Group4_VideoTutorialScript

by Lucina Martin

THE UNIVERSITY OF SYDNEY

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Discipline of Physiology

Assignment Coversheet – Video Tutorial

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Personal Details of Students

Family Name	Given Name (s)	Student Number (SID)	Email (University email only)	
Paling	**Sita**	450165126	spal5003	@uni.sydney.edu.au
Cao	**Brooke**	450171161	bcao8833	@uni.sydney.edu.au
Martin	**Lucina**	440187567	lmar0506	@uni.sydney.edu.au
Liu	**Weber**	450214701	wliu9927	@uni.sydney.edu.au
				@uni.sydney.edu.au
				@uni.sydney.edu.au

Assignment Details

Assignment Title	**Script**				
Assignment number (if applicable)					
Unit of Study Code (e.g. HSBH1006)	**PHSI2905**				
Unit of Study Name	**Integrated Physiology A**				
Unit of Study Coordinator or Tutor	**Haydn Allbutt and Atomu Sawatari**				
Group or Tutorial ID:	**4**				
Due Date	**20/04/2016**	Submission Date	**20/04/2016**	Word Count	**3036**

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Late Submission: Assignments handed in after the due date will be subject to penalties. If your assignment will be late due to reasons you feel can be justified please lodge a special consideration form with the Faculty of Science Student Office, within 5 working days of the due date..

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THE SKELETAL MUSCLE CONTRACTION CYCLE

by BROOKE CAO, WEBER LIU, LUCINA MARTIN and SITA PALING

SIXTH DRAFT
APRIL 2016

34 Stewart Ave, Curl Curl
NSW 2096, Australia
Ph: (61 2) 9905 4616

1: TITLE

"The Skeletal Muscle Contraction Cycle" will be presented as white words on a black background in Times New Roman font while the initial 6 seconds of "Spy Glass" by Kevin Macleod plays as background music.

2: TYPES OF MUSCLE

Very wide shot of an individual walking in the distance.

NARRATOR (V/O)
At any point in time, an individual experiences contraction of three types of muscle.

Zoom into the individual's chest and fade on an overlaid animation of a pumping heart.

NARRATOR (V/O) (CONT'D)
Cardiac muscle contracts to allow circulation of blood through the body and the lungs,

Tilt camera down to the individual's stomach whilst animation of the heart fades into animation of peristaltic contractions of the gut.

NARRATOR (V/O) (CONT'D)
Smooth muscle, which is responsible for moving substances through the gut, as well as the blood vessels and airways,

Tilt camera down to the individual's legs whilst animation of the gut fades to animation of skeletal muscle contractions.

NARRATOR (V/O) (CONT'D)
And skeletal muscle, which is attached to bones, and allows voluntary body movement,

Dolly shot of individual walking and then bending their legs to squat.

NARRATOR (V/O) (CONT'D)
Such as flexing,

Freeze for 2 seconds while individual is squatted then unfreeze to show individual standing up straight again and walking again.

NARRATOR (V/O) (CONT'D)
And extension of limbs. Skeletal muscles including biceps, hamstrings and most other voluntary muscles are made of myofibrils, of which the smallest contractile unit is the sarcomere.

Zoom out and then Continue dolly shot of walking individual for 5 seconds

3: OVERVIEW OF SKELETAL MUSCLE CONTRACTION

Fade to cardboard models of actin and myosin laid on white background.

NARRATOR (V/O)
Here, we look into the composition of sarcomeres and the sliding filament theory, which describes how skeletal muscles contract at a molecular level. This involves the binding of the motor protein, myosin,

Draw blue circle around the myosin and manually move the head so it binds to actin.

NARRATOR (V/O)(CONT'D)
And the microfilament, actin.

Fade off circle around myosin and draw blue circle around actin.

NARRATOR (V/O)(CONT'D)
The conformational change of myosin,

Manually move the filaments to perform a powerstroke.

NARRATOR (V/O)(CONT'D)
The release of the actin,

Manually detach the myosin head from the actin.

NARRATOR (V/O) (CONT'D)
The recovery stroke,

Manually perform recovery stroke of myosin head.

NARRATOR (V/O) (CONT'D)
And the repetition of this process.

Repeat the manual movements of the myosin molecule to show the contraction cycle.

NARRATOR (V/O) (CONT'D)
Now we will look at this contraction cycle in detail.

Fade to large flow diagram that consists of images of all four steps, labelled, and in a circle, joined by arrows. While Kevin Macleod's "Spy Glass" plays in the background, zoom in on step 1, labelled "Crossbridge formation," then pan to step 2, "Powerstroke," then step 3, "Detachment," and finally step 4, "Recovery stroke." Zoom back out to show full diagram.

4: INTRO TO COMPONENTS OF THE SARCOMERE

Fade to close up of all the cardboard cut-outs of each element of the sarcomere, including the troponin, actin, tropomyosin, myosin, titin and nebulin, sitting on a white table.

NARRATOR (V/O)
Firstly, let's look at the components of the sarcomere which are involved in the sliding filament theory.

Move all of the cut-outs off screen and place the actin polymer in the centre of the shot.

NARRATOR (V/O) (CONT'D)
Here we have actin also known as the 'thin filament'. It contains many myosin binding sites along each monomer in its structure, which are coloured yellow.

Overlay type on screen "THIN FILAMENT" in black, Times New Roman font. Fade off "THIN FILAMENT". Move the actin cut-out off screen place the myosin cut-out in the centre of the shot.

NARRATOR (V/O) (CONT'D)
Myosin is a mechanochemical protein, more commonly referred to as a motor protein. Motor proteins use the energy obtained from the hydrolysis of ATP to do mechanical work.

Fade to cardboard cut-out of myosin molecule on white table.

NARRATOR (V/O)(CONT'D)
Myosin can be divided into three structurally and functionally different domains. Firstly, the two globular heads. One of these is an ATPase, meaning it can hydrolyse ATP, converting it into ADP and inorganic phosphate.

Zoom in on myosin head and draw circle around the ATPase. Move a cardboard molecule of ATP towards the head and then switch out the ATP cut-out with the ADP and Pi cut-out.

NARRATOR (V/O)(CONT'D)
And the other contains an actin-binding site. This site has a strong affinity for the myosin-binding site on the actin polymer.

Remove ADP and Pi. Draw circle around the actin-binding site.

NARRATOR (V/O)(CONT'D)

Next we have the alpha helical neck region.
It regulates the activity of the head.

Zoom out to show whole myosin molecule then zoom in on myosin neck. Move the neck to show how it controls the movement of the head.

NARRATOR (V/O)(CONT'D)
And lastly, the alpha helical coiled-coil tail. It associates with other myosin tails to form the thick filament of the sarcomere.

Zoom out to show whole myosin molecule then zoom in on myosin tail. Add numerous more myosin tails to the diagram and overlay type on screen "THICK FILAMENT" in black Times New Roman font. Fade off "THICK FILAMENT", zoom out to show whole myosin molecule and add titan cut-out to the diagram.

NARRATOR (V/O)(CONT'D)
These thick filaments are held in place by a long elastic protein called titin. This protein has a dual function of ensuring the myosin is stabilised in position, *pause* and the sarcomere doesn't overstretch.

Move myosin cut-out off screen and replace with tropomyosin cut-out, placed on top of actin.

NARRATOR (V/O)(CONT'D)
This is tropomyosin, a regulatory protein. It covers the myosin binding sites on actin when the muscle fibre is at rest.

Move myosin into view, with the head cocked, unattached (but close) to yellow actin binding regions, because of the tropomyosin covering all of the yellow binding regions *pause* Add troponin cut-out to the diagram and zoom in on troponin, bound to actin and tropomyosin.

NARRATOR (V/O)(CONT'D)
This is troponin-C, which is attached to tropomyosin and actin. It contains a binding site for calcium ions labelled white. It is common to confuse tropomyosin with troponin, so, an easy way to remember is…

Type text 'Tropo<u>**myosin**</u> regulates <u>**myosin**</u> ' overlaid on screen in black Times New Roman.

NARRATOR (V/O)(CONT'D)
Tropomyosin regulates myosin's attachment to actin. Troponin on the other hand has direct regulatory contact with tropomyosin but not myosin. Hence…

Fade to '**Tropo**nin regulates **tropo**myosin' overlaid on screen in black Times New Roman font. Leave text for 3 seconds before fading text off screen.

NARRATOR (V/O)(CONT'D)
Let's now try to put this all together.

Fade to large labelled drawing of sarcomere.

NARRATOR (V/O)(CONT'D)
Titin attaches the myosin to a Z-disk which holds together all the actin polymers - the thin filaments. In our myofibril, we can easily see our A-band. This stands for 'anisotropic' and it is the region occupied by myosin. Within the A-band, we can find our M-line, which is the site of connection of myosin molecules. The H-zone is the region occupied by only myosin, without any overlap. We also have our I-band which is the region consisting of only Actin. Within our I-band, we can also see the Z-disk, which is formed by the connection of surrounding actin molecules.

Point (with hand) to each feature of the sarcomere as it is mentioned.

NARRATOR (V/O) (CONT'D)
With a good understanding of the zones, disks and bands, we can now answer our crucial question: How does muscle contraction occur?

5: STEP 1 OF CONTRACTION CYCLE - CROSSBRIDGE FORMATION

Underneath the video, a small white progress bar divided into four sections (labelled in black text with each step of cycle) will appear. As we progress through the steps the bar will fill in blue.

Fade to large flow diagram of the full cycle. Zoom in on Step 1, "Crossbridge formation", while Kevin Macleod's "Spy Glass" plays in the background, for 5 seconds. Fade to cardboard cut-out diagram of myosin, actin, tropomyosin and troponin on white table.

NARRATOR (V/O)
Let's start with the myosin molecule in its cocked state, with ADP and inorganic phosphate bound to the head. At this stage it contains potential energy, much like a stretched rubber band.

Cut to close-up of a rubber band being stretched. Cut back to cardboard cut-out diagram on white table.

NARRATOR (V/O)(CONT'D)
As there is tropomyosin blocking the myosin binding sites on actin, the affinity between the two polymers is reduced and so they form a very weak cross-bridge.

Point (with hand) to tropomyosin blocking binding sites.

NARRATOR (V/O)(CONT'D)
When calcium ions are present, they will bind to troponin-C, which causes conformational changes in troponin. This causes troponin to move so that the binding sites on actin are now exposed.

Introduce cardboard cut-out of calcium ion to the diagram, move it to bind with troponin and then move tropomyosin to expose binding sits on actin.

NARRATOR (V/O) (CONT'D)
This drastically increases the affinity between the actin and myosin molecules, hence, the weak crossbridges become much stronger.

Move myosin head closer to touch actin binding site.

6: STEP 2 OF CONTRACTION CYCLE - POWERSTROKE

Fade to large flow diagram of the full cycle. Zoom in on Step 2, "Powerstroke", while Kevin Macleod's "Spy Glass" plays in the background, for 5 seconds. Fade to cardboard cut-out diagram of myosin, actin, tropomyosin and troponin on white table.

NARRATOR (V/O)
When the strong crossbridges form, a phosphate ion is released.

Remove the inorganic phosphate cut-out from the myosin head.

NARRATOR (V/O)(CONT'D)
This causes a conformational change in the myosin molecule, causing the head to swivel from about a 90-degree angle to 45 degrees. This converts the potential energy stored in the myosin molecule into kinetic energy.

Cut to release of the stretched rubber band.

NARRATOR (V/O)(CONT'D)
During this motion, the myosin remains bound tightly to actin, so that the actin filaments are moved close to the centre of the sarcomere.

Cut back to Cardboard cut-out diagram. Move the myosin head while it is attached to actin to demonstrate the powerstroke motion.

NARRATOR (V/O) (CONT'D)
This is called the powerstroke. It results in the shortening of the I-bands, as well as the shortening of the whole sarcomere, because the M-lines move closer together

Fade to diagram of a contracted sarcomere, indicating the bands.

NARRATOR (V/O) (CONT'D)
Macroscopically, this is observed as a shortening of skeletal muscle, or muscle contraction.

Cut to close up shot of individual's bicep as they lift a weight.

NARRATOR (V/O)(CONT'D)
The ADP is released at the end of the powerstroke but the myosin head remains bound to the actin filament.

Cut back to cardboard cutout diagram. Remove the ADP from the myosin head.

7: STEP 3 OF CONTRACTION CYCLE - DETACHMENT

Fade to large flow diagram of the full cycle. Zoom in on Step 3, "Detachment", while Kevin Macleod's "Spy Glass" plays in the background, for 5 seconds. Fade to cardboard cut-out diagram of myosin, actin, tropomyosin and troponin on white table.

NARRATOR (V/O)
In its current state, the sarcomere is in rigor conformation. Observed externally, this muscle fibre will appear to be contracted, as in rigor mortis.

Cut to close up shot of individual's contracted bicep. After 2 seconds cut back to cardboard cutout diagram.

NARRATOR (V/O) (CONT'D)
The binding of ATP to the myosin head will result in a conformational change, which reduces the affinity of the myosin head to the actin filament. Thus, the myosin head detached from actin.

Introduce ATP cardboard cut-out molecule to the diagram and attach it to the myosin head, before detaching the myosin head from the actin.

NARRATOR (V/O) (CONT'D)
During this time, an ATP-driven Calcium ion pump is rapidly removing calcium ions from the cytosol. This means that, if there is not another influx of calcium ions from another nerve signal, the tropomyosin will once again cover the myosin-binding sites on the actin molecule.

Remove calcium from troponin and place the tropomyosin over the myosin-binding sites.

8: STEP 4 OF CONTRACTION CYCLE - RECOVERY STROKE

Fade to large flow diagram of the full cycle. Zoom in on Step 4, "Recovery stroke", while Kevin Macleod's "Spy Glass" plays in the background, for 5 seconds. Fade to cardboard cut-out diagram of myosin, actin, tropomyosin and troponin on white table.

NARRATOR (V/O)
But how does myosin prepare for its next powerstroke? A series of conformational changes in the myosin molecule couple the activation of its ATPase function with the movement of the head back to its original, pre-power stroke position.

Manually move the myosin head through the recovery stroke motion.

NARRATOR (V/O) (CONT'D)
This repriming of the myosin head is called the recovery stroke,

Overlay type text "RECOVERY STROKE" on screen in black Times New Roman font. After 3 seconds fade off text.

NARRATOR (V/O) (CONT'D)
And it is rapidly followed by ATP hydrolysis.

Manually replace ATP with ADP and Pi.

NARRATOR (V/O) (CONT'D)
The products of ATP hydrolysis, ADP and Pi, remain bound to myosin, forming a metastable complex.

Zoom in on ADP and Pi bound to myosin head.

NARRATOR (V/O) (CONT'D)
And there we have it! The cycle is completed. The myosin head is now primed to form a weak crossbridge with the actin

filaments, ready to start the cycle all over again.

9: CONCLUSION

Zoom into the progress bar at the bottom of the screen and animate it to form a circle.

NARRATOR (V/O)
Let's have one last look at our contraction cycle in summary.

Fade on overall flow diagram of the contraction cycle while Kevin Macleod's "Spy Glass" is playing in the background, for 5 seconds.

NARRATOR (V/O)(CONT'D)
At rest, with no calcium present, myosin and actin form a weak cross-bridge. They are separated by tropomyosin. A nerve signal eventually leads to an influx of calcium ions into the sarcoplasm, which bind to troponin, causing a conformational change in tropomyosin. Thereby, the myosin-binding sites on the actin filament become exposed. This allows for strong binding between the myosin head and actin, which in turn induces the power stroke. During the power stroke, the inorganic phosphate ion is released and then ADP is released. At this point, if no ATP is available, the myosin remains bound to the actin filament, in the 'rigor state'. However, when an ATP molecule binds to the myosin head, this induces the detachment of myosin and actin. Finally, myosin performs the recovery stroke and ATP hydrolysis, so it is in its original conformation once again.

Point (with hand) to each step and component of the diagram as it is mentioned.

NARRATOR (V/O)(CONT'D)
An easy way to remember these 4 steps is 'Can People Die Rockclimbing?'

Fade on black Times New Roman text "CAN PEOPLE DIE ROCKCLIMBING?" overlaid on a background picture of a rock climbing wall.

NARRATOR (V/O)(CONT'D)
Crossbridge formation,

Fade black Times New Roman text onto white background "Can" (with emphasis on the C by typing it in a bigger font and bold).

NARRATOR (V/O)(CONT'D)
Powerstroke,

Fade off "Can" and fade on "People" (with emphasis on the P by typing it in a bigger font and bold).

NARRATOR (V/O)(CONT'D)
Detachment,

Fade off "People" and fade on "Die" (with emphasis on the D by typing it in a bigger font and bold).

NARRATOR (V/O)(CONT'D)
Recovery stroke.

Fade off "Die" and fade on "Rockclimbing" (with emphasis on the R by typing it in a bigger font and bold).

NARRATOR (V/O)(CONT'D)
Now let's try a question to test your understanding. Consider a situation where the myosin heads have just performed a powerstroke, but there is no ATP available. What would happen?

Fade on multiple choice options in black text on white background.

"a. The myosin heads would detach from actin
b. The recovery stroke would occur whilst the myosin is still attached to actin
c. The myosin heads would remain bound to actin, but the muscle fibre would relax
d. The myosin heads would remain bound to actin but the muscle fibre would remain contracted"
Remain on this screen for 15 seconds.

NARRATOR (V/O)(CONT'D)
Explanation: (a) is incorrect because the myosin heads won't detach from actin without ATP binding.

Draw red line through option (a) on the screen.

NARRATOR (V/O)(CONT'D)
(b) is incorrect because the recovery stroke cannot be performed while myosin is still bound to actin.

Draw red line through option (b) on the screen.

NARRATOR (V/O)(CONT'D)
(c) is incorrect because if the recovery stroke is not performed, the muscle fibre cannot relax.

Draw red line through option c) on the screen.

NARRATOR (V/O)(CONT'D)
And therefore, (d) is correct! This is the rigor state we mentioned earlier. When this happens in a dead body it is called rigor mortis.

Draw large red tick next to option (d) on screen. Fade to wide shot of individual climbing up a rockclimbing wall.

NARRATOR (V/O)(CONT'D)
So, if all else fails, just ask yourself, Can People Die Rockclimbing?

Fade on black Times New Roman text "Can People Die Rockclimbing?" overlaid on wide shot of individual rockclimbing. Play Kevin Macleod's "Spy Glass" for 5 seconds.

10: CREDITS

Cut to black Times New Roman text on white background:

"'The Skeletal Muscle Contraction Cycle' by Weber Liu, Lucina Martin, Brooke Cao and Sita Paling.

References:

Boundless Biology 2016, *Sliding Filament Model of Contraction*, Boundless, viewed 10 April 2016, https://www.boundless.com/biology/textbooks/boundless-biology-textbook/the-musculoskeletal-system-38/muscle-contraction-and-locomotion-218/sliding-filament-model-of-contraction-825-12068

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Geeves, M.A. and Holmes, K.C. 2005, 'The molecular mechanism of muscle contraction', *Advances in Protein Chemistry*, vol. 71, pp. 161-193.

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Mansson, A., Rassier, D., Tsiavaliaris, G. 2015, 'Poorly understood aspects of striated muscle contraction', *BioMed Research International*, vol. 2015, article ID 245154, 28 pages.

Silverthorn, D. U. 2016, *Human Physiology: An Integrated Approach*, Pearson Education Limited, Harlow, England.

"Spy Glass" Kevin MacLeod (incompetech.com)Licensed under Creative Commons: By Attribution 3.0 License http://creativecommons.org/licenses/by/3.0/"

Play Kevin Macleod's "Spy Glass" in the background for 10 seconds.

Group4_VideoTutorialScript

GRADEMARK REPORT

FINAL GRADE

70/70

GENERAL COMMENTS

Instructor

Very Good. I like the style. The little details like the animated progress bar which shows where you are in the cycle, the related images which demonstrate the concept you are describing visually to keep viewer attention and the educational techniques you used like repetition of important points, mnemonics, a quiz to test understanding, were great.

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PHSI2905 (Session 1, 2016) - Groups for Video Assessment Task

Updated: 4/4/2016

Assignment 2

Given Names	Family Name	Email	Video Groups
SITA SALLY	PALING	spal5033@uni.sydney.edu.a	4
BROOKE LIU	CAO	bcao8833@uni.sydney.edu.a	4
LUCINA	MARTIN	lmar0506@uni.sydney.edu.a	4
WEBER	LIU	wliu9927@uni.sydney.edu.au	4

Element	Statement	Max Mark	Mark Awarded
Title	Script should Show the title of the video. Should describe how the title will be presented. Title should be informative.	5	5
Introduction	Script should detail the short introduction that will be included in the video. What is the dialogue that will be included, how will it be presented, ie over music as a voice over, presented to camera, what is the location of the shot, what is the vision that will be on screen during the introduction. Introduction should be interesting, engaging and informative. Should detail what specific topic will be covered and what is interesting/useful/novel about the video.	10	10
Body	Script should provide detail about everything that will be seen during the video and everything that will be heard during the video. Students should write the dialogue that will be delivered and describe *how* will it be delivered. Students should describe what will be seen on the screen during the dialogue and what will be heard during the dialogue.	20	20
Graphics/Visual Aids	Students should detail what visual aids/diagrams/graphics/animations will be used to illustrate or demonstrate the mechanisms described in the video. Students should endeavor to make their own visual aids, but stock footage, properly cited in credits, used to suit the purpose of the video is acceptable. The intended visual aids etc should be described	15	15
Style	The style and formatting of the script should be in the form of a screen play as described in the handout the students were given. The style of the writing and dialogue should be scientific, not colloquial/comedic. Video should be in the style of a tutorial or an educational documentary. The script should be concise and to the point, should not include too many separate topics. The information presented should be factually correct and should be presented clearly and logically. Information should be pitched at a University level science student.	10	10
Conclusion	Script should detail the conclusion/summary of points what will be included in the video. This conclusion should summarize and highlight the topics you have covered.	5	5
References	Script should list where information was obtained in order to create the script in the form of a bibliography similar to those found at the end of scientific journal articles.	5	5
	Total	70	70