COORDINATIVE CHANGES IN THE ACTIVITIES OF ENZYMES IN CARBOHYDRATE METABOLISM DURING OOGENESIS IN *MYSGURNUS FOSSILIS*

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1. Introduction

Oogenesis and early embryogenesis offer a useful model for the investigation of principles in the coordination of enzyme patterns. This communication presents changes of enzyme activities in oocytes of the loach during oogenesis. It is concerned with the question of cooperative changes of enzymes in the pathways of glycolysis, glucogenesis and the hexose monophosphate shunt.

2. Materials and methods

Oocytes were isolated according to Ozernyuk [1]. The activities of enzymes in glycolysis and the hexose monophosphate shunt were measured as described previously [2]. PEP-carboxykinase was assayed according to Opie and Newsholme [3]. Enzyme activities were referred to 10^4 oocytes, since accumulation of yolk granules during oogenesis prevents the use of protein content as a reference.

3. Results and discussion

The activities of all enzymes tested increase during oogenesis (table 1). During vacuolization, the activities of the phosphotriose glycerate group [4] of glycolysis are about 2% of those in the mature oocyte. During vitellogenesis, when the diameter of the oocytes increases from 200 to 400 μm, the enzyme content increases 4 to 6 times. During transition to the mature oocyte, the activities of glycolytic enzymes increase about 15 fold, whereas the diameter of the oocyte increases from 400 to 800 μm. Enzymes of both glucogenesis and the hexose monophosphate shunt show similar changes. Furthermore, the enzymic activities of mature oocytes are identical to those of eggs following fertilization. The activities of enzymes of the phosphotriose glycerate group and in addition aldolase maintained constant proportions throughout all stages of oocyte development (except possibly enolase), despite the fact that the activities increased by two orders of magnitude. Thus, it is concluded that biosynthesis of this group of enzyme occurs in a cooperative manner. In contrast, the ratios of phosphofructokinase:pyruvate kinase activities are not constant. During vacuolization, this ratio is 0.025, whereas in the mature oocyte a ratio of 0.09 is observed. Hence, a possible coordination of these two key enzymes of glycolysis, as suggested by Weber [5, 6], is not supported by our data. Furthermore, coordinated changes of enzymes in glucogenesis and the hexose monophosphate shunt are less striking than those of the phosphotriose glycerate group of glycolysis.

References

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Table 1

Enzyme	Stages of oogenesis			
	Vacuolization diameter of oocyte 200 μm	Vitellogenesis diameter of oocyte 400 μm	Mature oocyte diameter of oocyte 800 μm	Egg after fertilization
Enzymes of phosphotriose glycerate group				
Aldolase (EC 4.1.2.13)	2.4 ± 0.2 (0.40)	16.0 ± 1.3 (0.66)	260 ± 2.4 (0.65)	260 ± 2.4 (0.65)
Triosephosphate dehydrogenase (EC 1.2.1.12)	6.0 ± 0.3 (1)	24.0 ± 1.0 (1)	400 ± 2.8 (1)	400 ± 2.8 (1)
Triosephosphate isomerase (EC 5.3.1.1)	3.0 ± 0.1 (0.50)	16.0 ± 0.9 (0.66)	240 ± 2.0 (0.60)	240 ± 1.5 (0.60)
Phosphoglycerate kinase (EC 2.7.2.3)	1.8 ± 0.1 (0.30)	7.0 ± 0.3 (0.29)	80 ± 1.8 (0.25)	80 ± 2.0 (0.25)
Enolase (EC 4.2.1.11)	2.0 ± 0.1 (0.33)	9.6 ± 0.5 (0.40)	70 ± 2.5 (0.18)	70 ± 3.0 (0.18)
Enzymes of gluconeogenesis				
Fructose diphosphatase (EC 3.1.3.11)	0.75 ± 0.04 (1)	4.0 ± 0.3 (1)	24 ± 0.8 (1)	24 ± 0.8 (1)
PEP-carboxykinase (EC 4.1.1.32)	0.2 ± 0.02 (0.27)	0.8 ± 0.04 (0.20)	3.2 ± 0.2 (0.13)	3.2 ± 0.2 (0.13)
Enzymes of hexose monophosphate shunt				
Glucose-6-P dehydrogenase (EC 1.1.1.49)	1.2 ± 0.1 (30)	3.6 ± 0.2 (18)	10.8 ± 0.6 (7)	11.0 ± 0.7 (7)
6-Phosphogluconate dehydrogenase (EC 1.1.1.49)	0.08 ± 0.01 (2)	0.4 ± 0.02 (2)	3.4 ± 0.2 (2.4)	3.4 ± 0.2 (2.4)
Transketolase (EC 2.2.1.1)	0.04 ± 0.005 (1)	0.2 ± 0.02 (1)	1.4 ± 0.15 (1)	1.4 ± 0.15 (1)
Transaldolase (EC 2.2.1.2)	0.2 ± 0.02 (5)	1.2 ± 0.1 (6)	2.4 ± 0.15 (1.7)	2.4 ± 0.15 (1.7)

Enzyme activities at different stages of oogenesis (U per 10^4 cells)*. The relative activities with triosephosphatedehydrogenase, fructose diphosphatase and transketolase as reference enzymes are given in parenthesis.

* Mean values ± S.E.M. with 7–8 determinations in each group.