endurance-type demands of treadmill running is compatible with the apparent selective use of red fibers as shown with glycogen depletion.

CARROW et al.[1] reported greater capillarity increases in white regions of the gastrocnemius than in the red regions of the same muscle. His method did not include establishing the type of each fiber such as was done with NADH-D in this study; rather, zones were selected for examination. We found in our sections that even in white areas significant quantities of red fibers were present. Thus an increase in capillarity in the white zone could have been due simply to an increase in capillarity of the red fibers.

No studies heretofore considered nor showed any change in capillarity with respect to fiber type following an exercise training program. This study shows a selective effect on red fibers and is compatible with previous data showing a greater activity of red than white fibers in endurance type exercise[11].

Résumé. Le dressage des cochons d'Inde sur un moulin de discipline augmente la capillarité des fibres musculaires rouges, tandis que les fibres blanches et intermédiaires ne changent pas. Ces résultats sont compatibles avec les données précédentes qui conseillent d'employer de préférence les fibres rouges dans les exercices de résistance.

Mean number of capillaries in contact with muscle fibers of various histochemical classifications

		White	Moderate	Red	Intermediate[b]
Control (4)		3.9 ± 0.6	4.6 ± 0.3	4.5 ± 0.2	5.3 ± 0.3
	n[c]	74	26	22	265
Exper. (4)		3.8 ± 0.4	4.9 ± 0.4	5.8 ± 0.3[a]	5.2 ± 0.1
	n	69	42	50	275

[a] Significant difference between control and experimental ($P < 0.05$). [b] Intermediate fibers taken from 6 soleus muscles. [c] n, number of fibers.

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Divergence of the in vitro and in vivo Extracellular Space Measurements in Heart Muscle

As has already been published, the extracellular space indicator inulin-carboxyl-C^{14} did not distribute uniformly in the heart muscle in vitro, while in vivo a nearly homogenous distribution could be demonstrated[1]. In a succeeding experimental series, however, we failed also to find a fairly uniform indicator distribution in the myocardium in vivo (Table). The experiments were performed in the same tissue, namely the left ventricular wall of the hearts of female Syrian golden hamsters (London School of Hygiene-strain), and under rather identical conditions as previously described[1]. As the reason of this apparent discrepancy, we claim the deviation in the tissue slicing technique. Formerly, the myocardial piece was sectioned into a nearly cube-like central part and into a total of 6 peripheral parts (one for each face of the cube), while now we preferred to get a rectangular central part, paying more attention to the middle layer of the ventricular wall (Figure 1). Nevertheless, we referred to the previous weight proportion of about 1 to 3 between central and peripheral parts.

Statistically exact evaluation of the in vivo results showed significantly less indicator in the center of the myocardial wall than in its periphery similar to the in vitro results gained by an identical slicing technique ($p < 0.01$, sign-test) (Table). Yet a comparison of both methods demonstrated in the center a significantly higher ($p < 0.05$, Wilcoxon-test) and in the periphery a significantly lower ($p < 0.01$, Wilcoxon-test) content of indicator in vivo than in vitro.

From the results described above it is concluded that the extracellular space in the ventricular wall is variable. This reasoning may be explained by morphology. In mammalian hearts coronary arteries and veins are located in the epicardium, while in the inner layer there are intertrabecular sinusoids. In addition there are also 2 networks of lymphatics in the heart, one in the epicardium and the other in the endocardium[2]. These extracellular compartments are missing in the middle layer of the ventricular wall. In addition, the inner and outer layer does not only consist of myocardium but also of fatty and connective tissue, which might have quite another interstitial space than the pure myocardium of the middle layer. In order to reflect those morphological characteristics, the in vivo and in vitro methods seem to be equivalent, and it may solely depend on the way the tissue is sectioned. But it is worthwhile to point out that in our previous in vitro experiments a similar indicator distribution pattern could be discovered, though cutting out a cube-like central part, while under in vivo conditions this could not be revealed[1]. Hence it is very doubtful whether the in vitro data do really represent morphological characteristics of the ventricular wall or whether they are only an indicator of pecularities due to the in vitro technique. That the latter is more likely may be inferred from a comparison of the in vitro and in vivo results (Table). The striking discrepancy of the indicator distribution between both methods seems to be a consequence of tissue damage partly by cutting the myocardium prior to incubation and also by swelling, vacuolisation and myolysis during the incubation. These

[1] K. LOSSNITZER and T. F. KELLEY, Experientia *24*, 126 (1968).
[2] A. HARRY and B. M. PATTEN, in *Pathology of the Heart*, 2nd edn (Ed. S. E. Gould; Charles C. Thomas Publisher, Springfield 1960), p. 93.

Myocardial indicator content in vitro		in vivo	
Tissue parts		Tissue parts	
Superficial	Central	Superficial	Central
2077	1180	1781	1563
2551	858	1765	1459
3347	1812	1842	1524
2542	913	1714	1474
3108	1615	1745	1345
2895	1371	1923	1560
3090	1529	1783	1480
2430	1000	1701	1517
2782	1189	1879	1575
2301	939	1761	1400
2476	756	1601	1321
2691	1197	1772	1474
± 368	± 327	± 90	± 89

The single data are expressed as dpm/100 mg wet weight of myocardium and summarized as the mean ± S.D. They are based on a level of 10,000 dpm/75 λ of radioactivity in the serum and in the incubation fluid respectively

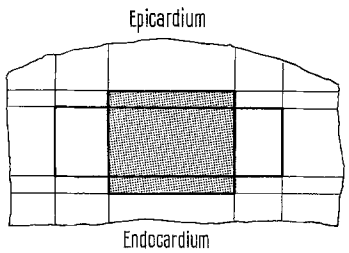

Fig. 1. In previous experiments the myocardial piece was sectioned in a cube-like (⁝⁝) central part, while now a rectangular central part (□) was excized. The new slicing pattern corresponds to the morphological characteristics of the ventricular wall, which consists of 3 different layers: endocardium with adjacent myocardial area, pure myocardium, and myocardium with epicardium.

histological phenomena are demonstrated in Figure 2 and are assumed to originate in the standstill of contraction and circulatory functions. There also exist 2 overlapping processes as a function of time, i.e., the tissue deterioration and the indicator penetration into the central parts. Swollen cells as well as material from myolyzed cells occluding the diffusion ways may hinder the indicator in penetrating the tissue. In addition an emigration of red blood cells from the tissue into the surrounding incubation medium can be observed by the naked eye. The same process is also believed to occur for other

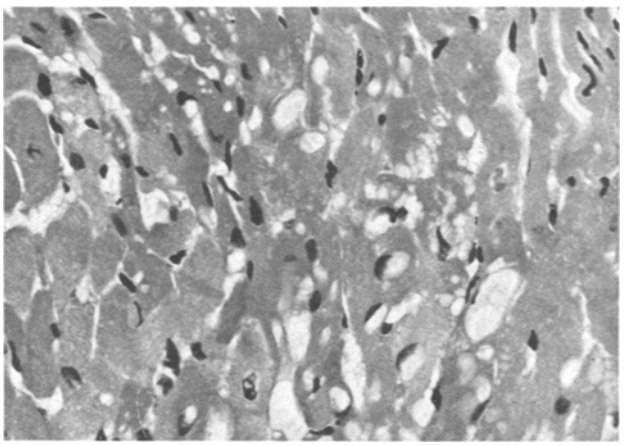

Fig. 2. Swelling, vacuolization and myocytolysis of myocardial cells of the left ventricular wall after 60 min of in vitro-incubation. The heart muscle piece was excized from the heart of a 104-day-old healthy female Syrian golden hamster of the London School of Hygiene-strain (hematoxylin-eosin), × 400.

substances, i.e., hyaluronic acid and other macromolecules, which are known to exclude inulin from a homogenous distribution[3]. Since those particles mainly emerge from peripheral interstitial and vascular spaces, this phenomenon might be attributed to the unequal indicator distribution in vitro.

The findings described above demonstrate that there is no homogenous extracellular space throughout the ventricular wall of the mammalian heart and also that the in vitro approach of extracellular space measurements does not reproduce normal or other in vivo conditions, which are likely to be explored. Therefore in vitro results are highly questionable.

Zusammenfassung. Extrazellulärraumindikatorverteilung ist in vivo und in vitro unterschiedlich, trotz ähnlicher Tendenz. Das Myokard verändert sich während der in-vitro-Inkubation. Deshalb erscheint es unmöglich, in vitro normale beziehungsweise in vivo herrschende Extrazellulärräume zu messen.

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[3] A. G. OGSTON and C. F. PHELPS, Biochem. J. *78*, 827 (1960).

Measurement of Collateral Flow in Experimental Coronary Occlusion

The currently available methods to study coronary collateral circulation after acute or chronic occlusion of coronary arteries, which include backflow measurements, electromagnetic flowmeter methods, clearance studies, cinearteriography and corrosion cast techniques, are imperfet[1,2]. A recently described autoradiographic technique[3] to assess the distribution of blood flow within organs has therefore been used to estimate regional myocardial blood flow after acute ligation of coronary arteries.

The method is based on the application of small radioactivity labelled particles, which do not pass through the systemic capillaries. If a calibrated amount of the particulate material is injected into the systemic circulation, its distribution represents the regional distribution of blood flow, provided the indicator is completely mixed