SOME PHYSIOLOGIC FACTORS INFLUENCING RADIATION SENSITIVITY
1. LOW TEMPERATURE

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Introduction :

There is no reason to believe that the primary absorption of radiation energy is influenced by the temperature. Only the consequent biochemical reactions would dependent of temperature in radiobiology. The inffuences of the temperature on the radiation sensitivity are very complex, and various results have been obtained, which sometimes are contradictory to each other[1]. When the famouse law of Tribondeau-Bergonié comes into the qustion, is this law concerned to the high metabolic activity either during irradiation or after irradiation?

The recovery process would likely to take place at every moment whatever the injury occurs. The high metabolic activity plays the role in the restoration in one case, but claims the cell division without balanced metabolism' in another case, which otherwise may be balanced with some intervals.

The higher organisms demands the more difficult analysis in the radiation sensitivity compared to the unicellular matter, which, nevertheless, is very complex compared to the water solution. In our experiment, yeast cell was chosen so as at least to get rid of the mutual action between the cells. Although as simple a living matter, yeast cell is very different from phage or virus which is, like a solute, affected by the environment. In the experiment of yeast cell, one cell must be regarded as one unit of the solution system and the environmental medium does not likely to influence directly in irradiation.

Experiment :

Yeast cell (Saccharomyces Sake) was cultured in Naegeli's solution at 28°C. After irradiation cells were disseminated on the plate culture media and counted the cells which were able to devide per cent of disseminated cells. Low temperature administrations were caried out controlled by the same procedures except for irradiation. Percentage of devided cells were described as survival in this experiment.

1). Administration of low temperature during irradiation.

Yeast celle in Naegeli's media were kept at −10°C for 30 minutes prior to irradiation. For the experimental ease, 5 minutes irradiation was followed by 5 minutes of cooling in a freezing mixture. These procedures repeated to obtain 20,000r: total irradiation time was 17 minutes. Temperature of the medium was considered to be

0°to −10°C in the course of irradiation. After these, yeast cells were disseminated on the plate culture media and devided cells were counted.

Table 1.

survival	not irradiated	20,000r
low temp. administered	93.9±0.6	57.2±1.8
control	95.2±0.8	50.0±1.2

There was significant difference between irradiated with and without low tempemrature administration. Thus low temperature at the time of irradiation seemed to reduce the radiation injury.

2). Low temperature administration after irradiation.

After irradiation cultutre media were kept in low temperature (-10°C) for 10 minutes, soon after, 10 minutes after and 20 minutss after irradiation. Each media were kept at 28°C for 30 minutes after irradiation except for 10 minutes of low temperature admistration. Then cells were disseminated on the plate culture media and counted afterwards.

Table 2.

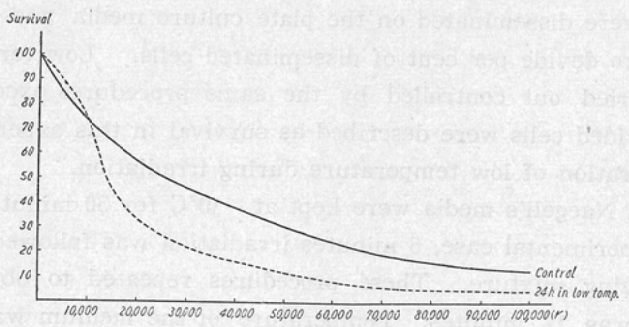
survival, (10 min. at-10°C)	not irradiated	20,000r
0-10 min. after irrad.	95.8±1.5	43.6±1.3
10-20 min. after irrad.	96.2±2.1	50.5±2.6
20-30 min. after irrad.	96.0±1.3	53.0±0.9

There seemed no significant differences btween low temperature treated and control, listed in the Table 1. except for 43.6±1.3 in the Table 2. Thus it was suggested that lowered metabolic activity soon after irradiation enhanced the injury or was not adequate for the restoration. On the experiment of malonic acid, analogous results were obtained. This substance, famouse inhibitor of the TCA cycle and of the growth of plant, enhanced the radiation injury[3], when given immediately after irradiation though did not do so when given after some intervals.

3). Culture media were kept at low temperature for long time.

Culture media were kept at-12° to-5°C for 24 hours prior to irradiation. In these temperature, cell was not likely to devide. After irradiation cells were disseminated

Fig. 1



on the plate culture media and kept at 28°C. The survival curve thus obtained is traced in the Fig. 1. Every experimental points were significantly different from the survivals to which the low temperature were not administered.

Conclusion and consideration :

Storage at low temperature is not likely to slow down the cellular activity in harmonious way. Unbalanced metabolism might cause, when continues for long time, the cell to torelate less the irradiation, (3rd experiment). Low temperature at short time during irradiation might well to be regarded otherwise; no exhaustion owing to unbalanced metabolism takes place in the cell within a short time. Only the slow down of metabolic activity favoured the cell to torelate the irradiation, (1st experiment). Latarjet[2] reported an increased survival when the cells were kept at 5°C for a few days after irradiation in the his experiment on Saccharomyces ellipsoideus. But short administration of the low temperature immediately after irradiation would likely to affect otherwise (2nd experiment); our experiment on malonic acid suggests an analogy.

References

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2. Latarjet, P., Compt, Rend. Acad. Sci. 217. 186. 1943.
3. Kiga. M., Science 122, 468, 1955.

特別掲載

放射線感受性に影響する二三の生理学的要素 1. 低温

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抄 録

酵母細胞を用い寒剤により低温処理して，細胞の分裂能力を実験した．処理する時期，時間によつて次の結果が得られた．

1) 照射中低温処理を行うと障害が軽減される．

2) 照射後低温処理を短時間（10分間）行うと照射直後10分以内のものゝみは障害を強めた．Latarjet は酵母細胞照射後数日間低温処理を続け障害を軽減しているが，時間及時間の関係の差であろう．Malon 酸処理も照射直後のみ障害を強めた．当教室の実験の Anology がある．

3) 照射前長時間（24時間）の低温処理も障害を強めた．照射中の処理と違い代謝の平衡関係が乱れて，例えばある代謝のみ進んでいたゝめ物質の過不足が照射時間に悪く影響したと考える．1)の問題は放射線作用機序的に一番興味のある問題である．