

ANSC/FSTC 607
Physiology and Biochemistry of Muscle as a Food
ABNORMAL POSTMORTEM MUSCLE METABOLISM

I. Dark-firm-dry (DFD) beef

A. Characterized by:

1. High ultimate pH.
2. Increased water-holding capacity (WHC).
3. Dark red-to-brown color.

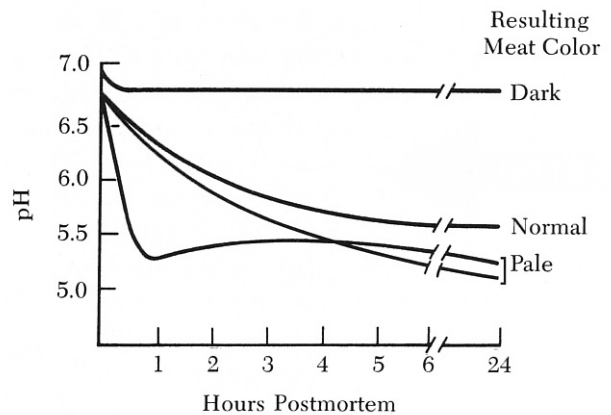
B. Due to:

1. Extensive antemortem stress.
2. Depressed glycogen content at slaughter.

Table 3. Muscle glycogen concentrations in horses fed different diets.

Diet	Muscle glycogen (mg/g wet tissue ± SE)		
	Pre-test	Post-test	Amount used
Control	15.77 ± 0.52 (n=5)	8.78 ± 1.40 (n=4)	6.99 ± 0.75 (n=4)
Fat-suppl.	22.89 ^a ± 0.42 (n=6)	9.81 ± 0.81 (n=6)	13.08 ^a ± 0.43 (n=6)

^aDifferent from control (P<.05).



II. Pale-soft-exudative (PSE) pork

A. Characterized by:

1. Rapid early postmortem pH decline.
2. Decreased WHC (hence, exudative).
3. Pale color due to altered reflectance.
4. Higher glycolytic potential ($\geq 200 \mu\text{mol/g}$).

glycolytic potential = 2 x (glucose + glycogen + glucose-6-phosphate) + lactate

B. Due to:

1. Increased glycogen storage antemortem.
2. Lower (0.1-0.2 units) ultimate pH.
3. Genetically determined by the Rendement Napole gene.
 - a. Located on chromosome 15.

b. Identity: AMP-dependent protein kinase (AMPK).

C. Molecular basis for RN mutation

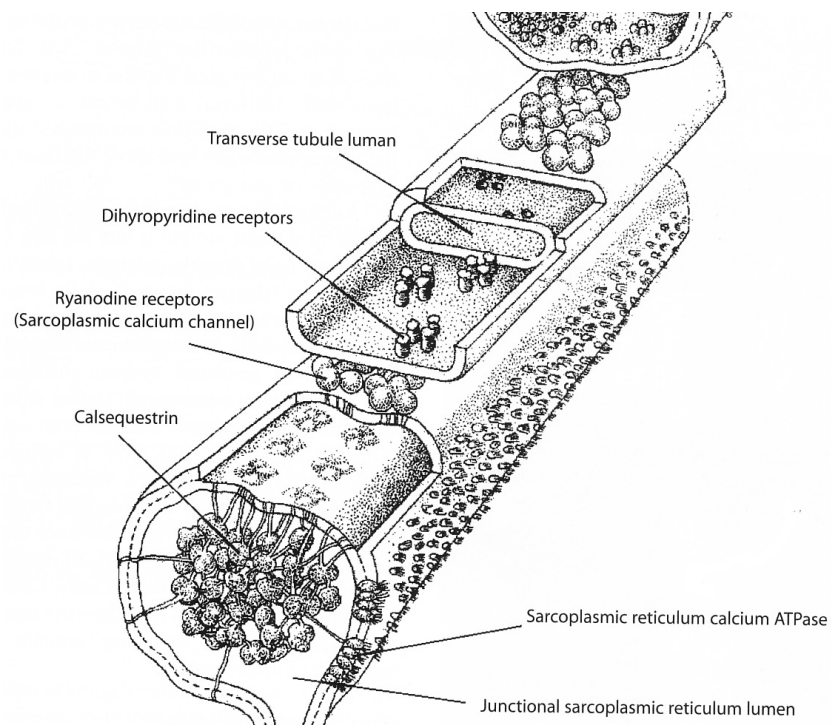
1. AMP-dependent protein kinase normally stimulates glycolysis.
 - a. Increases in AMP concentrations activate the protein kinase.
 - b. Active AMPK induces the expression of 6-phosphofructose-2-kinase, which causes the production of fructose-2,6-bisphosphate.
 - c. Fructose-2,6-bisphosphate strongly stimulates 6-PFK activity.
2. AMPK also inhibits glycogen synthesis
 - a. Wild type AMPK phosphorylates one of the serine residues of glycogen synthase.
 - b. The RN defect leads to more active glycogen synthesis.
3. A mutation in AMPK causes an increased rate of glycogen storage.
 - a. Arg(200) → Gln missense mutation in AMPK.
 - b. Leads to increased glucose uptake (possibly via GLUT4).

III. Red-soft-exudative (RSE) pork

A. Observed in porcine-stress-susceptible pigs.

1. Detected by sensitivity to halothane.
2. Also known as malignant hypothermia.

B. Caused by a defect in the ryanodine receptor gene (chromosome 6)

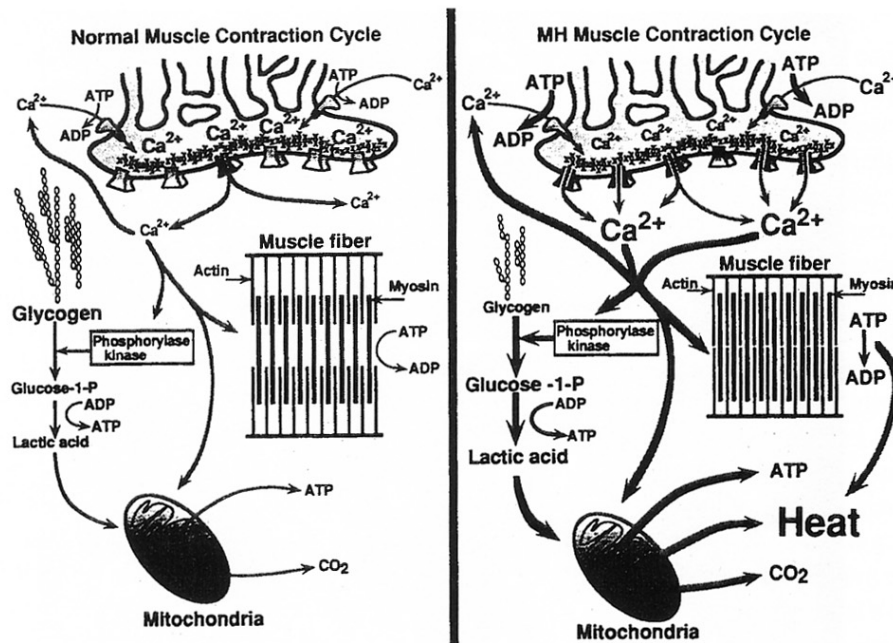


C. Characterized by:

1. Rapid pH decline postmortem, which denatures proteins.
2. No difference in ultimate pH.
3. Typically tougher meat.

D. Due to:

1. Extensive antemortem stress.
2. Genetically-determined rapid muscle glycolysis, due to uncontrolled release of Ca^{++} from the sarcoplasmic reticulum.
 - a. Glycogen degradation is accelerated (via activation of glycogen phosphorylase kinase).
 - b. Actinomyosin ATPase activity is accelerated.
 - c. Sarcoplasmic calcium pump activity is accelerated.



Role of enhanced sarcoplasmic calcium release on various cellular functions in a muscle cell. Reprinted with permission from *Science*, Vol. 256, May 8, 1992 by D. H. MacLennan & M. S. Philips. Copyright 1992 American Association for the Advancement of Science.