(liver, kidney). The significance of this pathway for DNA synthesis therefore remains to be elucidated.

Several attempts were made to characterize the enzyme further. The pH activity curve (Figure 1) shows a very broad peak from pH 5–7, with the maximum around pH 6. The Lineweaver Burk plot for the determination of the Michaelis constant for deoxycytidine as substrate yields a value of K_m 20 mM. This value is significantly different from that of deoxycytidilate deaminase (K_m 4.1 mM)[9] measured in the absence of dCTP and Mg^{++}. The enzyme may not be specific for deoxycytidine but appears also to react with other nucleosides and nucleic bases containing amino groups (Table III). For this assay a partially purified enzyme preparation was used (see above). Highest activities are found for deoxyadenosine and adenosine, lower ones for deoxycytidine and cytidine, and still lower ones for methyldeoxycytidine, guanosine and cytosine. Nucleotides were not attacked to a significant degree.

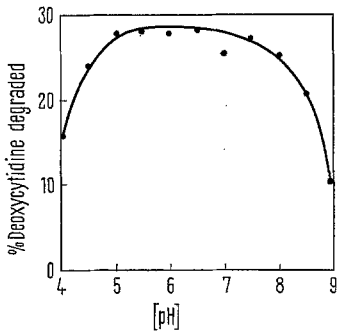

Fig. 1. pH dependence of nucleoside aminohydrolase activity (substrate deoxycytidine) in liver homogenate from hamster; liver tissue was homogenized with 5 volumes of 0.9% NaCl and diluted with 1 volume of veronal buffer of different pH values.

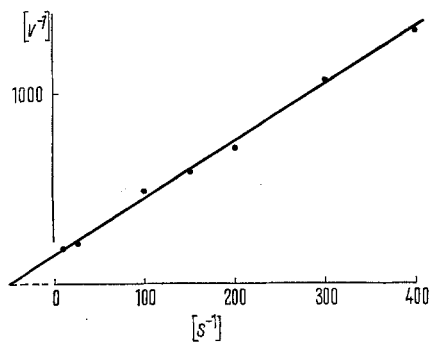

Fig. 2. Lineweaver-Burk plot of nucleoside aminohydrolase (substrate deoxycytidine) in liver homogenate of hamster ($K_m = 20.8$ mM).

Table III. Reaction of partially purified nucleoside aminohydrolase with different substrates

Substrate (final concentration and activity added)	Activity (nmole/mg protein/min)
Cytosine (5 mM, 5 μCi C-5,6-T)	4
Deoxycytidine-5′-monophosphate (5 mM, 0.5 μCi dCMP-C^{14}	$\leqslant 0.5$
Cytidine (5 mM, 0.8 μCi CR-C^{14})	9.0
Deoxycytidine (5 mM)	8.0
Methyldeoxycytidine (1 mM)	2.0
Deoxyadenosine (1 mM, 2 μCi dA H^3)	18
Adenosine (1 mM)	15
AMP (1 mM)	$\leqslant 0.5$
ATP (1 mM)	$\leqslant 0.5$
Guanosine (1 mM)	3.0

Partial purification of the nucleoside amino hydrolase was carried out starting from liver homogenates of hamsters. The enzyme is present in the supernatant of the homogenate centrifuged at 105,000 g for 1 h. Precipitation of the enzymatic activity occurs at 50% saturation with ammonium sulphate. The material was then dialysed and separated on a column of Sephadex G150, eluted with phosphate buffer 0.1 M pH 7. Most of the enzymatic activity was not retained by the column under these conditions. By these procedures, the specific activity of the enzyme could be increased by a factor of 4 compared to liver homogenate. Experiments are now in progress to improve this separation further[10].

Zusammenfassung. Hohe Nukleosidaminohydrolase-Aktivitäten finden sich in Niere, Leber und Darm von Hamstern. Bei Mäusen hängt die Aktivität vom Tierstamm ab und steht in Beziehung zur Deoxycytidinausscheidung.

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[9] G. F. MALEY and F. MALEY, J. biol. Chem. *239*, 1168 (1964).

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Recording and Analysis of Sounds Produced by Human Lungs During Respiration

The activity of certain human organs, like the lungs or the heart, is associated with the emission of characteristic sounds (respiration sounds, heart beats).

By hearing these sounds the physician obtains information on the condition of these organs. This so-called auscultation method, although affected by a certain degree of subjectivism, is widely used in practical medicine. Inspite of this, very little is known about the physical characteristics of the sounds produced within the human body. This is true especially for respiration sounds. Taking this into account, we started a detailed investigation of the sounds emitted by normal and pathological lungs during the respiratory cycle, with the purpose of finding some objective criteria for evidencing deviations from the normal, associated with special morbid changes. Such criteria could lead, we think, to a better interpretation of the information provided by the respiration sounds and to the elaboration of more objective diagnostic methods in certain respiratory diseases.

As a first step, we carried out the recording and analysis of the respiration sounds of 2 randomly chosen

subjects, free from pulmonary diseases, in order to verify our experimental procedure, as well as the reproducibility of the sound characteristics determined by this procedure. Some preliminary results are presented in this paper.

The 2 subjects chosen for our investigation were 2 healthy adult males. Both were afebrile and with no prior serious pulmonary disease. We shall refer to them as P_1 and P_2. Subject P_1, 45 years old, is rather tall with normal body proportions and a longiline thorax. Subject P_2, 50 years old, is of short stature, with a well developed chest and presenting a little overweight.

The respiration sounds, picked up by a small dynamic-type microphone placed firmly against the chest wall of the infraclavicular fossae, were recorded by means of a tape recorder. After recording several complete respirations (deep inspirations and expirations, effected through the mouth), parts of the tape, containing each a group of 3 respirations, were selected. With these parts, closed loops were obtained, so that the same group of respirations could be brought periodically in front of the recording head. It thus became possible to carry out the analysis, by means of an audio-frequency spectrum recorder, of the sounds related to any desired respiration of the group.

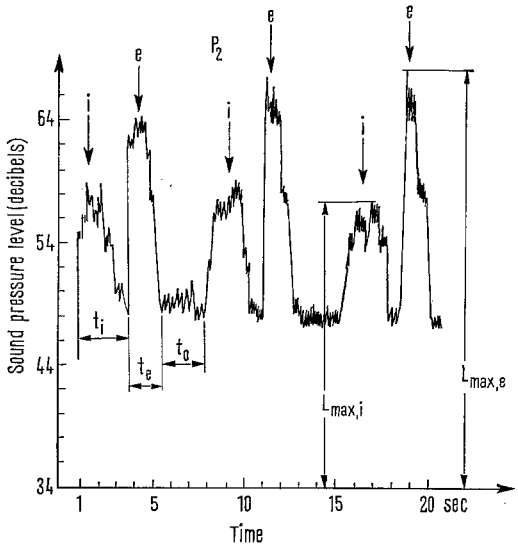

Fig. 1. Time dependence of the total sound pressure level (in decibels) for a group of 3 respirations. i, inspiration; e, expiration; t_i, inspiration time; t_e, expiration time; t_o, time interval between an expiration and the following inspiration. $L_{max,i}$, maximum sound pressure level at inspiration; $L_{max,e}$, maximum sound pressure level at expiration.

The recorded vibrations are irregular, which places the respiration sounds in the category of noises. Since the results obtained for both subjects and both lungs are very similar, we will present here only those related to the right lung of subject P_2.

The time dependence of the recorded sound pressure level (expressed in decibels) for a group of 3 respirations and the spectrograms of the respiration sounds analyzed in 1/3 octave bands have been obtained (Figures 1 and 2).

From these curves the durations of the inspiratory and expiratory phases, as well as the ratio of the 2 maximum sound pressures related to these phases of the respiratory cycle, can be determined with a satisfactory degree of accuracy and repeatability.

Of special interest are the respiration sound spectrograms (Figure 2). Although they are not identical for the 2 subjects, they are characterized for both of them and for both lungs by 3 maxima occurring at approximately the same frequencies: 2 marked maxima at lower frequencies (150–200 Hz and 500–600 Hz), and a less marked maximum at nearly 2500 Hz. The presence of these maxima at the same frequencies in the sounds produced during inspiration (Figure 2, curve i) as well as during expiration (Figure 2, curve e) is an indication of the fact that these frequencies are characteristic for the sound-sources within the respiratory system.

From these results one may draw the conclusion that recording, storing and objective analysis of sounds produced in the process of respiration is possible and that the clear evidencing of some common features in the sound characteristics could serve for an objective 'acoustic' characterization of normal lungs.

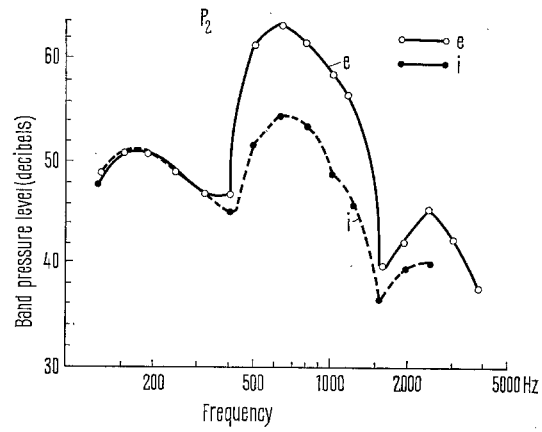

Fig. 2. Spectrograms of the respiration sounds, analyzed in $^1/_3$ octave bands. i, inspiration; e, expiration.

The extension of the present investigation to a larger number of healthy subjects, as well as to subjects presenting respiratory diseases, could lead, we think, to the elaboration of more objective diagnostic methods based on the information provided by the respiration sounds.

Résumé. Les sons émis par les poumons de l'homme au cours de l'acte respiratoire ont pu être enregistrés sur bande magnétique et analysés à l'aide d'un audio-spectromètre. Les résultats des expériences montrent qu'à l'aide des méthodes physiques objectives on peut obtenir, sans difficultés majeures, des renseignements sur les bruits dus à la respiration plus détaillés que ceux fournis par l'auscultation.

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