CATHODE LUMINESCENCE OF NORMAL AND CANCEROUS CELLS

Translation No. 1642

12 August 1965

U. S. ARMY
BIOLOGICAL LABORATORIES
FORT DETRICK, FREDERICK, MARYLAND

CATHODE LUMINENSCENCE OF NORMAL AND CANCEROUS CELLS

/Following is the translation of an article by Pyatenko, V. S. and Tarusov, B. N., published in the Russian-language periodical Biofizika (Biophysics) No 9, 1964, pages 134--135. It was submitted on 2 Feb 1963. Translation performed by Sp/7 Charles T. Ostertag Jr./

It was established earlier that animal tissues continuously emit an ultraweak light stream in the blue-green range of the spectrum /1/. In malignant tumors this emission is weakened in comparison with normal /2/. This emission is the result of the interaction of natural antioxidants with the structural biolipoids of the cells. We carried out an investigation of the quantity of antioxidants by a method which guaranteed the significant increase in the intensity of emission.

During electrolysis of certain aromatic amino-acids in a diluted saline solution, luminescence is observed which is due to free-radical reactions /3/. We detected that during the passage of a direct current through a suspension of cells in a physiological solution, a set-up, which is constructed by using a FEU-18 in a quantometric system with thorough cooling /1/, registers the light stream coming from the cathode. /FEU = photomultiplier/

The cells, in a quantity of one million in 0.85 ml of physiological solution, were placed in an electrolytic cell with platinum wire electrodes. The intensity of the passing direct current is 15 ma, density of the current 200 ma/cm^2, voltage 4.5 v. The cells which were investigated may be divided into four groups.

1. Normal cells, prepared by means of trypsinization: a) monkey kidneys; b) lungs of a 3--5 month human embryo; c) 9-day check embryos.

2. Culture cells of non-cancerous origin: a) from the cardiac muscle of a monkey - Sots; b) from tissue from the upper limb of a 3--5 month human embryo, cultivated since October 1958 -- strain 580; c) from the tissue of a human embryo, cultivated 3 months.

3. Cancerous cells, prepared by means of trypsinization: a) cancer of the stomach; b) cancer of the mammary gland.

4. Culture cells of a cancerous origin: a) from cancer of the cervix uteri -- HeLa; b) from cancer of the larynx -- Hep-2; c) from cancer of the pancreas -- CaPa; d) from cancer of the mammary gland -- CaMa.

The maximum values of intensity for the emissions are presented in the table.

It can be seen from the table that the intensity of emissions for the cells which were taken from normal tissues is significantly greater than the intensity of the emissions from cells which were prepared both directly from tumors and from tissue cultures. Based on the intensity of emissions the culture cells of non-cancerous origin approximates that of cancerous, and the closer they are then the greater is the age of the stated culture /4/. A control experiment showed that the density of the suspensions investigated changed insignificantly with time.

The emissions were studied in time for the cells from monkey kidneys and HeLa -- cancer of the cervix uteri (see drawing).

It can be seen from the drawing that the emission from cells which were prepared from monkey kidneys has two maximums -- in the 3rd and 10th minutes, and the emission from HeLa -- only in the 10th minute.

With the passage of a direct current with a density of 200 ma/cm^2 through a suspension of cells, substances are set free from the latter and on the cathode they produce radicals which react with antioxidants, which are also present during the destruction of the cells. It is known that cancerous cells have an increased content of antioxidants /5/, which apparently also causes the lowered emission from the cathode during the passage of a current through the cancerous cells.

CONCLUSIONS

1. A method has been developed for determining the antioxidative effect in culture cells and cells prepared by means of the trypsinization of animal tissues, based on the dying out of luminescence which accompanies the free radical processes at the cathode during the passage of direct current with a density of 200 ma/cm^2 through a suspension of cells.

2. It has been established that cancerous cells, prepared by means of trypsinization of cancer of the stomach and cancer of the mammary glands, and also culture cells of a cancerous origin: Hela, Hep-2, CaPa, CaMa -- lose luminescence more intensively than normal cells, prepared by trypsinization of monkey kidneys, lungs of a 3--5 month old human embryo, and 9-day chick embryos.

3. Based on their antioxidative effect, the culture cells of non-cancerous origin (Sots, strain 580, cells from an upper limb of a 3-month old human embryo) approximate those of cancerous cells (Hela, Hep-2, and others).

Literature

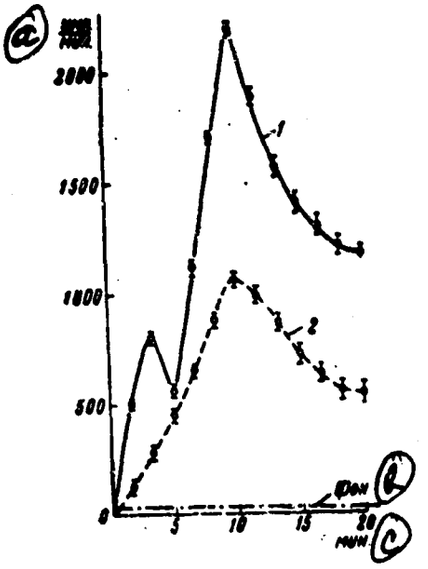
1. Tarusov, B. N., Polivoda, A. I. and Zhuravlev, A. I., Radiobiologiya 1, 150, 1962.

2. Zhuravlev, A. I., Tarusov, B. N., Yesakova, T. D., VIII International Anticancer Congress, Thesis of Reports, 136, Medgiz, 1962.

3. Ahnstrom, G., Natarajan, A. T., Nature, 188, 4754, 961, 1960.

4. Staroverova, N. S., Voprosy onkologii, 4, 31--38, 1961.

5. Shuster, C. W., Proc. Soc. Exp. Biol., Med., 90, 423, 1955.



Change of intensity of luminescence in time for the cells from monkey kidneys (curve 1) and Hela (curve 2) during the passage of a current with a density of 200 ma/cm^2 through a mne million suspension in 0.85 ml of physiological solution; t = 20°, phon 30±10 imp/min. Axis of abscissae -- time in minutes after turning on the direct current, axis of ordinates -- luminescence in imp/min. a = imp/min; b = phon; c = minutes.

Maximum values of intensity of emission (imp/min) from the cathode during passage of direct current with a density of 200 ma/cm^2 at a voltage of 4.5v through a suspension of one million cells in 0.85 ml of physiological solution at 20°.

No.	Name of cells	Maximum intensity
1	Monkey kidneys	2200 ± 50
2	Lungs of a 3--5 month human embryo	1920 ± 50
3	9-day chick embryos	1750 ± 80
4	Sots	1300 ± 110
5	Strain 580	1350 ± 120
6	Cells of a 3--month human embryo	1430 ± 40
7	Cancer of the stomach	950 ± 50
8	Cancer of the mammary glands	870 ± 40
9	Hela	1080 ± 60
10	Hep-2	1100 ± 60
11	CaPa	1100 ± 70
12	CaMa	980 ± 70
	Physiological solution	100 ± 30
	Phen	30 ± 10