On the Conductivity of Perfusion Fluid of Frog's Heart under Abnormal Atmospheric Pressure.

(According to the experiment of H. Miyazaki* and M. Ogata)

By

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Abnormal atmospheric pressure exerts mechanical influence not only upon the surface, but also upon the interior of body. All the tissue cells of the body exist thus under the abnormal pressure. Physicochemical conditions and properties of the body fluid and also cells have perhaps been developed under the present atmospheric condition as a factor at least. Physicochemical study of the body fluid under abnormal atmospheric pressure may be an important branch of the high and low pressure physiology. So far as we know, reports on this line are very scanty, and even those can not be regarded as such as we expect, and shall not be here referred as our control. Some chemical changes have been noticed by a few investigators in the blood of the animal under abnormal atmospheric pressure.

Bornstein¹⁾ found hydraemia of dog and monkey under high atmospheric pressure (2 atmosph.). His finding has been very often referred to by later investigators, but they disregard the fact that the experiment of Bornstein was of longer duration (several months) and could not directly be compared with those of short duration (a few hours). Sakai²⁾ found an increase of viscosity and serum protein of Caisson worker by repetition of work, which he regarded as a cause of adaptation of the worker to the high pressure. Moteki³⁾ says that he

* The essentials of the results on the high pressure were read by H. Miyazaki before the annual meeting of the Kumamoto Medical Society, November, 1937.

1) Bornstein, A., Pfügers Arch., 1911, 138, 609.

2) Sakai, Y., Nippon Naikagakkai Z., 1927, 15, 575.

3) Moteki, K., Kaigun-gun-i-kai Z., 1931, 20, 428.

found decrease of serum protein and a tendency of increase of blood chloride of rabbit under 30 mm Hg. pressure increase for one hour. Kagiya⁴⁾⁵⁾⁶⁾ performed a more systematic experiment on the high pressure (15–30 pounds), and found some chemical changes of blood of rabbit and man, decrease of protein and chloride of the serum and also of viscosity. Hosokawa⁷⁾ attributed a decrease of haemoglobin under high pressure (30–50 pounds) to the hydraemia which he believed to be an established fact. He found further that the resistance of blood corpuscle to hypotonic solution weakened under high pressure, but this was also the case under low atmospheric pressure. Shilling, Thomson, Behnke, Shaw and Messer⁸⁾ did not prove the chemical change of the blood of dog under 45 pounds of 97% oxygen during 2–4 hours.

On chemical changes of blood of animal and man under low atmospheric pressure, references available here are still few. Endō⁹⁾ reported that blood quantity and protein decreased under low atmospheric pressure at first and recovered later, and chloride and non-protein nitrogen increased at first and recovered later. These findings are not the reverse of those under high atmospheric pressure. Loewy¹⁰⁾ perceived decrease of calcium of blood at high mountain and slowing of the sedimentation velocity, which he was inclined to attribute to change of plasma protein. Sekiguti¹¹⁾ observed a tendency of increase of serum protein and colloid-osmotic pressure of serum, but his data showed a too large variation for any definite decision.

Our experiment to be reported in this paper was as the first intended as a study of the influence of abnormal atmospheric pressure upon the physicochemical properties of the blood.

METHOD.

As a pressure chamber an iron box was used which was in general of the same structure as that described in a previous paper¹²⁾ from our institute, but which was larger to allow a small kymograph to be put in.

Heart of *rana nigromaculata* was employed for the experiment. Straub's perfusion preparation of heart was made, the fluid reservoir of the cannula being larger enough to serve as a conductivity vessel with

4) Kagiya, S., Kumamoto Igakkai Z., 1934, **10**, 263.

5) Kagiya, S., *ibid.*, 519.

6) Kagiya, S., *ibid.*, 528.

7) Hosokawa, S., Kaigun-gun-i-kai Z., 1936, **25**, 73.

8) Shilling, C. W., R. M. Thomson, A. R. Behnke, L. A. Shaw and A. C. Messer, *Am. J. Physiol.*, 1934, **107**, 29.

9) Endō, H., Kaigun-gun-i-kai Z., 1934, **23**, 405.

10) Loewy, A., *Kl. W.*, 1934, **13**, 545.

11) Sekiguti, E., Kaigun-gun-i-kai Z., 1936, **25**, 633.

12) Kodama, S., *Tohoku J. Exp. Med.*, 1937, **31**, 357.

ca. 4 cc content. Two cores connected with two poles of the conductivity vessel were led out through a side hole of the pressure box to a Kohlrausch's bridge which was used to measure the conductivity of the perfusion fluid in the vessel. Kohlrausch's arrangement as in the usual manner consisted of a rheocord, resistance boxes, a small inductorium and a telephone. As the experiment was made at room temperature which was not kept at constant, the specific conductivity of the perfusion fluid at each temperature had to be calculated for a standard temperature to be compared to each other and to be used for calculation of the mean value. In the case of high pressure experiment, 28° was taken as the standard temperature and the specific conductivity of the perfusion fluid at each temperature was recalculated for that temperature. This was done as follows: The difference between the rheocord reading (the resistance box being always at constant) of perfusion fluid before pressure increase, after the preparation had reached an equilibrium state, and those during the pressure experiment was taken, which was added to the rheocord reading before pressure increase at 28°. Allowance was made in this case for the fact that the change of the rheocord reading during the pressure experiment from that before pressure increase was the same at each temperature: this change was, strictly taken, not the same, but might be small during so small a temperature range (ca. 3°).

In the case of low pressure experiment, the vessel constant of conductivity was previously measured at various temperatures, which was applied for the calculation of the conductivity of the perfusion fluid at respective temperatures. Recalculation for a standard temperature was not made in this case.

Change of conductivity was always expressed by the ratio of the value under abnormal pressure before pressure change.

High pressure in the chamber was attained by an air compressor and regulated at a constant level to $\pm$ one pound by a specially devised apparatus. Low atmospheric pressure in the chamber was attained by a rotary pump and regulated only by watching any change.

Heart beats were recorded in the case of high pressure experiment with a lever attached to the heart apex on the small kymograph, the movement of which was started or stopped from outside of the box by an electrical switch at will.

Perfusion fluid was composed as follows:

NaCl	0.65%	H_2HPO_4	0.0069%
KCl	0.02 „	NaH_2PO_4	0.016 „

CaCl ₂	0.02%	Glucose	0.1%
NaHCO ₃	0.01 „		

The pH was potentiometrically 7.3.

Experimental procedures: About 20–30 minutes after having finished the perfusion preparation and arrangements for the pressure experiment conductivity of the perfusion fluid was measured at the normal atmospheric pressure, and then the pressure in the experimental chamber was changed by the above mentioned apparatus. In the high pressure experiment the pressure was increased from zero pound (the atmospheric pressure) through 10, 20, 30 to 40 pounds, taking about 40 minutes to attain the final pressure. At each pressure of the first three kinds, it was kept at the same for 5 minutes and the conductivity was measured and at the same time the kymograph was started to record the heart beats of frog for a few minutes. The 40 pound pressure was kept for 2 hours, during which the conductivity was measured every 30 minutes and the heart beats were recorded. Pressure recovery was performed in just the reverse order and the conductivity measurement and recording of the heart beats were again taken.

Low pressure experiment was done in the same manner as the high pressure. The pressure experimented with in the chamber was 400mm Hg. lower than the atmospheric pressure at that time.

EXPERIMENT.

1. Conductivity of Ringer's solution under high atmospheric pressure.

No change of conductivity was found in Ringer's solution which was to be used as the perfusion fluid, under influence of the high pressure effected in the manner above described.

2. Conductivity of perfusion fluid of frog heart under the normal atmospheric pressure (Table 1 and Figure).

Conductivity of perfusion fluid of frog heart was measured during three hours. Slight changes were noticed during the three hours, especially in the first thirty minutes, but the direction of change seemed not to be constant.

TABLE 1.

Conductivity of perfusion fluid of frog heart under the normal pressure.

No.	Time (min.) after beginning of experiment, specific conductivity $\times 10^{-5}$ and ratio of the value at various period to that at the beginning							
	0	20	40	60	80	100	120	140
1	1087	1083	1083	1080	1075	1075	1080	1080
	1.00	1.00	1.00	0.99	1.00	0.99	0.99	0.99
2	1106	1106	1115	1117	1113	1113	1115	1124
	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.02
3	1071	1068	1078	1087	1087	1078	1078	1078
	1.00	1.00	1.01	1.01	1.01	1.01	1.01	1.01
4	996	978	978	989	989	989	989	989
	1.00	0.98	0.98	0.99	0.99	0.99	0.99	0.99
5	1004	1009	999	988	988	988	1002	1002
	1.00	1.00	0.99	0.98	0.98	0.98	1.00	1.00
6	820	806	806	812	812	812	812	812
	1.00	0.98	0.98	0.99	0.99	0.99	0.99	0.99
7	967	963	961	962	962	962	961	963
	1.00	1.00	0.99	0.99	0.99	0.99	0.99	1.00
8	843	888	888	903	919	920	920	920
	1.00	1.05	1.05	1.07	1.09	1.09	1.09	1.09
9	967	966	966	966	966	966	966	966
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	932	915	918	918	918	925	935	935
	1.00	0.98	0.98	0.98	0.98	0.99	1.00	1.00
Mean	978	978	979	983	983	983	986	987
	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01
		± 0.004	± 0.005	± 0.006	± 0.007	± 0.007	± 0.006	± 0.006

Fig. Percentage (%) change of conductivity of perfusion fluid of frog heart under abnormal atmospheric pressure.

3. Conductivity of perfusion fluid of frog heart under high atmospheric pressure (Table 2 and Figure).

TABLE 2.

Conductivity ($\times 10^{-5}$) of perfusion fluid of frog heart under high atmospheric pressure (10-40 pounds).

Min. No. (P)	0 (0)	10 (10)	20 (20)	30 (30)	40 (40)	70 (40)	100 (40)	130 (40)	160 (40)	170 (30)	180 (20)	190 (10)	200 (0)
1	1782	1802	1802	1823	1836	1836	1832	1832	1832	1823	1802	1802	1782
	1.00	1.01	1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01	1.00
2	1782	1802	1823	1823	1867	1867	1867	1823	1823	1741	1741	1741	
	1.00	1.01	1.02	1.02	1.05	1.05	1.05	1.05	1.02	1.02	0.98	0.98	0.98
3	1782	1782	1802	1808	1814	1823	1841	1841	1841	1867	1867	1867	1867
	1.00	1.00	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.05	1.05	1.05	1.05
4	1782	1802	1802	1823	1832	1832	1832	1832	1823	1823	1823	1823	1802
	1.00	1.01	1.01	1.02	1.03	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.01
5	1782		1802	1823	1836	1836	1836	1836	1836	1823	1802		1782
	1.00		1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.01		1.00
6	1782	1802	1823	1836	1836	1836	1836	1836	1836	1823	1802	1802	1802
	1.00	1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01	1.01
7	1782		1802	1823	1823	1823	1823	1823	1823	1802	1802	1802	1782
	1.00		1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.01	1.00
8	1782	1782	1811	1815	1867	1836	1836	1836	1836	1823	1823	1782	1782
	1.00	1.00	1.02	1.02	1.05	1.03	1.03	1.03	1.03	1.02	1.02	1.00	1.00
9	1782	1782	1802	1823	1836	1836	1836	1836	1836	1823	1802	1802	1782
	1.00	1.00	1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.01	1.00
10	1782	1802	1823	1828	1836	1836	1836	1836	1836	1802	1802	1741	1741
	1.00	1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.01	1.01	0.98	0.98
11	1782	1802	1807	1823	1823	1823	1836	1836	1836	1823	1802	1802	1782
	1.00	1.01	1.01	1.02	1.02	1.02	1.03	1.03	1.03	1.02	1.01	1.01	1.00
12	1782	1802	1823	1823	1836	1836	1836	1836	1836	1823	1823	1802	1782
	1.00	1.01	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.00
13	1782	1815	1832	1836	1836	1836	1836	1836	1836	1823	1815	1802	1782
	1.00	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.00
14	1782	1802	1823	1823	1823	1823	1823	1823	1823	1823	1802	1761	1741
	1.00	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	0.99	0.98
15	1782	1808	1802	1823	1836	1836	1836	1836	1836	1823	1823	1802	1802
	1.00	1.02	1.01	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.02	1.01	1.01
16	1782	1802	1815	1823	1823	1823	1823	1823	1802	1802	1782	1761	1753
	1.00	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.00	0.99	0.98
17	1782				1867	1867	1867	1867	1867	1823	1823	1802	1782
	1.00				1.05	1.05	1.05	1.05	1.05	1.02	1.02	1.01	1.00
18	1782				1802	1823	1823	1823	1823	1808	1802	1802	1782
	1.00				1.01	1.02	1.02	1.02	1.02	1.02	1.01	1.01	1.00
19	1782		1802	1823	1802	1802	1802	1802	1761	1741	1721	1702	1702
	1.00		1.01	1.02	1.01	1.01	1.01	1.01	0.99	0.98	0.97	0.95	0.95
20	1782	1802	1802	1802	1802	1802	1823	1823	1823	1823	1808	1808	1802
	1.00	1.01	1.01	1.01	1.01	1.01	1.02	1.02	1.02	1.02	1.02	1.02	1.01
Mean	1782	1799	1811	1822	1832	1832	1834	1834	1833	1822	1803	1789	1789
	1.00	1.01	1.02	1.02	1.03	1.03	1.03	1.03	1.03	1.02	1.01	1.00	1.00
	$\pm$ 0.000	$\pm$ 0.001	$\pm$ 0.001	$\pm$ 0.001	$\pm$ 0.002	$\pm$ 0.002	$\pm$ 0.001	$\pm$ 0.001	$\pm$ 0.002	$\pm$ 0.002	$\pm$ 0.002	$\pm$ 0.003	$\pm$ 0.002

Min: time after beginning of pressure/increase.

(P): pounds of added pressure.

Distinct increase of the conductivity was always found according to the pressure increase, the conductivity during stay at 40 pounds being kept almost at the same level.

These results show that there is some ion exchange between perfusion fluid and the heart tissue, resulting ion increase in the former. This process seems to occur very quickly following change of the pressure.

4. Conductivity of perfusion fluid of frog heart in low atmospheric pressure (Tables 3, 4 and Figure).

The conductivity changed according to the pressure variation just in the reverse direction. That is the conductivity decreased following

TABLE 3.
Conductivity of perfusion fluid of frog heart under the normal atmospheric pressure.

No.	Time (min.) after beginning of the experiment, specific conductivity $\times 10^{-5}$ and ratio of the value at various period to that at the beginning.						
	0	30	60	90	120	150	180
1	1782	1777	1782	1782	1777	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1782	1782	1782	1782	1782	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1782	1782	1782	1797	1777	1777	1782
	1.00	1.00	1.00	1.01	1.00	1.00	1.00
4	1782	1782	1782	1782	1782	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
5	1782	1782	1782	1782	1782	1782	1798
	1.00	1.00	1.00	1.00	1.00	1.00	1.01
6	1782	1782	1782	1782	1782	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1782	1782	1782	1777	1777	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1782	1782	1782	1782	1782	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1782	1741	1786	1782	1782	1782	1782
	1.00	0.98	1.00	1.00	1.00	1.00	1.00
10	1782	1765	1782	1782	1782	1782	1782
	1.00	0.99	1.00	1.00	1.00	1.00	1.00
11	1782	1782	1782	1782	1782	1782	1782
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean	1782	1776	1782	1783	1781	1782	1783
	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		± 0.001	± 0.000	± 0.001	± 0.000	± 0.000	± 0.001

TABLE 4.

Conductivity of perfusion fluid of frog heart under low atmospheric pressure (-400 mm Hg.).

No.	Time (min.) after beginning of pressure decrease, specific conductivity $\times 10^{-8}$ and ratio of the value under low pressure to that before pressure change.									
	before	immed.	20	40	60	80	100	120	immed. after	20
1	1104	1082	1075	1075	1077	1077	1079	1079	1104	1104
	1.00	0.98	0.97	0.97	0.98	0.98	0.98	0.98	1.00	1.00
2	1092	1092	1097	1099	1095	1095	1095	1103	1108	1121
	1.00	1.00	1.00	1.01	1.00	1.00	1.00	1.01	1.01	1.03
3	1105	1093	1085	1086	1089	1095	1095	1095	1105	1105
	1.00	0.99	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00
4	1020	1000	993	993	993	993	993	993	992	992
	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
5	1000	993	984	976	976	975	975	979	1001	1001
	1.00	0.99	0.98	0.98	0.98	0.98	0.98	0.98	1.00	1.00
6	833	818	799	796	793	793	793	793	813	830
	1.00	0.93	0.90	0.90	0.90	0.90	0.90	0.90	0.92	0.94
7	971	957	949	949	949	949	949	950	964	971
	1.00	0.99	0.98	0.98	0.98	0.98	0.98	0.98	0.99	1.00
8	827	810	799	799	800	826	840	852	859	875
	1.00	0.98	0.97	0.97	0.97	1.00	1.02	1.03	1.04	1.06
9	979	965	958	952	952	952	951	951	956	971
	1.00	0.99	0.98	0.97	0.97	0.97	0.97	0.97	0.98	0.99
10	941	907	882	882	882	882	881	888	913	913
	1.00	0.96	0.94	0.94	0.94	0.94	0.94	0.94	0.97	0.97
Mean	982	972	962	961	961	965	965	968	982	988
	1.00	0.98	0.97	0.97	0.97	0.97	0.97	0.98	0.99	1.00
		± 0.004	± 0.006	± 0.006	± 0.006	± 0.007	± 0.007	± 0.008	± 0.007	± 0.007

lowering of the pressure and recovered according to the pressure recovery. Though the conductivity of the control (Table 3) showed an increase at the end of 2 hours, the decrease during the lower pressure was beyond doubt. Here again we found some ion exchange between fluid and heart tissue, resulting in ion decrease in the former.

5. On the heart beats of perfusion frog heart under abnormal atmospheric pressure (Table 5).

As can be seen from the table height of heart beat showed only slight change during three hour observation under high atmospheric

TABLE 5a.

*Height (Ht, cm in kymographic record) and frequency (Frq, in 8 seconds)
of heart beat of frog under high atmospheric pressure.*

No.	Min.	0	10	20	30	40	70	100	130	160	170	180	190	200
	Pound	(0)	(10)	(20)	(30)	(40)	(40)	(40)	(40)	(40)	(30)	(20)	(10)	(0)
1	Ht	1.70	1.80	1.97	1.87	1.91	1.96	1.86	1.70	1.55	1.28	1.15	1.00	0.79
	Frq	11	10	10	10	11	12	12	11	10	10	10	11	11
2	Ht	1.30	1.40	1.60	1.80	1.90	1.87	1.90	1.90	1.87	1.70	1.50	1.45	1.43
	Frq	12	12	13	13	13	13	13	12	12	12	10	9	9
3	Ht	1.57	1.48	1.45	1.47	1.40	1.40	1.39	1.38	1.48	1.58	1.60	1.60	1.60
	Frq	9	14	13	13	13	13	13	13	8	9	8	8	8
4	Ht	1.81	1.79	1.50	1.45	1.38	1.12	1.18	1.22	1.27	1.31	1.31	1.25	1.20
	Frq	6	12	13	13	15	14	13	13	13	13	13	14	14
5	Ht	1.30	1.11	1.10	1.07	1.03	0.94	0.92	0.90	0.88	0.83	0.84	0.90	0.90
	Frq	7	11	12	12	11	11	11	6	6	6	5	6	6
6	Ht	1.55	1.52	1.55		1.58	1.46	1.35	1.19	1.08	0.99	0.90		
	Frq	11	10	10		11	11	10	11	13	6	6		6
7	Ht	1.46	1.75	1.65	1.56	1.56	1.65	1.50	1.45	1.42	1.36	1.30	1.19	
	Frq	16	13	11	12	13	12	12	11	10	9	10	10	
8	Ht	1.55	1.51	1.67	1.69	1.61	1.35	0.97	0.94	0.95	0.81	0.81	0.78	0.75
	Frq	12	11	11	12	11	10	11	11	10	12	13	12	12
9	Ht	1.95	2.28	2.47	2.55	2.58	2.35	2.34	2.18	2.10	2.08	1.90	1.90	1.70
	Frq	13	11	13	13	12	12	12	12	12	8	8	8	9
10	Ht	1.51		1.65	1.56	1.64	1.80	1.90	1.98	1.20	1.95	1.87	1.81	1.80
	Frq	12		12	11	11	11	12	11	11	10	10	10	11
11	Ht	1.60	1.59	1.48	1.56	1.56	1.55	1.55	1.55	1.55	1.47	1.40	1.35	1.43
	Frq	13	14	13	13	13	13	13	13	13	13	13	12	12
12	Ht	0.81		0.81	1.04	1.07	1.07	1.10	1.10	1.05	0.83	0.75		0.90
	Frq	14		13	12	12	13	10	10	8	8	7		8
Mean	Ht	1.51	1.62	1.58	1.60	1.60	1.54	1.50	1.46	1.37	1.35	1.28	1.32	1.25
	Frq	11	12	12	12	12	12	12	11	11	10	9	10	10

TABLE 5b.

*Height (Ht, cm in kymographic record) and frequency (Frq, in 8 seconds)
of heart beat of frog under the normal atmospheric pressure.*

No.	Time (min.) after beginning of observation													
	0		30		60		90		120		150		180	
	Ht	Frq	Ht	Frq	Ht	Frq	Ht	Frq	Ht	Frq	Ht	Frq	Ht	Frq
1	2.10	10	1.90	9	1.85	6	2.05	6	1.93	6	1.80	6	1.80	6
2	1.55	14	1.50	11	1.50	11	1.75	9	1.80	8	1.50	7	1.47	7
3	1.90	11	1.90	11	1.85	11	2.00	11	1.95	12	2.00	11	1.80	10
4	1.30	12	1.20	12	1.05	13	1.00	12	0.95	12	0.95	13	0.87	12
5	1.40	11	1.55	6	1.45	6	1.35	6	1.40	6	1.40	5	1.30	5
6	1.30	11	1.40	9	1.45	9	1.30	9	1.25	9	1.25	9	1.20	9
7	1.85	9	1.50	8	1.37	8	1.37	8	1.32	7	1.32	8	1.30	8
8	1.30	14	1.35	14	1.33	11	1.40	12	1.65	7	1.37	7	1.55	8
9	1.40	10	1.45	10	1.40	11	1.37	10	1.35	10	1.35	9	1.30	8
Mean	1.57	11	1.53	10	1.47	10	1.51	9	1.51	9	1.44	8	1.40	8

pressure as well as under the normal pressure. Also the rate of heart beat showed only a slight change—a tendency to increase at the beginning of pressure increase, while that under the normal pressure rather decreased.

SUMMARY.

Conductivity of perfusion fluid of frog heart was measured under abnormal atmospheric pressure during the perfusion.

The conductivity increased under high atmospheric pressure and decreased under low pressure.

Heart beats of frog showed no change of height under high atmospheric pressure but only a slight tendency to increase the rate at the beginning to the pressure increase.