ULTRAVIOLET AND VISIBLE CHEMILUMINESCENCE OF THE MOUSE LIVER MAINTAINED AT DIFFERENT TEMPERATURES

L. S. Kopylova

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After the exposed liver had been kept for 10 min at 30°C, cooling to 5°C led to "degradation" emission in both the visible and the ultraviolet parts of the spectrum. The presence of the ultraviolet component is explained by the higher energy level of the unbalanced molecular constellations in the cell substrate at 30°C than at a temperature of 38°C in the previous experiments, in which only the visible component was obtained during cooling. Further evidence of the higher level of metabolism at 30°C was given by the curves of the change in body temperature depending on the conditions of local heating or cooling of the liver.

KEY WORDS: mitogenetic radiation; mouse liver; bioenergetics.

Previous investigations [3, 5] have shown that "degradation" mitogenetic radiation reflects the energetic state of the labile molecular structures of the cell, the so-called unbalanced molecular constellations (UMCs). Cooling to 5°C, which lowers the level of cell metabolism sharply, is one such disturbing factor.

The object of this investigation was to study the spectral changes in the radiation from the exposed liver when kept at different temperatures.

EXPERIMENTAL METHOD

A description of the recording system was given in an earlier paper [7]. Experiments were carried out on 20 mice whose exposed liver was centered in front of a quartz lens; the radiation was recorded on the FEU-18-A photoelectric multiplier. After a temperature of 30°C had first been maintained in the liver for 10 min (by means of Ringer's solution at the appropriate temperature), the surface of the liver was cooled to 5°C (10 min) and then warmed to 38°C (10 min). Measurements were made from the time of the change in temperature. The rate of flow of the Ringer's solution was constant (2.5 ml/sec).

EXPERIMENTAL RESULTS AND DISCUSSION

As Table 1 shows, when the temperature of the liver surface was 30°C, only visible radiation was emitted. During subsequent cooling, in the first 3-4 min a statistically significant ultraviolet (UV) radiation appeared, but it disappeared in the following minutes. It was accompanied by a weaker visible component that persisted throughout the period of cooling. At 38°C the visible component was again completely restored. Allowing for the quantum yield of the apparatus these results imply mean values of 180 phot-sec/ cm^2 for visible radiation at 30°C, 60 phot-sec/ cm^2 for visible and 160 phot-sec/ cm^2 for UV-radiation at 5°C, and 180 phot-sec/ cm^2 for visible radiation at 38°C.

Preliminary (before cooling) maintenance of a temperature of 30°C in the liver thus did not prevent the appearance of UV-radiation during cooling, whereas cooling after maintenance of a temperature of 38°C did not cause the appearance of UV radiation [7].

Institute of Normal and Pathological Physiology, Academy of Medical Sciences of the USSR, Moscow.
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TABLE 1. Intensity of Emission by the Mouse Liver at Different Temperatures (M ± m)

Conditions	Intensity of emission (in impulse/10 sec)					
	30°		5°		38°	
	I_1-I_2	I_1	I_1-I_2	I_1	I_1-I_2	I_1
First 3-4 min from beginning of meas.	−0,32 ± 0,34	3,15 ± 0,39	1,02 ± 0,34	0,95 ± 0,32	−0,32 ± 0,25	3,03 ± 0,44
P		<0,001	<0,005	<0,005		<0,001
Second 3-4 min from beginning of meas.	0,03 ± 0,34	2,87 ± 0,49	−0,08 ± 0,23	1,00 ± 0,32	0,20−0,43	3,70 ± 0,32
P		<0,001		<0,005		<0,001

Legend: I_2) Intensity of radiation through glass (350-600 mm), I_1) intensity of radiation through quartz (230-600 mm).

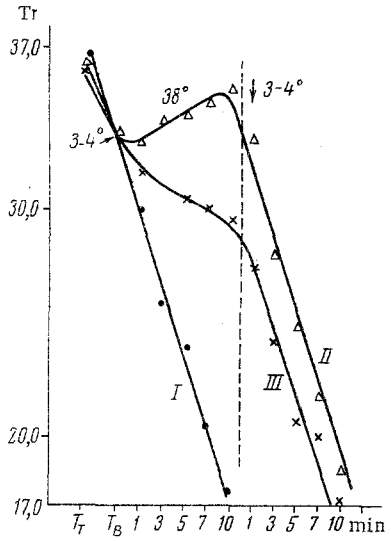

Fig. 1. Changes in rectal temperature depending on temperature of the exposed liver. T_b) Body temperature before laparotomy; T_1) during laparotomy; I) cooling after laparotomy; II) cooling from 38 to 3-4°C; III) cooling from 30 to 3-4°C. Mean results of 5-6 experiments.

Since the temperature conditions were created not only for the liver, but for the body as a whole, measurements of the rectal temperature (T_r) under these experimental conditions are of definite interest.

It will be clear from Fig. 1 that immediately after exposure of the liver T_r fell from 36-37 to 32.5-33°C. Irrigating the liver with warm Ringer's solution also kept T_r at about the same level. Cooling caused all three curves to fall sharply.

According to data in the literature, in the initial stage of cooling (T_r of the order of 26-30°C) the level of the gas exchange rises (compensatory thermoregulation) but in deeper hypothermia it falls [4, 8, 9]. The total gas exchange at 30°C must evidently reach a maximum between the 5th and 10th minute, but cell respiration in the surface layers of the liver must be effective from the very beginning, for the surface temperature of the liver reaches the temperature of the solution very rapidly.

By the time of cooling, both the organism as a whole and the surface layers of the liver are therefore at a higher metabolic level at 30°C than at 38°C. Direct contact of the liver with air must lead to an increase in the intensity of oxidative processes of both an enzymic and nonenzymic character in the cell substrate. The reactions of lipid oxidation are known to increase particularly sharply with a rise of temperature, with the character of a chain effect [6]. The natural process of cell respiration must be depressed under these circumstances, with a consequent lowering of the energetic levels of the UMC, which require an effective process of respiration for their maintenance. It is this decrease in the energetic potential that may lead to disappearance of the UV component in the degradation radiation of the liver on subsequent cooling of the organ.

More moderate heating of the exposed liver is more physiological for the organ and does not create an excessive increase in the intensity of oxidative processes or of the secondary after-effects that could lower the energy of the UMC. As a result, being "preserved" at normal energetic levels the UMCs emit high-energy UV photons during cooling.

In the study of degradation mitogenetic radiation in various objects including liver [1, 2, 7] it is becoming increasingly probable that the UMCs play an important role in metabolic processes.

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