feature of the long-lived animals was a progressive change in the cellular type of reaction from an early infiltration of mononuclears with little cytoplasm to a stage of consolidation with epithelioid cells and finally to a "regressive" type of mononuclear reaction in which lesions decreased in size, epithelioid cells were few and mononuclears with little cytoplasm predominated.

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17116. Ante-Mortem Failure of the Aural Microphonic in the Guinea Pig.*

J. S. RIESCO-MACCLURE,† H. DAVIS, B. E. GERNANDT,‡ AND W. P. COVELL.
(Introduced by H. Lester White.)
From the Central Institute for the Deaf and Department of Otolaryngology, Washington University, St. Louis, Mo.

In the course of an extended study of the electrical response of the cochlea of the guinea pig to pure tones and to clicks we have collected incidental observations on the conditions of survival of these responses. Since these conditions are pertinent to any theory of the origin of the aural microphonic or "cochlear response" we present them herewith. Our report concerns only the aural microphonic, which apparently is closely related to the physical movements of the basilar membrane or some closely adjacent structure, and not the action potentials of the auditory nerve (or spiral ganglion) which are usually recorded with the microphonic. In general the action potentials fail equally with or before the microphonic. We have never yet observed the action potentials under conditions where the aural microphonic could not also be elicited, although sometimes a greater intensity of stimulus is necessary to make the microphonic visible on the oscilloscope.

Our sound-generating system and our pick-up amplifiers and oscilloscopes follow conventional design and will be described in detail elsewhere. We make electrical contact with the cochlea through a tiny wick applied to the round window and through fine copper or silver wires passing through or fitted like a cork into small holes drilled through the bony shell of the cochlea. A reference electrode is connected to the edge of the wound in the neck.

Mere placement of an electrode on the round window membrane does not necessarily cause a reduction of the aural microphonic over a period of many hours or even 2 or 3 days. Neither does the anaesthetic *per se* (dial in urethane), provided the dose is light enough to allow reflex muscular movements and circulation and respiration remain adequate. Fall in body temperature sometimes seems to cause a reversible reduction of the microphonic, but no more than can reasonably be explained by the associated fall in metabolic rate and changes in circulation and respiration. Such effects of temperature have been more prominent in our experiments on cats than in guinea pigs.

It is well known that the aural microphonic falls off sharply when the animal dies, but that it persists for many hours after death at a few per cent of its original strength.[1] In the guinea pig, when respiration gradually fails from too much anesthetic, the microphonic falls to this low level *before* the heart stops. The failure is partly reversible. If the animal takes a few gasping breaths the microphonic may double its voltage (and action potentials return) as the heart beats faster and more regu-

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† Now in Santiago, Chile.

‡ Traveling Fellow of Rockefeller Foundation.

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TABLE I.
Changes in Threshold (Decibels) for 20 Microvolt Response at Round Window (1000 Cycles) following Deliberate Injury.

Exp. No.	Injury	Time after injury			
		1 hr	2 hr	3 hr	21 hr
60	Turn 3; all 3 scalae	+ 4	- 3	—	- 7
63	" 3; " " "	+14	+13	—	—
66	" 2; large hole in scala media	0	—	—	—
67	" 3; all 3 scalae, hole enters the modiolus	- 2	—	—	—
68	" 3; amputation	+ 2	+ 4	+12	—
70	" 3; amputation	- 4	- 4	—	—

Positive values indicate rise in threshold, negative a fall.
See Fig. 1A for Experiment No. 60, 1B for No. 67.

larly. It is our clear impression that there are two mechanisms underlying the microphonic, one of which is quite sensitive to lack of oxygen and the other sufficiently hardy to persist (at a low level) for hours after death.

Frequently, but not always, as respiration and circulation fail and as the microphonic approaches the postmortem level, the microphonic undergoes *half-wave rectification.* The phase of the microphonic in which the scala media and scala vestibuli are relatively more positive and the scala tympani more negative is depressed much more than the opposite half of the pattern. The phase which is most depressed corresponds to *condensation* in the external canal. This effect is most dramatic on the oscilloscope when clicks are used as stimuli, because the quiet base-line before the click gives an obvious reference level; but rectification can be clearly seen with pure tones also. The rectification is almost instantly reversible if the animal takes a few good breaths. At this stage rather strong stimuli, 30 or 40 db stronger than are necessary for a fresh preparation, are required to obtain clear responses and the maximum responses are rarely more than 10 microvolts. Action potentials always fail when or before rectification begins.

There are several sufficient conditions for failure of the microphonic, including lack of oxygen, overstimulation, certain chemicals applied to the round window (including the orthophosphoric acid we use in mixing the dental cement that attaches our electrode wires to the edge of the surgical opening into the bulla.) Gross injury, such as rupture of the round window membrane with outpouring of perilymph and perhaps entrance of air bubbles, also abolishes all responses.

Milder surgical injury associated with drilling a hole 300 μ in diameter and deliberately rupturing Reissner's membrane and the basilar membrane does not necessarily cause any deterioration of electric response over several hours except for a narrow band of frequencies associated with the actual site of injury. (See Table and Figure). In two experiments complete amputation of the 3d and 4th turns caused very little change in two hours of the stimulus necessary to yield at the round window a 20 microvolt response to medium and high tones. Small holes (60 μ) at the apex without rupture of the endosteum seem quite innocuous. We have not detected any effects that we must attribute to a moderate "escape of endolymph" or to "serous labyrinthitis."

Two general conditions are important, and they may reduce ultimately to one. They are 1) a general factor associated with progressive deterioration of the preparation in a long experiment. The electrical responses may gradually fall and thresholds rise. High tone responses are usually more depressed than low. 2) Local oxygen supply, which may be reduced by failure of circulation or by inadequate respiration. For example, the responses fail within a few seconds of cessation of respiration under pure nitrous oxide and return quite or nearly to normal promptly when breathing is resumed. The general factor suggested above may be nothing more than cumulative irreversible or slowly reversible effects of prolonged partial anoxia.

The stability of the responses in the presence of holes drilled into the cochlea opens the way for more intimate approach to the

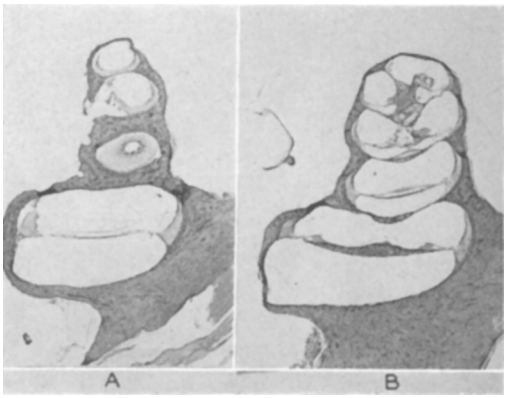

FIG. 1.
A. Exp. 60. Large hole and deliberate injury in Turn 3. Reissner's membrane and basilar membrane torn. Beneath the large hole is the outer end of a small hole that entered Turn 2, scala media.
B. Exp. 67. Hole entering modiolus in Turn 3. Axis of hole is perpendicular to plane of section.

nervous structures in labyrinth and modiolus.

Summary. The aural microphonic of guinea pigs was recorded from the round window and from copper wires applied to or passing through tiny holes drilled through the bony shell of the cochlea. When the guinea pig's respiration fails gradually, the microphonic falls to a few percent of its original strength before the heart stops. The failure is partly reversible if respiration improves.

Frequently near the postmortem level the microphonic undergoes partial or complete half-wave rectification. The phase corresponding to condensation in the external canal is more depressed than the phase corresponding to rarefaction. This effect also is temporarily reversible.

Extensive surgical injury including amputation of the two apical turns may cause little or no change in the microphonic (1000 cycles per second) at the round window over several hours.

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17117. Differences in Hemagglutination by Strains of Influenza Virus in Presence of Egg White and Normal Serum.*

H. BERNKOPF.† (Introduced by Thomas Francis, Jr.)

From the Department of Epidemiology and Virus Laboratory, School of Public Health, University of Michigan, Ann Arbor, Mich.

Substances of various origin have been shown[1-10] to inhibit the hemagglutination reaction of influenza virus. Evidence has also been presented[5,11,12] suggesting that some of these inhibitors are identical with, or closely related to, the receptor substance of red cells. When it was shown[13] that serum inhibits hemagglutination by heated virus to a much higher degree than hemagglutination by fresh

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