ances in fitness is proposed and a convenient instrument for giving the test is briefly described. The test falls well within the technical capabilities of the average flight surgeon and should not require more than ten minutes to perform. It is recommended that the test should be given both immediately before and immediately after each flight. Reasons for this are: (1) The test before the flight can be used to prevent the aviator from going into the air when he is clearly and dangerously unfit for service. It is neither fair nor good public policy that a knowledge of his fitness should depend upon his own report. The responsibility for making such report should be taken out of his hands and consigned to a competent examiner. (2) The test at the end of the flight would indicate how well the aviator has stood the strain of his service. It would give valuable information as to his susceptibility to fatigue and make it possible to assign him to the length and kind of service he is capable of performing. It would also give a great deal of valuable general information as to the number of hours in the air and the amount of strain which aviators, taken collectively, can reasonably be expected to stand. (3) From the results of the tests, graphs or curves can be plotted which will give a splendid picture of the aviator's fitness, his endurance, his susceptibility to fatigue, the consistency of his service, etc. From these graphs it can also be readily seen when the aviator is becoming incapacitated for service through age or some other cause.

C. E. FERREE
G. RAND

SPECIAL ARTICLES

VISUAL PURPLE AND ROD VISION[1]

So much evidence has accumulated to show an approximate agreement between the absorption spectrum of visual purple and the spectral sensitivity at low intensity (rod vision) in the mammal that there can be little doubt that this substance is the light absorber for the process. Hecht and Williams[2] (1922) compared their data for the human retina with the average values for mammalian visual purple obtained by Köttgen and Abelsdorff,[3] and pointed out that the spectral sensitivity curve was uniformly displaced about 7 mμ toward the red from the absorption spectrum. This they accounted for on the basis of Kundt's rule, which states that the greater the refractive index of the solvent, the farther is the absorption spectrum shifted toward the red. They assumed that the solvent medium in the rods is of a higher refractive index than the aqueous solution in which the absorption spectrum of the visual purple was measured. Actually Kundt's rule has so many exceptions that it can hardly be regarded as a rule at all, so that this explanation is of little value, and it is the purpose of the present communication to show that if the data are properly expressed they can be made to agree within the limits of experimental variation so that there is no need of assuming a displacement toward the red nor invoking the questionable rule of Kundt.

It must be recalled in making such a comparison that while absorption spectra are always measured in terms of energies, the receptor actually responds to number of quanta. The latter must be true if the receptor response is based on some sort of photochemical process, which seems certain. Thus it is necessary to convert absorbed energies into number of quanta before comparing them with the relative stimulating energies. There are numerous factors which may prevent an agreement between the absorption spectrum and the receptor sensitivity, but no correspondence is to be expected except on the above basis.

The conversion from energies into relative number of quanta is easily made, since the size of the quantum is related to the wave-length in the following manner: $\varepsilon = hc/\lambda$, where ε is the quantum, h Planck's constant, c the velocity of light, and λ the wave-length. Since both h and c are constants, the quantum must be inversely proportional to λ. Thus the number of quanta in equal intensities of light of different wave-length is directly proportional to the wave-length, so that absorbed energies may be converted into relative number of quanta by merely multiplying by the wave-length. Since the wave-length range is not great in the present case, the correction can not be of great magnitude; in fact, Hecht[4] dismisses it in a recent review (1937) by the following statement: "Strictly, the assumption should be that a constant number of quanta is required, but because of the small range of wavelengths the difference between the two is negligible." However, the accompanying curves will show that the correction is of just sufficient magnitude to take care completely of the discrepancy pointed out by Hecht and Williams (1922) and still explained by Hecht on the basis of Kundt's rule in 1937.

In Fig. 1 are plotted the data of Hecht and Williams for the sensitivity of the dark-adapted human eye at very low light intensity, together with the measurements of mammalian visual purple by Köttgen and

[1] The Division of Physiology, University of California Medical School, Berkeley, Calif.

[2] S. Hecht and R. E. Williams, *Jour. Gen. Physiol.*, 5: 1, 1922.

[3] E. Köttgen and G. Abelsdorff, *Ztschr. f. Psych. u. Physiol. d. Sinnesorgane*, 12: 161, 1896.

[4] S. Hecht, *Physiol. Rev.*, 17: 239, 1937.

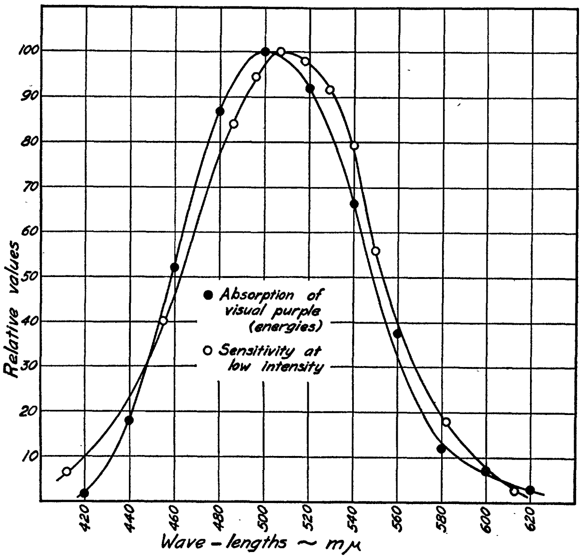

FIG. 1

Abelsdorff (1896). The data of Köttgen and Abelsdorff are for the monkey, the dog, the cat and the rabbit, all of which are in agreement. They are also in approximate agreement with rough measurements for a human eye made by Koenig, and it is reasonable to assume that the substance is identical in all mammals. The curves in Fig. 1 are essentially those plotted by Hecht and Williams except that I have included two values for absorption of visual purple at 420 mμ and 440 mμ, which Hecht and Williams discard. When these two points are included the shift toward the red is less evident. While there is a considerable variation in the values for these points it seems that they may be safely included in the data.

In Fig. 2, the absorption spectrum measurements

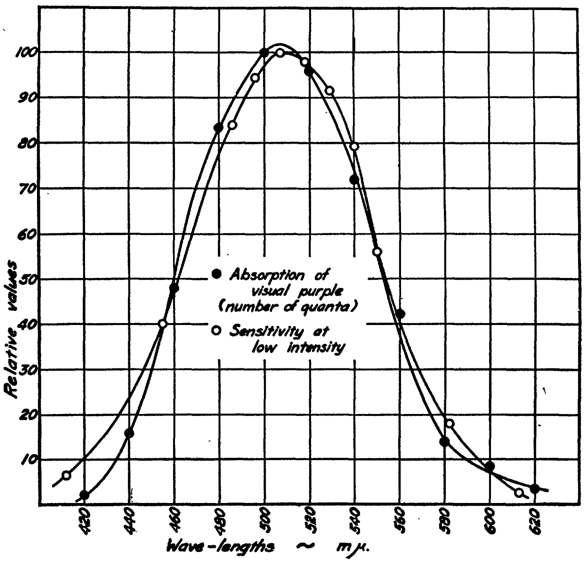

FIG. 2

are converted into relative number of quanta by multiplying by the wave-length and then by a comparison factor to bring the maximum value at 500 mμ into agreement with maximum sensitivity of the eye, at 507 mμ. The two sets of data are now in rather good agreement, but a separate curve has been drawn through each. The maximum of the absorption curve as drawn is at the same wave-length as the maximum of sensitivity, but about 2 per cent. above. Consequently, the points have all been lowered 2 per cent. in Fig. 3. In the latter figure are also included the

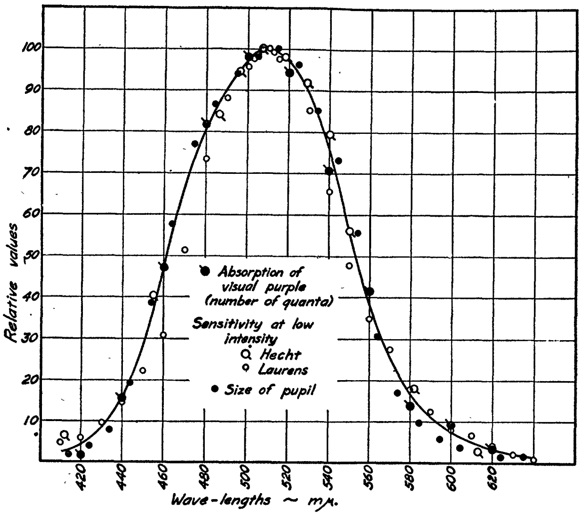

FIG. 3

data of Laurens[5] (1923) for pupil size as related to wave-length for the dark-adapted eye at low intensity, and also his measurements[6] (1924) of the spectral sensitivity of the human eye under similar conditions. The former, which constitute a purely objective measurement of the spectral response of the retina, agree very well with the recalculated absorption spectrum data, while the latter deviate somewhat from all the rest. With the exception of Laurens's spectral sensitivity measurements which were obtained for only two subjects, the data are in very close agreement. The alleged displacement toward the red has completely disappeared, and there is no further need for Kundt's rule.

H. F. BLUM

UNIVERSITY OF CALIFORNIA

ON THE SPIROCHETICIDAL ACTION OF THE ARSPHENAMINES ON SPIROCHETA PALLIDA IN VITRO[1]

SOON after the discovery of arsphenamine, it was reported that the substance had no direct spirocheti-

[5] H. Laurens, *Am. Jour. Physiol.*, 64: 97, 1923.

[6] H. Laurens, *Am. Jour. Physiol.*, 67: 348, 1924.

[1] From the Syphilis Division of the Department of Medicine, Johns Hopkins University Medical School, Baltimore, and the U. S. Public Health Service, Washington.