PRO EXPERIMENTIS

Light transmission. I. An acoustic method able to monitor transmitted light

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Summary. A method able to monitor transmitted light acoustically is described. It makes use of an amplifier of light variations, provided with a photocell and a sound device, a photometer, an optic probe and a special support.

There is an ever-growing interest in light. Its therapeutic applications are well-known and some of them are widely accepted and routinely employed. Blue light is used to lower plasma bilirubin in newborn jaundiced infants[3,4]. Some compounds excited by light are able to disrupt the DNA mechanism[5]. The use of some dyes along with light is being used in the treatment of herpes[6]. Hematoporphyrin, a compound which is taken up primarily by cells in mitotic activity, is lethal to these cells in the presence of light. To this effect studies are in progress for the use of light, along with hematoporphyrin, as a therapeutic weapon against cancer[7,8].

But for light to bring about its effects it has to be able to reach the site where its action has to take place in adequate amounts. It has been shown, using various methods, that light is able to penetrate biological tissues[9-12]. Its intensity, though, shielded by the overlaying tissues, may drop below its threshold values so that its effects will not take place. It is of paramount importance to know the actual intensity of light reaching the site where its action is needed. The purpose of this study is to present a method able to monitor transmitted light.

The entire set-up consists of the following parts: an electronic amplifier of light variations provided with an audio device, a photocell, a plastic platform with light source and lever, an optic probe, a photometer and a power supply with a rheostat.

The amplifier, whose schematic diagram appears in figure 2, is powered by a 12-V battery, uses a transistor BC107, an integrated circuit L141 and an integrated circuit NE555 for the sound. Variations in light intensity are amplified. Acoustic changes are clearly distinguishable and reflect the variations in light intensity. Light is detected by means of a cadmium-sulfide photoconductor type CL705HL, manufactured by the Clairex Corp. of New York, encased in an amphenol connector and wired to the amplifier. Variations in light intensity are brought about by intercepting the beam of light impingeing on the photocell. The plastic platform is provided with a light source holder and slots for the optic probe holder and the sample holder. The holder for the light source has a lever on top of it, which is pivoted on the back, and bent at a right angle in the front so that it lies in front of the light source when it is pushed down. A spring holds the lever in an up-position so that it does not interfere with the beam of light, when it is not pressed down. The optic probe is 3 feet long with 4.5 mm inner diameter. Both ends of the optic probe are provided with a female amphenol connector. One end is permanently connected with the male amphenol of its holder inserted in the slot of the platform, and faces the light source. The other end is alternatively connected with the photocell of the amplifier and with the photometer. The other holder, provided with a hole in the center, accomodates the sample and when it is inserted in its slot it is aligned so that the beam of light passing through the sample and the hole impinges on the free end of the optic probe. The values of light intensity are read on a Pasco photometer. A rheostat, not shown in the figure, is used to regulate the intensity of light.

Measurements are taken as follows: With the light source on, in a dark room, the free end of the optic probe is connected to the photometer and by using the rheostat the desired intensity of light is measured. Then, while one end of the optic probe is still facing the light source the other end is disconnected from the photometer and connected to the photocell of the amplifier to calibrate the latter to the light intensity read on the photometer. With the light remaining at the same intensity and while the lever of the platform is made to go up and down, so as to intercept the beam of light alternatingly, the sensitivity knob of the amplifier is turned from its minimum sensitivity position, very slowly, clock-wise, till a peep-like sound, synchronous

Percent light transmission measurements

ND filters No and nominal values		Method I Intensity of light source Constant	Method II* Variable
0.1	80%	67.6 ±1.9	68.7 ±1.3
0.2	63	53.7 ±1.6	55.8 ±1.6
0.3	50	43.1 ±1.3	44.8 ±2.4
0.4	40	34.7 ±0.7	38.0 ±3.7
0.5	32	26.3 ±0.9	29.2 ±2.4
0.6	25	20.4 ±1.9	22.0 ±1.1
0.7	20	17.7 ±2.1	19.3 ±1.4
0.8	16	13.6 ±1.4	14.4 ±1.0
0.9	13	11.9 ±1.5	13.2 ±1.5
1.0	10	8.7 ±0.7	9.9 ±1.0
2.0	1	0.95±0.1	1.1 ±0.06
3.0	0.1	0.16±0.04	0.16±0.05

* Acoustic method.

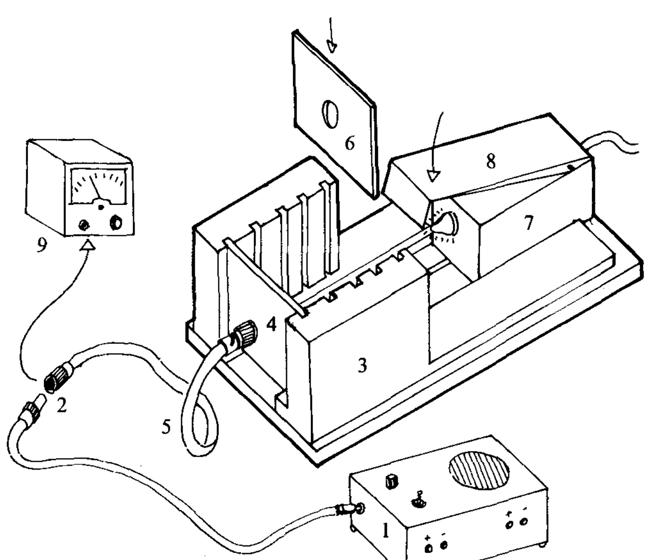

Fig. 1. Schematic representation of the system used to monitor transmitted light. 1: Amplifier of light variations. 2: Photocell wired to the amplifier. 3: Platform. 4: Holder for the optic probe. 5: Optic probe. 6: Holder for the sample. 7: Holder for the light source. 8: Lever. 9: Photometer.

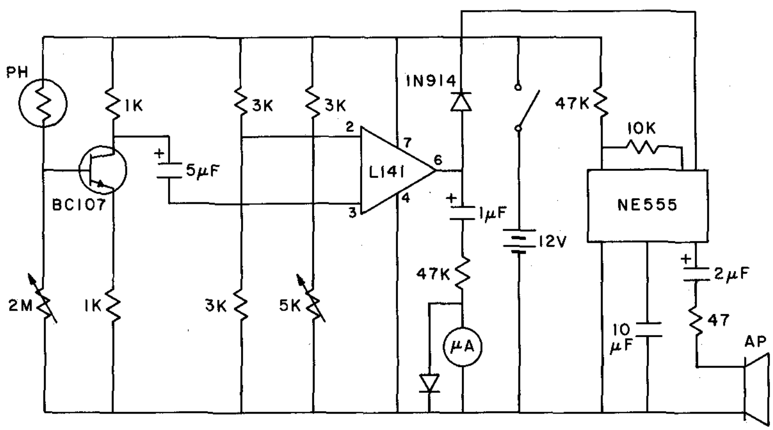

Fig. 2. Schematic diagram of the electronic amplifier.

with the movement of the lever is heard. This will indicate that at that precise moment the sensitivity of the amplifier has reached the same value as the previously chosen light intensity. With the sensitivity knob set at this point the amplifier is calibrated to that particular value and will not operate with lower intensities of light.

The sensitivity range of the amplifier runs from a maximum of 0.02 lux to a minimum of 160 lux. At its minimum sensitivity the amplifier will work only with light intensities of 160 lux or over. At its maximum even light intensities of 0.02 lux will make the apparatus work. Once the amplifier has been calibrated to the desired light intensity the sample is inserted in front of the light source. If the interposition of the sample makes the intensity of the light reaching the photocell of the amplifier drop below the sensitivity level for which the amplifier was calibrated, the up and down movement of the lever does not produce any change in sound. The intensity of light has to be slowly increased till the movement of the lever in front of the light source will produce the peep-like sound again. This indicates that, at that particular moment, an intensity of light equal to that for which the amplifier was calibrated has reached the photocell of the amplifier. The intensity of light is fixed at this particular value. The sample is then taken off and the optic probe is disconnected from the photocell of the amplifier and connected to the photometer (the other end of the optic probe still facing the light source) to read the new increased intensity of light which was able to make the system work again. From these 2 values the percent light transmitted can be calculated according to the formula $I_2:I_1 \times 100$; where the first intensity is represented by the values with which the amplifier was calibrated and the second intensity by the values the light reached at the start of the change in sound after the interposition of the sample.

In order to evaluate the validity of the method, measurements for light transmission were taken using both the usual method, in which the intensity of the light remains costant, and this audio method in which the intensity of light has to be increased instead, so that the same amount of light can reach the photocell after the interposition of the sample. Kodak neutral density filters were used as standards. The results, as percent light transmission, are shown in the table. A 5 V, 0.8 A bulb, powered by a battery and connected to a rheostat, was used as a light source. In using the usual method the free end of the optic probe was permanently connected to the photometer and the 2 different intensities of light with and without the interposition of the filters were obtained, while the intensity of light remained constant throughout the measurements.

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Light transmission. II. Instruments for making in-vivo light transmission measurements

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Summary. 2 instruments for making in vivo light transmission measurements are described. A special device makes it possible to measure the thickness of the tissue as well.

The increased therapeutic use of light[3-6] and the awareness of its potential deleterious effects have given a new interest to the study of its power to penetrate biological tissues. The various methods used to measure light transmission[7,8] do not offer the possibility of making in-vivo measurements. The purpose of this study is to present 2 instruments for