ANSC/FSTC 607
Biochemistry and Physiology of Muscle as a Food
PRIMARY, SECONDARY, AND TERTIARY MYOTUBES

I. Changes in fiber number

A. Species-specific

1. Virtually no increase in myofiber number in animals born relatively developed.
   a. Cattle
   b. Hares
2. Measureable increase in myofiber number early postnatally in animals born relatively undeveloped.
   a. Pigs
   b. Rabbits (domesticated)

B. Mechanism

1. Primary myotubes develop prenatally (late embryo and early fetal periods).
2. Secondary myotubes develop primarily prenatally (late gestation) and possibly early postnatally.
   a. Use primary myotube as template.
   b. Split away from primary myotube because of contraction.
   c. Are innervated by the same motoneuron as the primary myotube.

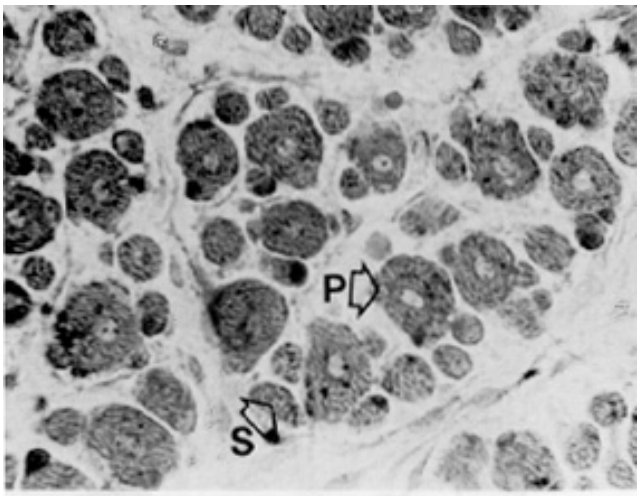


Plate 13 Transverse section of muscle from a fetal pig: (P) primary fiber or classical myotube; (S) secondary fiber.

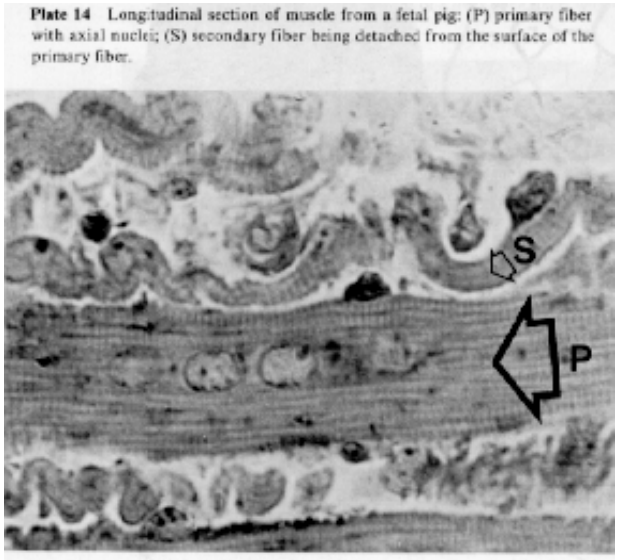
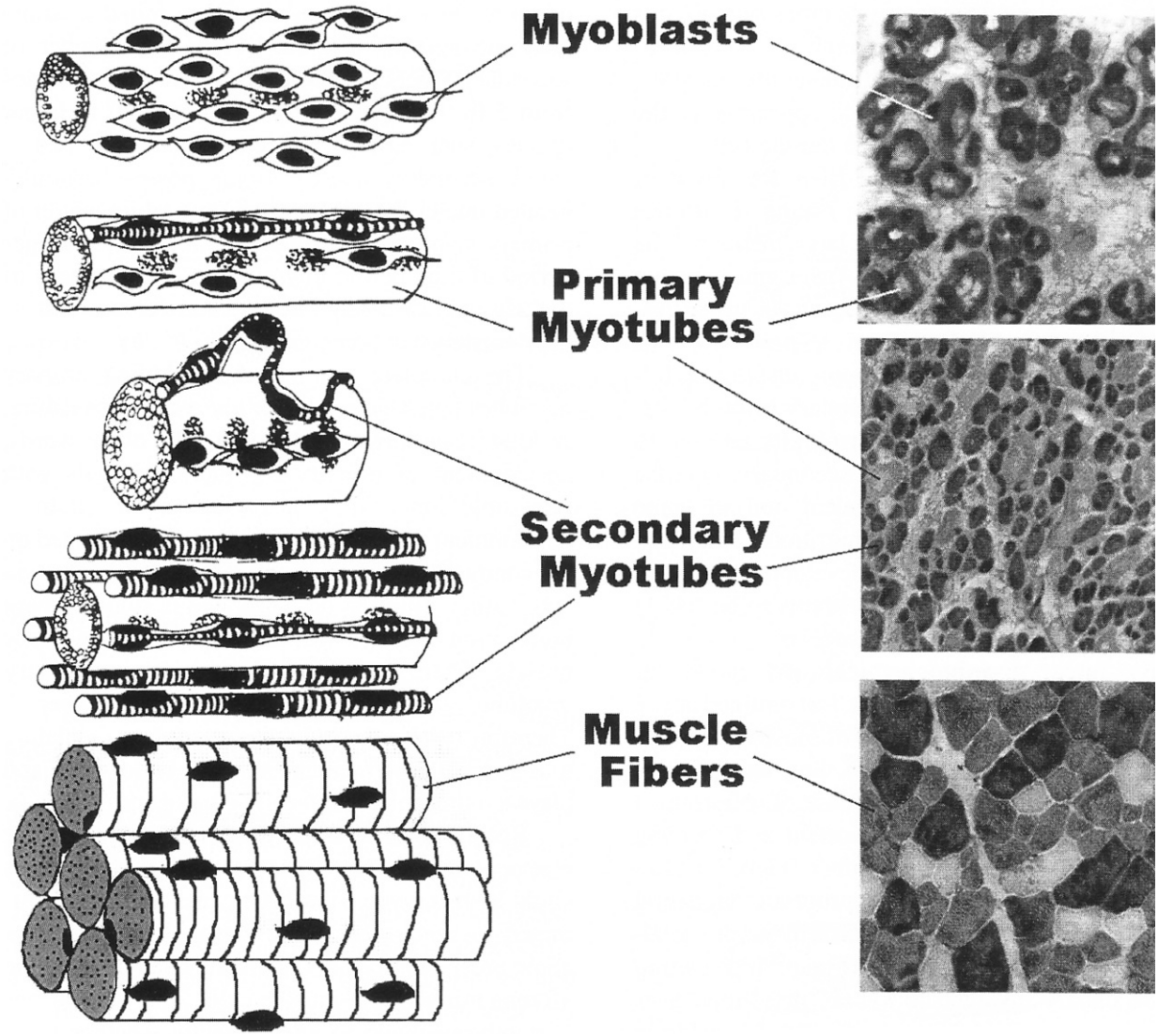


Plate 14 Longitudinal section of muscle from a fetal pig: (P) primary fiber with axial nuclei; (S) secondary fiber being detached from the surface of the primary fiber.



VI. Primary and secondary myotubes

A. Primary myotubes: progenitors of 10% of myofibers in adults.

1. From CMRI and CMRII myoblasts.
2. These myoblasts disappear once secondary myotube formation begins.

B. Secondary myotubes

1. Formed with primary myotubes as templates.
2. Formed with secondary myotubes as templates ("tertiary").
3. From CMRIII myoblasts.
    a. Require functional innervation for proliferation.

b. Disappear in denervated muscle.

VII. Acquisition of fiber type-specific myofibrillar proteins

A. Type I

1. From primary myotubes (type I_{emb}).
2. From secondary myotubes if they are surrounded by type I myofibers.
3. Denervation of a slow-twitch muscle:
   a. Primary myotubes remain as type I.
   b. Secondary myotubes convert to type II.

B. Type II

1. From type II_{emb} myotubes.
2. From secondary myotubes?

	Muscle type	
Gene family	Slow	Fast
Myosin heavy chain	S	F_{2A}, F_{2B}, F_{2X}, $F2_{EO}$, F_{SF}
Alkaline myosin light chain	1_{SA}, 1_{SB}	1_F, 3_F
Regulatory myosin light chain	2_S, $2_{S'}$	2_F
Actin (not fiber-specific)	α_{SK}	α_{SK}
Tropomyosin	S	F
Troponin C	S	F
Troponin I	S	F
Troponin T	S	F

C. Acquisition of MHC isoforms during embryonic, fetal, and postnatal growth

1. Embryonic and fetal isoforms are expressed during the development of early myofibrils.
   a. Primary myotubes begin as type I myotubes, and later some primary myotubes differentiate into type II myotubes.
   b. Secondary myotubes are programmed to develop into type II myofibers.
2. The embryonic MHC isoforms are replaced by fetal isoforms.
3. Fetal MHC isoforms are replaced by adult isoforms as more myofibrils are added to the growing myofibers.

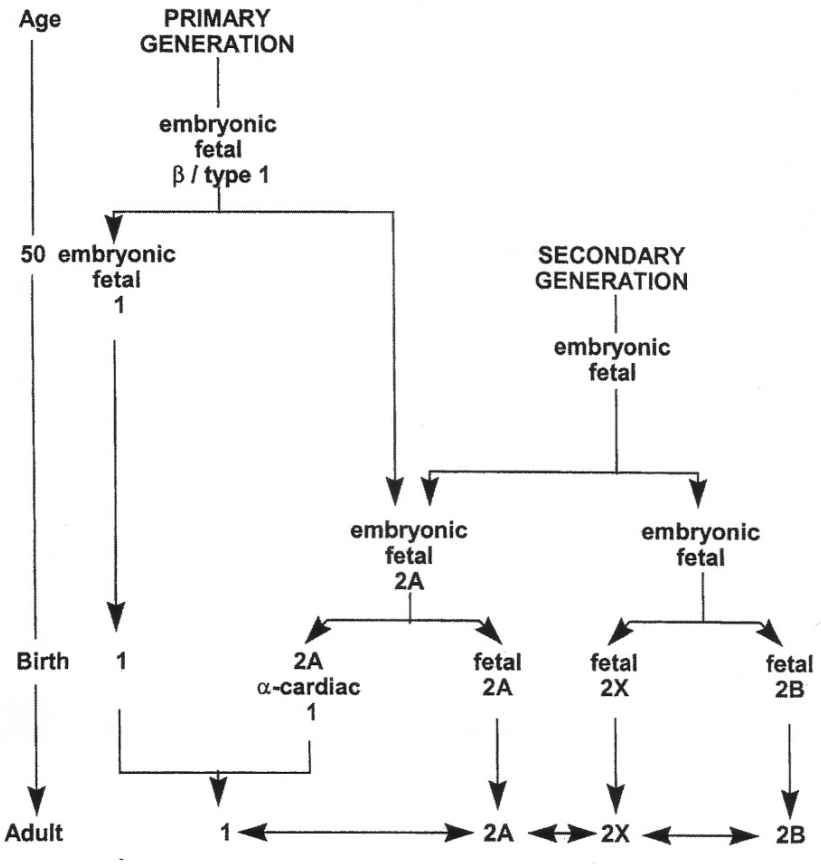
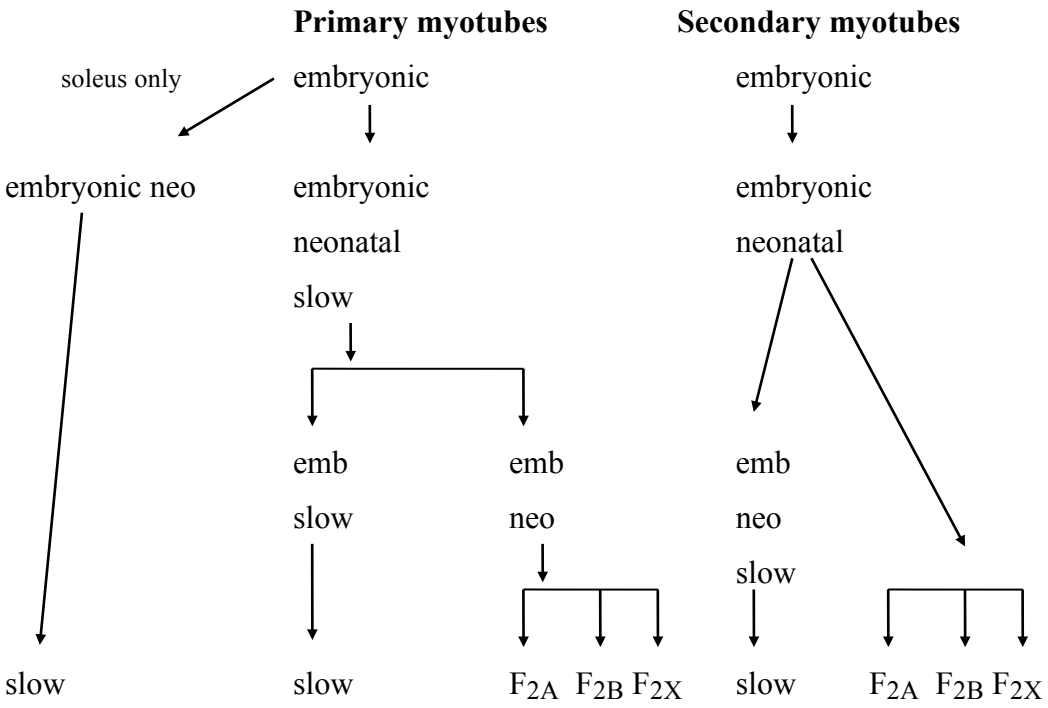


Figure 6.11 Evolution of muscle fiber types in pigs. From L. Lefaucheur and D. E. Gerrard, Muscle fiber plasticity in farm mammals, *Journal of Animal Science,* Savoy, Illinois.



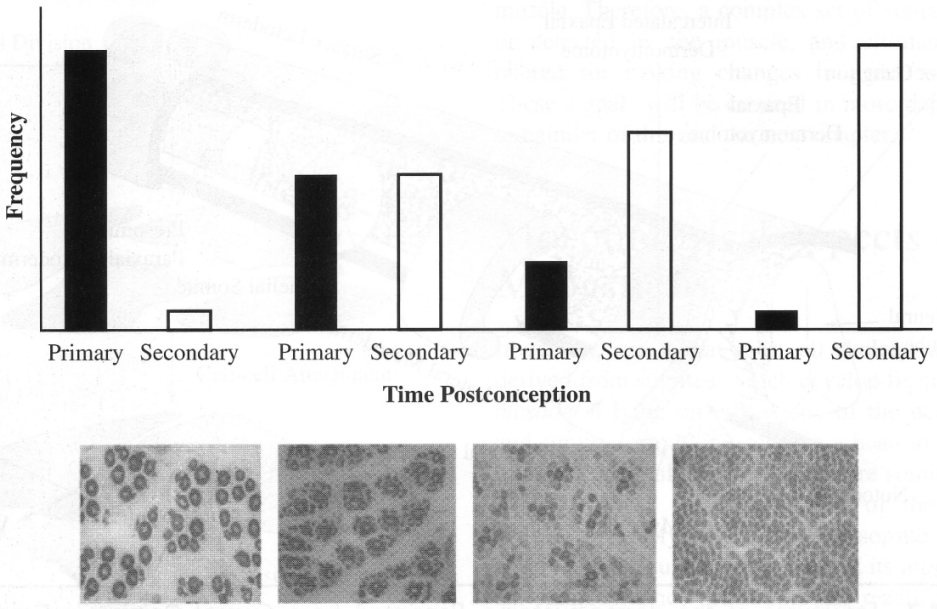


Figure 4.9 Change in the relative size and frequency of primary and secondary muscle fibers during fetal development.