2. There are specific repressor effects: galactose is an effective repressor for β -galactosidase but not for the other enzymes; conversely, pyruvate represses tryptophanase and serine deaminase but not β -galactosidase.

3. In wild-type *E. coli* glucose represses all three enzymes. A mutant has been selected in which there is no glucose effect for any of the enzymes but in which each enzyme remains specifically repressible.

4. β -Galactosidase synthesis in galactose-negative mutants has been examined. In kinaseless and transferaseless strains the enzyme is repressed both by glucose and galactose. In epimeraseless strains the glucose effect is largely abolished. This indicates that the ability to form uridine diphosphate galactose is an essential part of the glucose effect.

5. The conclusion is drawn that metabolic repression of an enzyme is specifically produced by an end product of the enzyme action or some closely related compound, and that glucose acts as a repressor only when it can give rise to sufficient amounts of the specific repressor.

6. The regulation of synthesis of induced degradative enzymes by end-product repression is analogous to that found in biosynthetic pathways.

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Renal Gluconeogenesis

2. THE GLUCONEOGENIC CAPACITY OF THE KIDNEY CORTEX OF VARIOUS SPECIES*

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The occurrence of renal gluconeogenesis is well established from experiments on tissue slices and the perfused organ (for references see Krebs, Bennett, de Gasquet, Gascoyne & Yoshida, 1963), but no systematic measurements have so far been reported on the gluconeogenic capacity of the renal cortex of different species. The present paper reports such measurements obtained with the procedure described by Krebs *et al.* (1963). An excess of various gluconeogenic substrates was added to

kidney-cortex slices so that lack of substrate was not a limiting factor.

EXPERIMENTAL

Slices of kidney cortex, suspended in the medium of Krebs & Henseleit (1932), were used throughout. The details of the procedure were essentially as described by Krebs *et al.* (1963). Glucose was determined by the glucose-oxidase method. Glycogen was not determined in every experiment because its contribution to gluconeogenesis proved to be very slight in a few test cases. Incubation was for 1 hr. at 40°. The concentration of added substrates was 10 mM. When three or more individual kidneys of the same

* Part 1: Krebs, Bennett, de Gasquet, Gascoyne & Yoshida (1963).

Table 1. Rate of gluconeogenesis in kidney cortex of various species

The substrate concentration was 10 mM. Diets 18 and 41 are described by Cassidy (1957); the low-carbohydrate diet was that described by Krebs *et al.* (1963). Means $\pm$ S.E.M. are given when the numbers of experiments were greater than three; otherwise individual values (average duplicate determination) are given. Further details are given in the text.

Species	Notes	No. of experiments	Glucose formation (μ moles/g. dry wt./hr.)									
			Substrate none	Substrate L-lactate	Substrate pyruvate	Substrate fumarate	Substrate L-glutamate	Substrate L-proline	Substrate propionate	Substrate L-ornithine	Substrate L-arginine	Substrate L-aspartate
Mouse (Swiss white)	Diet 41	2	14	329	558	411	364	248	—	64	24	—
		14	14	364	678	613	266	201	—	53	30	—
Mouse (Swiss white)	Low-carbohydrate diet (7 days)	6	15 $\pm$ 2	333 $\pm$ 34	392 $\pm$ 87	518 $\pm$ 75	264 $\pm$ 15	233 $\pm$ 16	—	40 $\pm$ 10	18 $\pm$ 2	—
Mouse (strain producing obese animals described by Falconer & Isaacson, 1959)	Diet 41 (non-obese animals weighing 20–25 g.)	* 13	13	171 $\pm$ 37 (4)	360 $\pm$ 58 (3)	321	141 $\pm$ 5 (13)	163	—	55	24	—
		16	16	—	—	478	—	172	—	21	15	—
Rat (Norwegian hooded)	Diet 41 (Low-carbohydrate diet (6 days))	3	9 $\pm$ 0.7	189 $\pm$ 27	390 $\pm$ 23	412 $\pm$ 46	131 $\pm$ 14	87 $\pm$ 8	—	42 $\pm$ 3	17 $\pm$ 2	35 $\pm$ 5
		3	16 $\pm$ 0.4	297 $\pm$ 21	515 $\pm$ 20	493 $\pm$ 32	205 $\pm$ 33	109 $\pm$ 14	—	52 $\pm$ 6	23 $\pm$ 3	49 $\pm$ 14
Golden hamster	Diet 41	2	11	53	271	570	152	75	—	11	10	—
		12	12	49	256	586	173	88	—	13	10	—
Low-carbohydrate diet (7 days)		2	17	92	320	905	394	290	—	35	13	—
		16	16	90	280	690	329	175	—	45	20	—
Guinea pig	Diet 18	3	18 $\pm$ 5	56	57 $\pm$ 11	216 $\pm$ 29	81 $\pm$ 12	67 $\pm$ 8.8	17	20 $\pm$ 5.4	12 $\pm$ 0.9	—
		—	—	58	—	—	—	—	—	—	—	—
Rabbit	Diet 18	3	2 $\pm$ 0.5	55 $\pm$ 4.2	89 $\pm$ 8	205 $\pm$ 18	58 $\pm$ 7	32 $\pm$ 4	100 $\pm$ 8.5	1.0 $\pm$ 0.2	—	—
Cat	7 weeks old	2	13	104	99	205	86	58	—	13	12	—
		10	103	103	103	198	59	51	—	8	12	—
Dog	5 weeks old	3	14 $\pm$ 6.7	71 $\pm$ 6.7	61 $\pm$ 6.8	102 $\pm$ 2.1	63 $\pm$ 5.3	47 $\pm$ 6.3	—	12 $\pm$ 1.2	15 $\pm$ 2.0	—
Sheep	Abattoir material	4	27 $\pm$ 3.5	91 $\pm$ 12	153 $\pm$ 14	285 $\pm$ 26	129 $\pm$ 4	93 $\pm$ 10	146 $\pm$ 5	23 $\pm$ 3.4	31	25
		—	—	—	—	—	—	—	—	—	34	35
Cattle	Abattoir material; ♀, 6 years old, lactating	8	8	28	18	35	42	44	22	6	—	—
	Abattoir material; ♀, not lactating	15	15	52	53	130	53	54	32	—	—	—
	Abattoir material; ♂, 10 days old	13	13	59	33	115	53	35	13	9	—	—
Pig	—	4	10	79	51	100	30	31	—	11	14	—
		11	11	68	45	78	21	20	—	12	12	—
		206	206	163	163	278	83	35	—	24	23	66
		16	104	106	106	187	100	32	—	14	19	35
Domestic fowl (Rhode Island Red $\times$ Light Sussex)	15 weeks old; fed on boiled eggs	2	37	407	412	298	167	82	—	—	—	—
		33	363	336	270	146	89	89	—	36	36	—
Pigeon	Fed on corn and maize	2	22	206	173	189	138	69	—	—	—	58
		21	179	—	—	174	101	52	—	—	—	44
Hyax (<i>Procapra capensis</i>)	—	1	7	9	53	53	18	17	12	—	—	6

* Given in parentheses after S.E.M.

species were tested and when the material was biologically reasonably uniform (same strain), the means $\pm$ s.e.m. and the numbers of measurements are given. Otherwise the individual measurements are recorded. Lack of biological uniformity applies in particular to the material obtained from the larger domestic animals. Sheep, pig and cattle kidney were obtained from local abattoirs as soon as possible after the death of the animals and transported on ice. A specimen of the rock coney (hyrax, *Procavia capensis*) became available through the courtesy of Dr H. Blaschko.

RESULTS AND DISCUSSION

The results are recorded in Table 1. The kidney cortex of all species shows a substantial capacity for synthesizing glucose from various precursors. Compared with other metabolic processes, especially biosynthetic ones, the rates are high. Thus the amounts of fumarate converted into glucose in the smaller animals (over 1000 μ moles/g. dry wt./hr.) are of the same order as the oxygen uptake of, say, liver or brain. There are wide variations according to the nature of the substrates and also from species to species. The smaller animals gave higher rates than the larger ones, and fumarate gave the highest rates in most species. The values obtained with the Norway rat were similar to those described by Krebs *et al.* (1963) for the Wistar rat when amino acids were the precursors, whereas they were higher with lactate, pyruvate and fumarate. Lactate gave especially high rates in the mouse, rat, domestic fowl and pigeon, and rather low rates in the hamster, guinea pig and rabbit. Of the amino acids glutamate and proline usually gave the

highest rates. Propionate, which is known to be formed in large quantities in the rumen, was, as may be expected, a very effective precursor in sheep kidney. It was also highly effective in rabbit kidney but less so in cattle kidney.

A low-carbohydrate diet that increased the rate of gluconeogenesis in rat kidney (Krebs *et al.* 1963) also increased it in the hamster, but had no effect in mouse kidney. The absence of an effect in this tissue may be connected with the very high rates given by the kidney of mice fed on the standard diet. The high rates found in chicken kidney were probably connected with the low-carbohydrate diet consisting of boiled eggs.

SUMMARY

1. The rates of glucose formation from nine precursors were measured in kidney-cortex slices of 13 different species. Relatively high rates were found in all species.

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