Muscular Dysgenesis
A Case Study on the Muscular System

Muscular dysgenesis or dysgeny is a lethal, recessive, genetic disease of mice that is caused by a mutation in the mdg gene. Skeletal muscles from dysgenic mice are paralyzed and the animals die shortly after birth. You are a research scientist interested in finding the cause of the cellular defect associated with this genetic disease.

You surgically remove a single muscle fiber from a dysgenic mouse fetus and place it in an experimental chamber in order to study abnormalities in the control of skeletal muscle activity during dysgenesis.

1. Which of the following structures is NOT a part of the muscle fiber?
   A. transverse tubule
   B. motor end plate
   C. sarcolemma
   D. bouton
   E. sarcoplasmic reticulum

2. You briefly apply a high concentration of acetylcholine (ACh) directly to the motor end plate and observe no contraction of the fiber. Since muscular dysgenesis only affects one type of cell in the body, you would suspect that the motor neurons of dysgenic mice work normally. Yes or no?

3. Arrange the events at the neuromuscular junction in the proper sequence from first to last:
   1. arrival of the action potential at the bouton
   2. generation of action potential in sarcolemma
   3. binding of ACh to ACh receptors in the motor end plate
   4. release of ACh into the synaptic cleft
   5. removal of ACh from the cleft by acetylcholinesterase
   A. 1, 2, 3, 5, 4
   B. 2, 3, 1, 4, 5
   C. 1, 4, 3, 2, 5
   D. 2, 5, 1, 4, 3

4. After you apply acetylcholine to the muscle fiber, you find that an action potential is generated in the sarcolemma. This result proves that certain events or conditions occur normally within the neuromuscular junction. Which event or condition is NOT PROVED by the above result?
   A. ACh receptors are present in the membrane of the motor end plate
   B. ACh receptors bind to ACh
   C. Sodium permeability of the end plate membrane is increased
   D. Acetylcholinesterase breaks down ACh
5. Arrange the events of excitation contraction coupling in the proper sequence from first to last

   1. cross-bridge cycling
   2. action potential in the sarcolemma reaches the triads
   3. release of calcium from the sarcoplasmic reticulum
   4. exposure of active site on the thin filaments
   5. binding of calcium to troponin

A. 2, 3, 5, 4, 1
B. 5, 3, 4, 2, 1
C. 5, 1, 3, 2, 4
D. 3, 5, 2, 4, 1

6. You artificially raise the calcium concentration within the sarcoplasm of the muscle fiber and observe that the cell contracts normally. From this observation, you conclude that the defect in muscular dysgeny occurs at which step in control of the muscle fiber?

   A. Exposure of the active site on thin (actin) filaments
   B. Binding of calcium to troponin
   C. Release of calcium ions from the sarcoplasmic reticulum into the sarcoplasm
   D. Repeated cycles of crossbridge binding, pivoting, and detachment

7. Where in the muscle fiber do you suspect that the normal protein made by the mdg gene functions in normal mice?

   A. motor end plate
   B. triad
   C. myofibrils
   D. thin filaments

8. All of the following conditions would have same effect on muscles (flaccid paralysis) as muscular dysgeny with a single exception. What is the exception?

   A. botulism
   B. poisoning with atropine
   C. poisoning with military nerve gas
   D. myasthenia gravis

9. You would expect the muscles from an animal afflicted with muscular dysgenesis to exhibit:

   A. hypertrophy
   B. atrophy

10. You would expect that a dysgenic mouse dies shortly after birth because:

    A. the heart fails to beat
    B. vasoconstriction of the carotid artery prevents blood flow to the brain
    C. vasodilation of the systemic blood vessels causes the blood pressure to drop to lethal levels
    D. the respiratory muscles are unable to contract