Name(s):

1. Muscle contraction as a function of stimulation intensity

Record the force of single twitches at different stimulus intensities to extract the charactersitic features of the force-intensity relation. Use appropriate stimulus strengths to construct the curve and to document your results with a copy of the oscilloscope screen (STORE mode)

Recording (1):

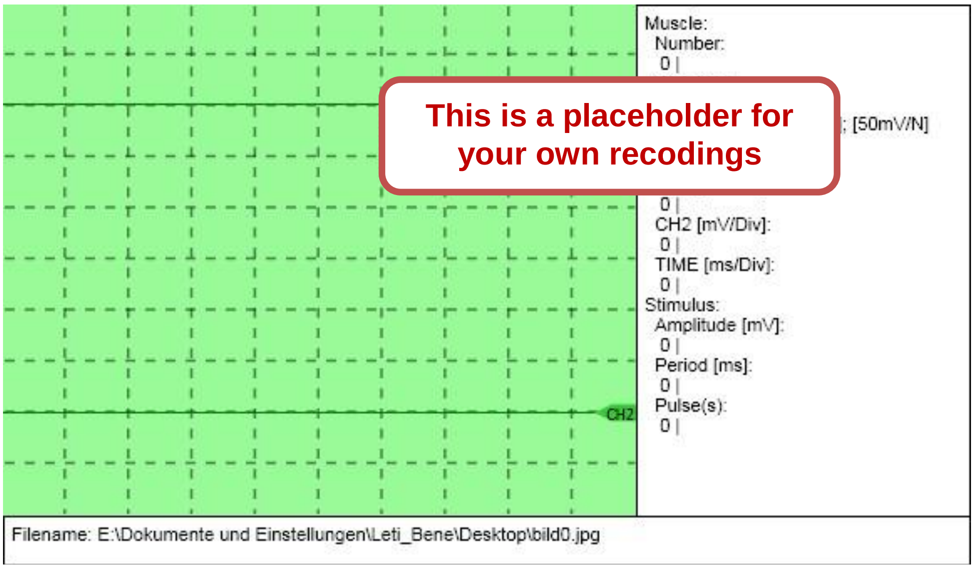
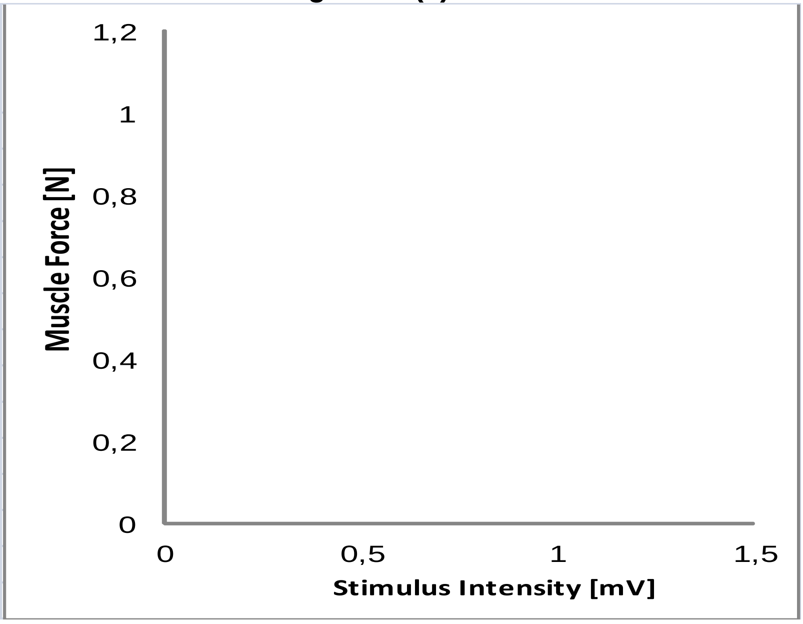


Table (1)

Stimulus Intensity [ ]	Muscle Force [ ]

Diagramm (1):



Stimulus intensity where a minimum contraction appears: ……………..

Stimulus intensity where the maximum contraction is reached: ………..….

Maximum contraction : Force: ………… Duration: ………

SimMuscle - Protocol Group: Supervisor: Date:

Name(s):

Questions (1)

1.1: Can you describe the major characteristics of the observed force-stimulus relation and explain their physiological background?

1.2: How can the observed characteristics be related to the adjustment of muscle force in everyday life when items of different weights need to be moved (lifted up)?

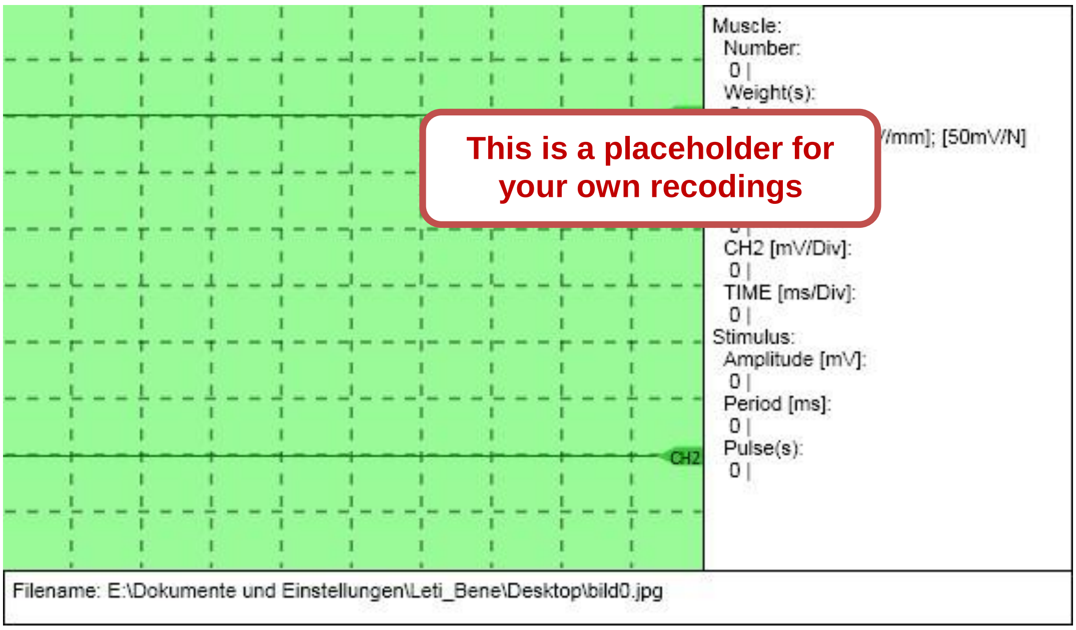
2. Superposition of single twitches (twin pulses):

Record the muscle contraction in response to twin pulses (supramaximal amplitude) of different pulse intervals (see table) and determine at what interaval the maximum amplitude is reached. Use the SAVE mode and copy the screen into the protocol form.

Stimulus Period	[ms] :	200	100	50
Contraction Anpl.	[ ]:	…..	…..	…..

Maximimum Contraction: ………. [ ] at ………. [ ] pulse interval (period)

Recordings (2)



Questions (2)

2.1: To understand how superposition can occur, recall that the duration of a single twitch of the M. gastrocnemius is much longer than of a muscle action potentail

Approximate duration a) of a muscle action potential …………

b) of a single muscle twitch: …………

2.2: Can you explain what makes the muscle twitches so much longer than the muscle action potentials?

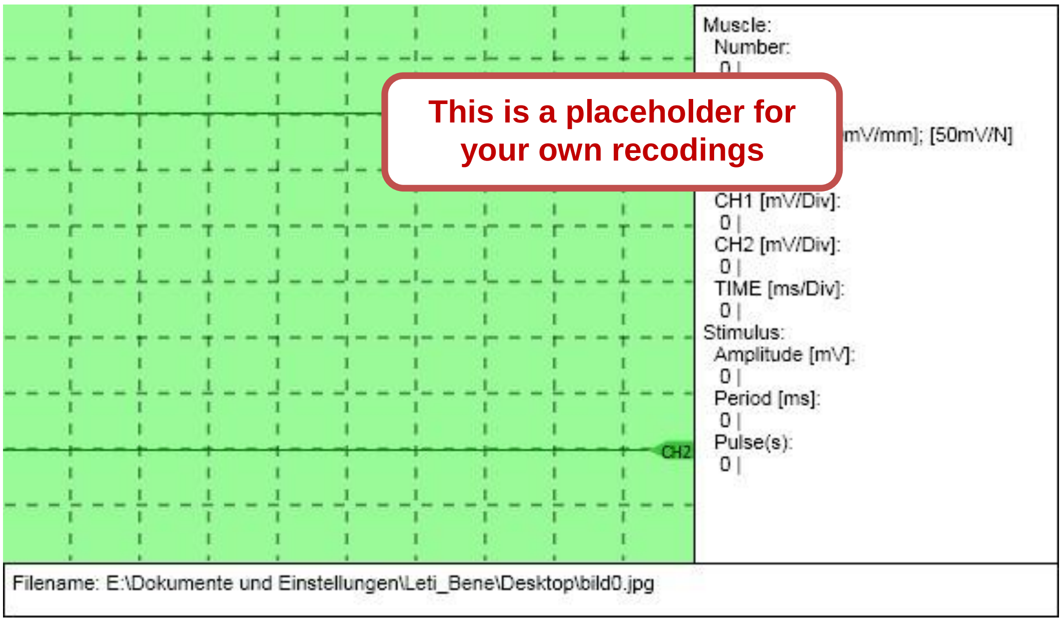
3. Single Twitches vs.Tetanic Contractions

Task: Stimulate the muscle with supramaximal pulses of different frequencies that lead to a) isolated single twitches, b) incomplete and c) complete tetanic contractions.

Try to display all three recordings on the same oscilloscope screen (STORE), keeping amplification and time-base (200ms/DIV) constant.

Table (3)	Stimulus		Muscle	only for stimulus adjustment	
	Frequency	Period	Contraction	Pulses	Stim.time
	[ ]	[ ]	[ ]	[ ]	[ ]
Single twitches	………..	………..	………..	………..	………..
Incomplete tetanus	………..	………..	………..	………..	………..
Complete tetanus	………..	………..	………..	………..	………..

Recording (3)



Questions (3)

3.1: Which are the two main control parameters of skeletal muscle innervation that allow adjustment of muscle force to different tasks also in everyday life (see also question 1.2)?

1. ………………………………………………………………………………………

2. ………………………………………………………………………………………

3.2: Can you explain why tetanic contractions can be induced in the skeletal muscle but not in the heart muscle cells?

SimMuscle - Protocol Group: Supervisor: Date:

Name(s):

4. Resting Tension Curve with Curves of Isometric and Isotonic Maxima

Tasks:

4.1. Record the **“passive” muscle lenthening** when it is stretched by different weights. Document your results in Table #4 (first two columns).

For these recordings, of course, the transducer need to be set to “free. and to switch off “zero adj”. Also, the stimulus amplitude should be set to zero because the stimulus is only used to trigger the oscilloscope. At the oscilloscope, the base line of the recording channel (Ch 2) should initially (i. e. without weights) be moved up because muscle lenthening instead of contractions will be recorded.
When the amplifier of the recording channel (Ch 2) is set to 100 mV/DIV it should be possible to display all muscle lengthenings (mostly up to 8 and 12 mm) without additonal changes of the oscilloscope settings.

4.2. Record **isometric and isotonic contractions** at different pre-stretchings. Copy the oscilloscope screens of isometric and isotonic contractions (Recordings 4.1 and 4.2) and document the active lanthenning (ΔL_a) and force (ΔF_a) in Table #4.

Considering that again active contractions are recorded don’t forget to readjust the oscilloscope base line and to switch on “zero adj” to compensate for base-line shifts by the weights.

4.3 Construct the **<u>diagrams</u> of isometric and isotonic contractions.**

4.3.1. Plot the active contractions (muscle shortening ΔL_a and force ΔF_a) at different pre-stretchings (weights) against the passive muscle length ΔL_P.

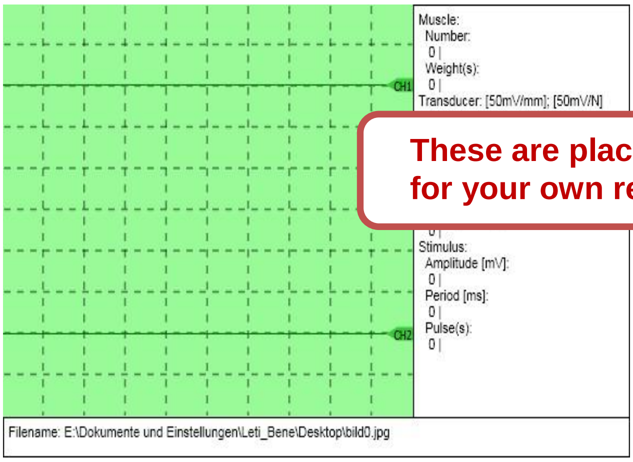
Please note that the force (weight), although it is the independent control variable, is plotted on the ordinate while the mucle length is plotted along the abscissa.

4.3.2. Construct the curves of isometric and isotonic contractions in their conventional form (also used for pressure-volume diagrams of heart contractions)

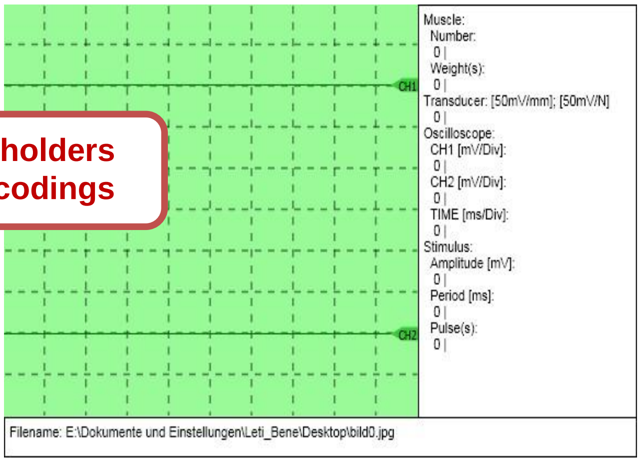
In this form, first the resting tension curve is plotted to/from which then the values of active muscle force/shortening are added t/subtracted. You should use the additonally provided columns in table #4 to document the final values of these curves of isometric and isotonic contractions. You may use your pencil or the“Office” tools to draw arrows from the resting tension curves to the related value of active muscle contractions according to the conventional textbook illustrations.

Recordings (4)

isometric **isotonic**



These are placeholders for your own recodings

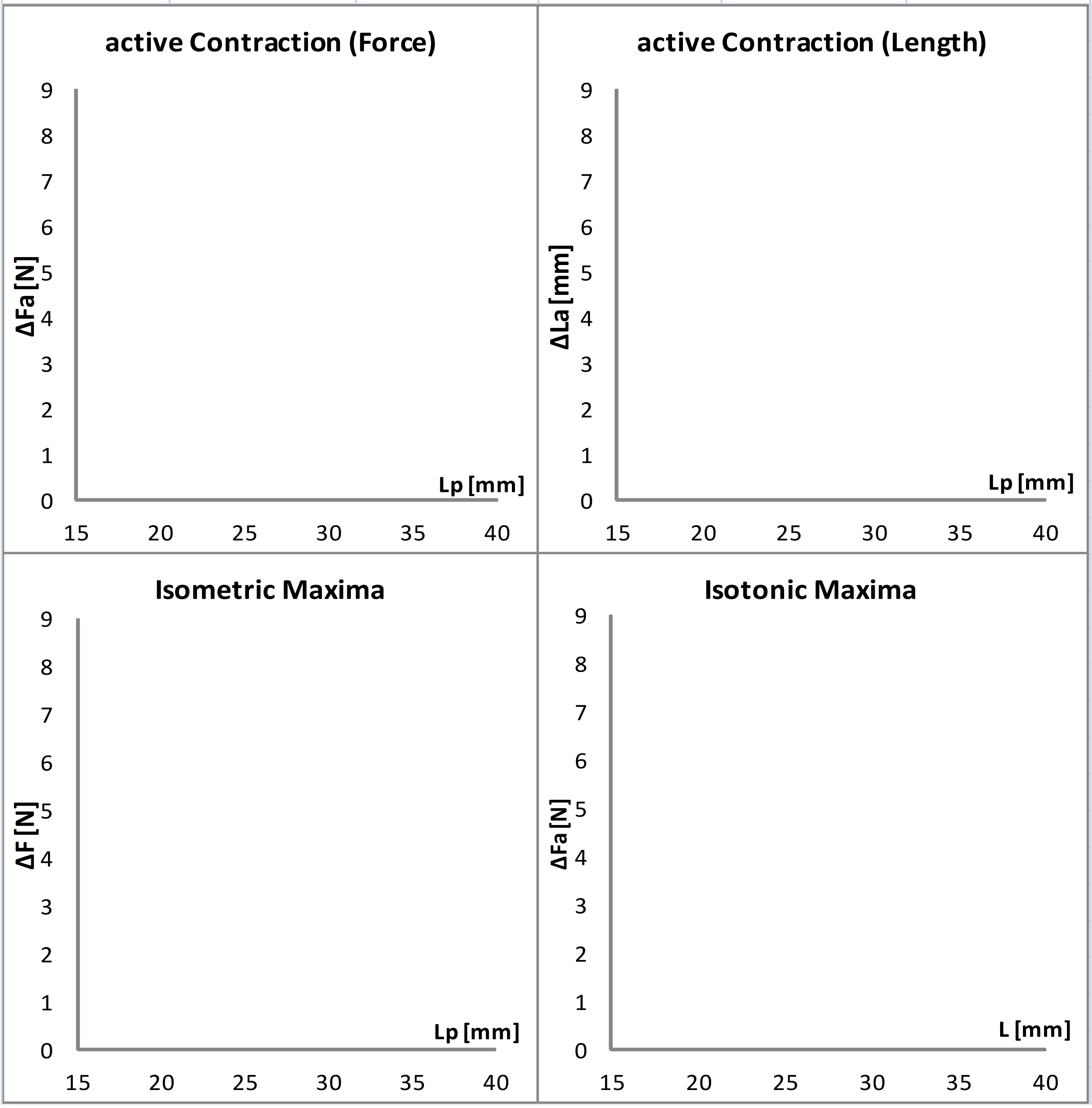


SimMuscle - Protocol Group: Supervisor: Date:

Name(s):

Table (4): for the construction of the curves of isotonic and isometric maxima

Weight(s) ΔFp [N]	passive Muscle Lengthening ΔLp [mm]	active Contraction (Length) ΔLa [mm]	active Contraction (Force) ΔFa [N]	Isometric Maxima	Isotonic Maxima
0					
1					
2					
3					
4					
5					
6					



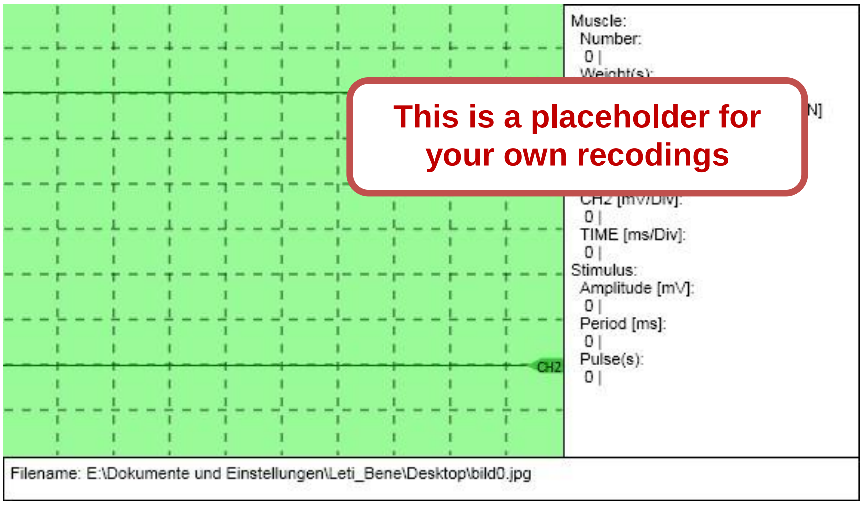
Diagrams (4)

Name(s):

5. Muscle Fatigue

5.1. Single Twitches before and after fatigue by strong tetanic contractions ("STORE" mode)

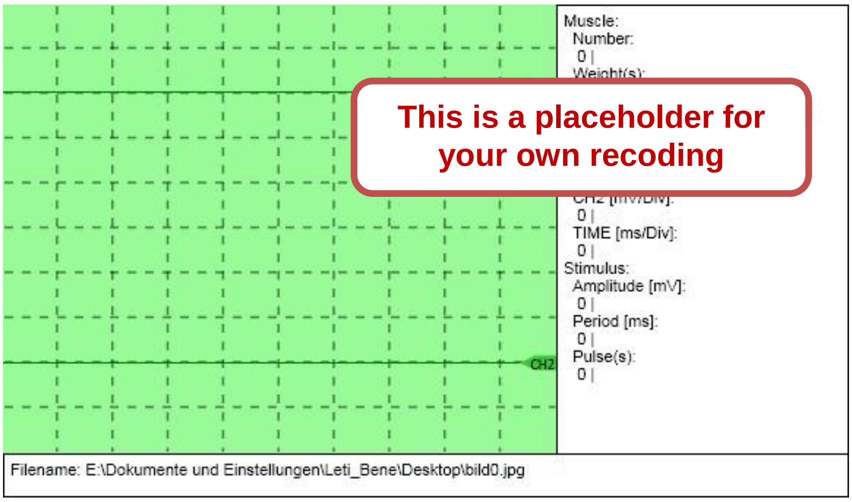
a) Record a single twitch (50ms/DIV suggested). b) Set the time-base to 200ms/DIV to record tetanic muscle contraction during a 50 Hz train of 90 impulses which should induce recognizable muscle fatigue. If necessary, use the UNDO button and adjust the oscilloscope amplification c) Record again a single twitch with oscilloscope amplification and time-base as in a).



Recordings (5.1)

5.1. Continous recording of muscle contractions during muscle fatigue.

Set the oscilloscope time-base to 50ms/DIV and apply a train of 50 supramaximal stimuli with a period of 200ms that initially should lead to isolated single twitches. Documents the altarations during muscle fatigue.



Recordings (5.2)

Questions (5)

5.1: Which are the most relevant changes of single twictches during muscle fatigue and what is their effect on superposition and tetanic contractions?

5.2: Can you explain what kind of physiological mechanisms could be responsible for these alterations?