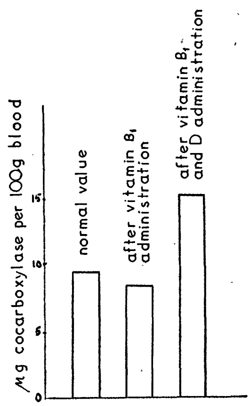


FIG. 1.

After this, the subject was given 0.05 g thiamin intramuscularly for 4 successive days, and finally 500,000 IU vitamin D and 0.05 g thiamin again for 4 successive days. The cocarboxylase concentration in the blood was determined throughout the course of the experiment. In some of the cases, vitamin D strongly activated the synthesis of cocarboxylase. Fig. 1 shows the

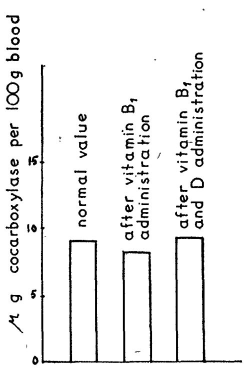


FIG. 2.

typical results of such an experiment. Younger subjects seemed less prone to this activation than older ones. In other cases, there was no activation (Fig. 2). This may have been due to the possibility of the subject's having been "saturated" with vitamin D before the experiment. In rickets, no activation was observed (Fig. 3).

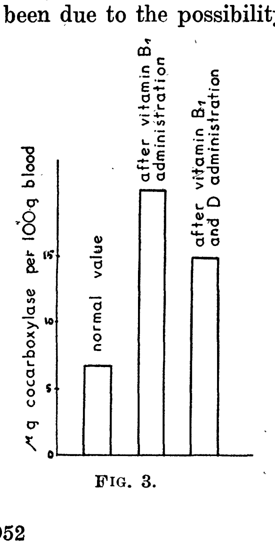


FIG. 3.

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## Demonstration Concerning Pressure-Tension Relations in Various Organs

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Most textbooks of physiology used in medical schools in this country fail to make use of the formulas of Laplace relating the pressure in a hollow body, its radius of curvature, and the tension in its wall. This neglect has occasioned, for example, misleading theoretical treatments in hemodynamics. Some widely used books base a tendency of an aneurysmal sacculation "to go from bad to worse" on Bernoulli's hydrodynamic principle that along a line of flow in a tube the lateral pressure is increased in a dilated portion, where the velocity of flow is reduced. This, it is true, puts added strain on an arterial wall already weakened by disease processes. But no note is taken that the percentual increase in lateral pressure in such conditions must be quite small, as can be indicated by calculation or by demonstration in models. Actually, the *tension* in the dilated wall, which is the important consideration, tends to increase in proportion to the radius of curvature of the sacculation; and this is the dominant factor.

For a hollow sphere, Laplace's formula states $P = 2T/r$, where $P$ is internal pressure (excess over external pressure), $T$ is tangential tension in the wall, and $r$ is the radius. For a cylinder the formula is $P = T/r$. Practically, the blood pressures in the aneurysm and in the portions of the vessel just proximal and distal to it may be essentially equal. If so, a sacculated segment with radius twice the proximal or distal segments would have to suffer a tension in its wall twice that of the wall of the proximal or distal vessel in order to sustain the pressure. Huge increases in tension may occur in the wall of greatly dilated vessels in which the change in blood pressure, following Bernoulli's theorem, is negligible.

Many students find it difficult to comprehend these pressure-tension relations in blood vessels. A model piezometer of glass or semirigid tubes is inadequate to suggest to an observer the state of tension in its walls. The demands on the imagination can often be obviated by an elementary demonstration in the classroom using a partially inflated tubular balloon (Fig. 1). It is easy for students to grasp the sense of Pascal's law

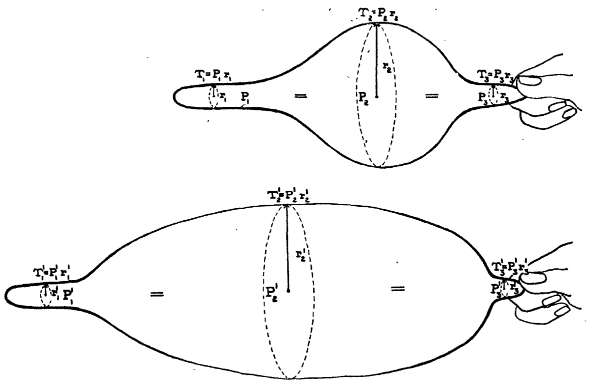

FIG. 1. Partially inflated rubber balloon may take these forms. The pressure $P$ within the balloon is equally transmitted to all parts of the contained air (Pascal's law: $P_1 = P_2 = P_3$; $P_1' = P_2' = P_3'$), and the tension $T$ in the wall of the balloon varies with the radius $r$ in that portion.

that the pressure of the air within the balloon must everywhere be equal. The obvious tautness of the dilated portion (under greater stretch, with the rubber plainly thinner) contrasts sharply with the relative flaccidity of the undilated portion, making concrete the direct relation between the radius of curvature and the tension in the wall at a given internal pressure. It is demonstrated at once that this relation obtains even when there is no flow of fluid. One may note that this experiment is the converse of that performed in physics classes in which the air contained within each of two soap bubbles, blown on separate pipes, is put in communication. The surface tensions of the two soap films are essentially equal. Where one bubble has a smaller radius than the other, the internal pressure in that bubble is necessarily greater, and the small bubble discharges its air into the large.

Laplace's formula applies more exactly the smaller the wall thickness. In the case of a thin-walled cylinder (where the ratio of outside diameter to inside diameter is less than 1.20) one often considers only the "hoop stress" and assumes it to be uniformly distributed throughout the wall cross section. Hoop stress (e.g., in an iron pipe) drops off from a maximum value at the inner wall to a minimum value at the outer wall, the drop being greater the larger the ratio of diameters. Since, when a viscus is dilated, the cross-sectional thickness of the wall may markedly decrease, the tension of the wall per unit cross section is increased even more than indicated by Laplace's proportionality between radius and tension, applied to a relatively unstretchable wall.

Even without consideration of this aspect of the matter, the thinness of the walls of capillaries, for example, takes on added physiologic significance when considered in terms of wall tension rather than merely in terms of blood pressure. One becomes more sensible of how capillaries can sustain high blood pressures without rupturing (as where venous return is blocked), despite the delicacy of their structure. Burton *et al.* (*1–3*) have carefully studied the application of Laplace's equations in this field and reviewed much of the literature. Although these equations have long been known to physiology, few physiologists appear to use them in their everyday thinking and teaching. Classes will better understand such diverse physiologic topics as pressure-tension relations in the eyeball (*4*), the urinary bladder (*5*), the heart (*6*), and the gut (*7*) when proper attention is given to the formulas of Laplace. D'Arcy Thompson (*8*) treats of some of the more beautiful applications of these relations in biology.

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# An Air-Cleaning Apparatus for the Flame Photometer


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We have found the flame photometer capable of measuring the sodium and potassium concentrations in biological materials with a precision comparable to that of the more laborious chemical methods. The simplicity and rapidity of the technique was, however, impaired by the extreme sensitivity of the instrument to room air contamination with dust and especially with tobacco smoke. In our instrument[1] the vaporized sample is led to the air inlet at the base of a Meker burner, where it is sucked with room air into the burner by the draft caused by the flame. An isolated or air-conditioned room was not available, and the photometer had to be used in a dusty room from which tobacco smoke could not always be excluded. Consequently the behavior of the instrument and the output were erratic, and much time was wasted in performing analyses under poor conditions because they had to be completed at once. To avoid the necessity of isolating the photometer or of air-conditioning the whole room, a closed air-cleaning system has been installed and has proved of value. The burner has been enclosed in an airtight chamber the inlet of which is through an air-cleaning apparatus and the outlet through a closed stack around the burner about 28 cm high.

In the Barclay instrument this was most easily

[1] A Barclay Flame Photometer, General Scientific Instrument Co., Hamden, Conn.