higher (at least 4–10-fold) in oxido-glycolytic bovine skeletal muscles than in oxidative muscles or heart. On the contrary, it has been previously shown in the rat that heart and oxidative muscles contain higher amounts of GLUT4 than glycolytic muscles. This species-specificity of GLUT4 expression may favour short-chain fatty acids and ketone body utilization by oxidative muscles in bovine and glucose utilization by oxidative muscles in the rat.

Differences in food digestion and metabolism between ruminant and monogastric species are well known. However, these results demonstrated large differences in the basic biological mechanisms of molecular regulation of muscle metabolism in ruminant and monagastric animals. These differences affect energy metabolism and particularly glucose transporters.

D-Glucose has an immediate and specific sensitizing effect on chicken pancreatic β cells. N Rideau [1], C Saulnier [2] (*[1] INRA, Station de Recherches Avicoles, 37380 Nouzilly; [2] CNRS URA 307, Laboratoire de Physiologie du Développement, Université Paris VII, 2, place Jussieu, 75251 Paris cedex 05, France*)

The perfused isolated chicken pancreas is insensitive to both D-glucose and other known 'initiators' of insulin release when used alone. For example the total cumulative insulin output in response to 10, 20 or 40 mM α-ketoisocaproic acid (KIC) perfused alone was low, 7 ± 3, 1 ± 1, 2 ± 1 ng/30 min (mean ± SEM, $n = 4$, $p > 0.05$) respectively. The potentiation of α-KIC (10 mM) was studied by associating α-KIC with various fuel nutrients perfused at non-insulinotropic concentration in the chicken. The total cumulative insulin output (ng/30 min, mean ± SEM, $n = 4$) was :

1. α–KIC (10 mM) in the presence of carbohydrates:

alone	+ D-glucose 14 mM	+ 3-*O*-methyl-D-glucose 14 mM
7 ± 3	212 ± 49	11 ± 6

+ D-glyceraldehyde 5 mM	+ D-mannose 50 mM
156 ± 49	16 ± 13

2. α-KIC (10 mM) in the presence of amino acids:

alone	+ L-aspargine	+ L-glutamine
7 ± 3	10 ± 10	24 ± 10

+ L-aspargine 17 mM + L-glutamine 17 mM
127±31

α-KIC was significantly ($P < 0.05$) potentiated by D-glucose (14 mM), D-glyceraldehyde (5 mM) or L-asparagine (17 mM) + L-glutamine (17 mM). The response with the last 2 nutrients was however delayed (7–70 min) as compared to that observed in the presence of D-glucose. These results suggest that D-glucose at non-insulinotropic concentrations exerts an immediate specific sensitizing effect on the chicken pancreatic β cell. A sensitizing effect of glucose was also observed with D-glyceraldehyde (poorly insulinotropic alone) or D-mannose (non-insulinotropic alone). Thus the metabolic step initiating insulin release is only found in the chicken. Before testing this hypothesis, it is necessary to isolate and characterize the A and B islets of Langerhans in the chicken. An immunohistochemical identification (immuno-peroxidase) method of isolated chicken islets is in progress.

Insulin resistance induced by post-weaning high fructose diet in Wistar rats: reversal by metformin. S Halimi [1], E Rossini [1], PY Benhamou [1], P Faure [1], P André [2] (*[1] Laboratoire de Recherches Métaboliques GREPO, Université et CHU de Grenoble; [2] Groupe Lipha, France*)

The fructose intake in the western diet is increasing and can sometimes reach 30% of the total carbohydrate intake. Fructose is known to have smaller hyperglycemic and insulinosecretory effects than glucose. Fructose has been recommended as sweetener of natural foods for both diabetic patients and normal subjects, including children. Some deleterious effects have been described, such as hypertriglyceridemia, hyperuricemia and hepatic insulin resistance in some circumstances or subjects. The aim of this work was to study hepatic and peripheral insulin sensitivity in post-weaning male Wistar rats fed a high fructose diet (58% of total carbohydrates, Fr58) for 4 weeks. They were compared with control animals fed a standard chow (Cer) and with another group of animals fed a high fructose diet

Table I. (S Halimi *et al*)

	(Cer) n = *8*	*(Fr 58)* n = *8*	*(Fr58 + Met)* n = *8*
Ra mg/min	2.3 ± 0.1	2.5 ± 0.1	2.1 ± 0.6
Rd mg/min	7.7 ± 1.1*	3.3 ± 0.05*	6.3 ± 1.0**
HGP mg/min	–0.1 ± 0.3*	1.3 ± 0.2*	0.6 ± 0.3**

* $P \leq 0.5$; ** $P \leq 0.05$.

plus a 2-week treatment with metformin 200 mg/kg/d (Fr58 + Met). The euglycemic hyperinsulinic clamp method (2 mg/min/kg) was used in conscious animals. The basal appearance rate of glucose (Ra), the disappearance rate of glucose stimulated by insulin (Rd) and the hepatic glucose production (HGP) were measured by (^{3}H-3-D) glucose infusion (table I).

This study demonstrates that a high fructose diet administered in the early post-weaning period induces a huge insulin resistance in both hepatic and peripheral tissues. After a 2-week treatment with metformin, the fructose-induced increments in insulin resistance were reduced by 80 and 100% in peripheral and hepatic tissues. Thus, the high fructose diet in post-weaning rats is an excellent and useful experimental model of nutritional insulin resistance.

Effect of the nutritional state on insulin receptors and phosphoenolpyruvate carboxykinase in chicken kidneys. S Bisbis, M Derouet, J Simon *(INRA, Endocrinologie du Métabolisme et de la Croissance, Station de Recherches Avicoles, 37380 Nouzilly, France)*

In chickens, kidneys contribute to gluconeogenesis to a large extent during fasting (30%). Kidney PEPCK (phosphoenolpyruvate carboxykinase, the rate-limiting enzyme of gluconeogenesis) is under hormonal control, in contrast to liver PEPCK. This difference is due to the intracellular location of the enzyme: mitochondrial in liver (at least 95% of total activity) and partially cytosolic (20–45%) in kidneys. Insulin probably contributes to the control of kidney PEPCK. In the present study PEPCK activity was studied and insulin receptors were characterized in the kidneys of chickens submitted to the following nutritional conditions: fed state, 48-h fasted state, and 24-h refed state following a 48-h fast. PECK activity was increased by the 48-h fast and returned to normal after refeeding (comparisons made with the *ad libitum* fed state). Binding of ^{125}I-insulin to the chicken kidney membranes was time-, temperature- and protein-dependent and specific: unlabelled insulin was more potent than IGF-1 at inhibiting tracer binding (about 6 times). Insulin binding was significantly higher ($P < 0.05$) following the 48-h fast and lower ($P < 0.05$) following refeeding compared to *ad libitum* feeding. Since receptor affinity (as estimated by insulin concentration inhibiting tracer binding by 50%) was similar irrespective of the nutritional state (6–8 ng/ml), the changes in insulin binding are explained by changes in membrane insulin receptor number. The sizes of α and β subunits of kidney receptors were similar to those of liver receptors: 135 and 90 kDa, respectively. Following Triton X-100 solubilization of membranes and wheat germ agglutinin purification, insulin-stimulated autophosphorylation of the β-subunit was decreased non-significantly by fasting. Phosphorylation of the artificial substrate, poly (Glu-Tyr) 4:1, was significantly decreased by the 48-h fast at high insulin concentrations (10 and 100 nM). In conclusion, typical insulin receptors are present in chicken kidneys, the number of receptors is inversely correlated to plasma insulin levels, and the kinase activity of receptors is inhibited by prolonged fasting. This suggests that insulin action in chicken kidneys is controlled by several steps at the receptor level.

Regulation of GLP-1 release: study with a model of isolated vascularly perfused rat colon. P Plaisancié [1,2], C Bernard [1], JA Chayvialle [1], JC Cuber [1,2] *([1] INSERM Unité 45, Hôpital É-Herriot, Pavillon Hbis, 69437 Lyon Cedex 03; [2] INRA, Unité d'Ecologie et de Physiologie du Système Digestif, 78350 Jouy-en-Josas, France*)

Glucagon-like peptide-1 (GLP-1), a potent insulinotropic peptide, is produced with peptide YY in open-type endocrine L-cells localized in the ileum and the colon. These cells can receive various chemical stimuli from the intestinal chyme at their apical side and neural and blood-borne stimuli at their basolateral side. The mechanisms