an index of toxicity and on the relation between respiration and growth we have investigated the effects of phenylmercuric nitrate on the growth and respiration of yeast and the ability of yeast extracts to modify those effects.

Respiration experiments were carried out at 37.5°C by the previously described Warburg manometric technic,[4,5] using a suspension containing 1.56 mg (dry weight) of Fleischmann's bakers' yeast in Ringer-phosphate-glucose (0.02% glucose, pH 7.2). Aqueous-alcoholic yeast extracts were pre-

1 Cook, E. S., and Kreke, C. W., *Nature*, 1940, **146**, 688.

2 Cook, E. S., Kreke, C. W., Eilert, M. R., and Sawyer, M. A., PROC. SOC. EXP. BIOL. AND MED., 1942, **50**, 210.

3 Cook, E. S., Hart, M. J., and Stimson, M. M., *Biochem. J.*, 1940, **34**, 1580.

4 Cook, E. S., Kreke, C. W., and Nutini, L. G., *Studies Inst. Divi Thomae*, 1938, **2**, 23.

5 Cook, E. S., and Morgan, M. N., *Biochem. J.*, 1940, **34**, 15; Cook, E. S., Walter, E. M., and Eilert, M. R., PROC. SOC. EXP. BIOL. AND MED., 1940, **44**, 547.