5.2 Practical Tests

5.2.1 Laboratory 1: Systematically-anatomically orientated

Introducing remarks:

In laboratory 1 you have to solve both of the following tasks:

Task 1: Anatomical examination of a plant leaf

Task 2: Examination and systematic classification of four different plant species.

Read the questions for both tasks and then decide in which order you would like to work.

Please, do not forget to write down your personal data (Surname, First name, Country, Code Number) in the space provided.

Task 1: Examination of a plant leaf

(14 pts)

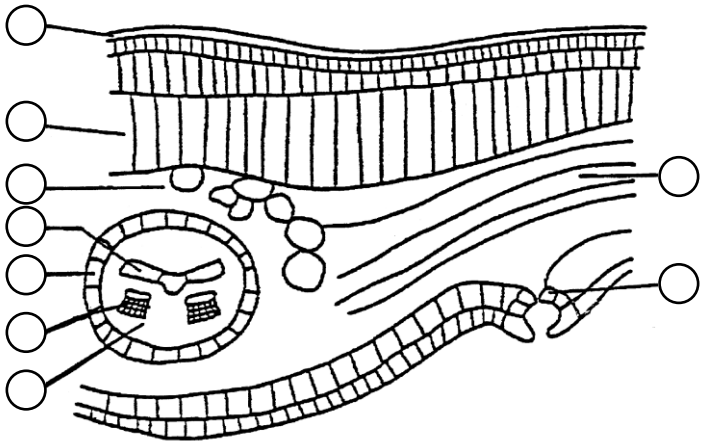
Introducing remarks:

The required equipment and chemicals for the examination are at your bench. Use the equipment and chemicals suitable for you examinations. Make several cross sections through the penne of the leaf (figure 1). Stain these cross sections with the aqueous solutions of the dyes Astra-blue (stains cellulose) and Auramin (stains lignin) and analyse the anatomic structures under the microscope. As supplementation you can make longitudinal and surface sections.

1 (1.1) (9 pts) **Label the given schematic drawing (figure 1). Write down the code numbers of the given anatomical structures next to the correct reference lines.**

Code numbers:

1. Cuticula
2. Epidermis
3. Hypodermis
4. Spongy parenchyma
5. Palisade parenchyma
6. Vascular bundle sheath
7. Xylem with lignin
8. Phloem with sieve cells and parenchyma
9. Transfusion tissue
10. Accessory transfusion tissue
11. Stomatic cells



1 (1.2) Which of the following systematical groups does the object refer (2 pts) **to? Mark with a cross.**

◯ Fern (*Polypodiophyta, Pteridophyta*)

◯ Gymnosperms

◯ Angiosperms

1 (1.3) Evaluate the object from the ecological point of view. (3 pts) **Mark with a cross.**

◯ Hydrophyte (swamp or water plant)

◯ Hygrophyte (plant with adaptions to damp locations)

◯ Mesophyte (plant with adaptions to balanced locations)

◯ Xerophyte (plant with adaptions to dry locations)

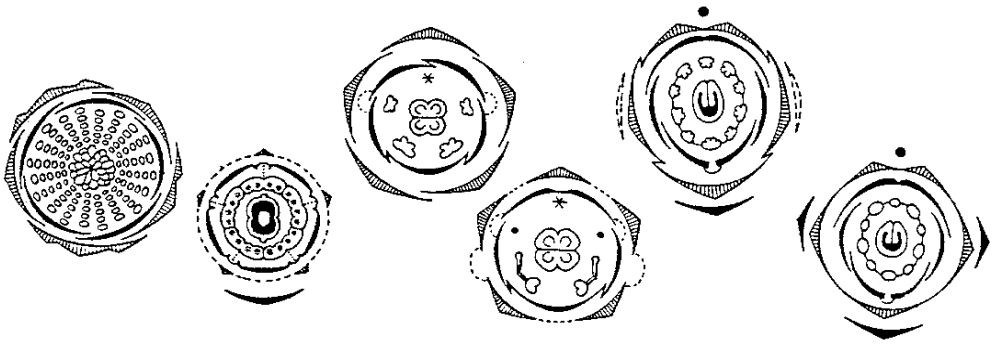
Task 2: Examination and systematic classification of four different plant species. (24 pts)

Introducing remarks:

On your bench there are four vessels. In each vessel there is a flowering shoot of a plant species. The species are labelled A, B, C and D. The required equipment and a magnifying glass microscope are on your bench as well.

Analyse the given objects A, B, C and D morphologically. Answer the following questions with the help of the answer code and fill in the corresponding code numbers in the table below.

1 (2.1) Which floral diagram (D 1 - D 6) belongs to which species? Fill in your decision (code number) in the table at the end of this task. (4 pts)



use **D1** **D2** **D3** **D4** **D5** **D6**
as code numbers

1 (2.2) Which family name belongs to which species? Fill in the corresponding code number in the table. (8 pts)

Code numbers:

1. *Asteraceae* 4.
2. *Brassicaceae*
3. *Fabaceae*
4. *Lamiaceae*
5. *Oleaceae*
6. *Ranunculaceae*
7. *Rosaceae*

1 (2.3) (4 pts) Which species have which kind of fruit (F 1 - F 7)? Fill in the corresponding code number in the table.

Code numbers:

F 1. Achene
F 2. Follicular fruit
F 3. Pulse
F 4. Fruit composed of four one-seed nutlets
F 5. Aggregate of nutlets
F 6. Stone fruit, Drupe
F 7. Berry

1 (2.4) (4 pts) Which species have which inflorescence (B 1 - B 7)? Fill in the corresponding code number in the table.

B 1. Spike
B 2. Capitulum
B 3. Panicle
B 4. Thyrsus
B 5. Bunch, Raseme
B 6. Solitary flower
B 7. Volute

1 (2.5) (4 pts) Which species have which leaf arrangement? Fill in the corresponding code number in the table.

Code numbers:

P 1. alternating
P 2. decussate
P 3. distichous

Table

	A	B	C	D
Diagram				
Family				
Fruit				
Inflorescence				
Leaf arrangement				

5.2.2 Laboratory 2: Physiologically - orientated

Task 1: Model experiment referring to the respiratory chain

(23 pts)

Introducing remarks:

Electron transfer through several redox systems to the terminal acceptor as it happens for instance in the endoxidation of the respiratory chain can be simulated in a model experiment in a test tube, following the so-called BAUMANN experiment.

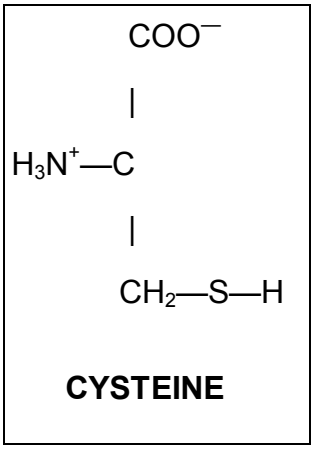
Add Fe^{2+} to a solution of sodium acetate containing the amino acid cysteine, shake it for a short time and write down the colour immediately and after some minutes. Shake the mixture again and write down the colour immediately and after some minutes etc.

Information*:* Cysteine forms a coloured compound with Fe^{3+}, whereas Fe^{2+} does not.

I: Preparation of the experiment

The following solution is necessary for the experiment:
10 ml of aqueous 0,1 M sodium acetate solution containing the amino acid cysteine in the concentration of 41 mM (=solution a).

It should be produced by mixing 0,2 M sodium acetate solution (solution b) with 82 mM cysteine solution (solution c).



CYSTEINE

2 (1.1) (3 pts) How many mg sodium acetate (waterless) have to be weighed for 00 ml of the 0,2 M sodium acetate solution? For calculation use the following

atomic masses: H:1; O: 16; C: 12; Na: 23.

Result (no decimals) **1640 mg**

2 (1.2) (3 pts) **How many g cysteine have to be weighed for 100 ml of the 82 mM cysteine solution? For calculation use the following atomic masses:**

H: 1; O: 16; C: 12; S: 32; N: 14.

Round off the result (no decimals): **1 g**

Obtain solution b (6 ml), solution c (6 ml) and the required Fe SO_4 from the assistant and start the experiment.

II: Procedure

2 (1.3) (2 pts) **Mix solution b and solution c in the correct volume ratio to get 10 ml of the required solution a.**

The use of a pipette aid is obligatory.

Present your experiment and the remaining solutions immediately for judgement (score credit) to the laboratory advisor. Leave your pipette aid with the laboratory advisor.

If you have made a mistake in the procedure you can get solution b and solution c again. In this case you cannot score in (3).

2 (1.4) (1 pt) **Add $FeSO_4$ to the solution a, plug the test tube with a stopper and shake it strongly. Which colour does the solution have after shaking? Mark with a cross.**

- ◯ red
- ◯ white
- ◯ green
- ◯ blue-violet

2 (1.5) (1 pt) **Leave the test tube open (without stopper) for 1-2 minutes. Which colour does the solution have after this time? Mark with a cross.**

◯ red

◯ white

◯ green

◯ blue-violet

2 (1.6) How often can the colour change be achieved by shaking?

(1 pt) **Mark with a cross.**

◯ once

◯ up to 5 times

◯ more than 6 times

◯ not repeatable

III: Evaluation of the experiment:

2 (1.7) Which component(s) is (are) used up in the experiment?

(1 pt) **Mark with a cross**

◯ iron and oxygen

◯ cysteine and oxygen

◯ sodium acetate

◯ oxygen

◯ cysteine

◯ none

2 (1.8) The redox potential Eo of the system Fe^{3+} / Fe^{2+} is + 0,77 Volt.

(1 pt) **Which redox potential does an e^- donator of this system have? Mark with a cross.**

◯ greater than + 0,77 V ◯ less than + 0,77 V

◯ equal to + 0,77 V

2 (1.9) Which value does the redox potential Eo of the e^- terminal

(1 pt) **acceptor have in the performed experiment? Mark with a cross.**

◯ greater than + 0,77 V

◯ less than + 0,77 V

◯ equal to + 0,77 V

2 (1.10) Which enzyme in the respiratory chain is analogous to the Fe-system in the BAUMANN experiment? Mark with a cross.
(1 pt)

◯ NADH ubiquinone reductase

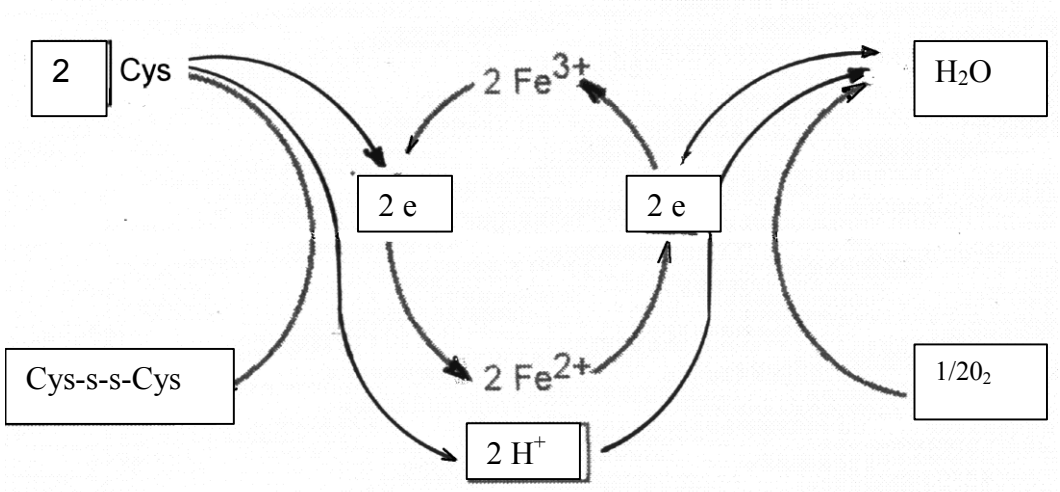
◯ cytochrome oxidase

◯ ATP synthase

◯ ubiquinone cytochrome c reductase

2 (1.11) Complete the incomplete schematic drawing of the electron transfer in the BAUMANN experiment.
(8 pt)

You can score 1 or 2 points per correct item in [ ] .



Task 2: Imbibition movements of the awns in *Avena sterilis*

(17 pts)

Introducing remarks:

The basis for each imbibition movement is the swelling capability of wall substances. If imbibition occurs in all directions equally, it is called isotropic; if one direction is preferred, the imbibition is called anisotropic. Curvatures can be the result of a substantially different wall structure as well as a different texture – even in homogeneous material. Texture is the arrangement of fibrils in the wall layers. The movements to be observed in the proposed experiment are caused by different textures. Your object is distinguished by two conspicuous awns. You have to examine their movements. A magnifying glass (direct light and transmitted light) is available.

I. Procedure*:*

2 (2.1) Observe the movement of the awns after moistening.

(2 pts) **Put the air-dry spikelets together with the awns on a piece of paper and sprinkle the awns with water (use the sprayer) and observe (with the help of the magnifying glass as well) your object. Which reactions can you observe? Mark with a cross.**

◯ No reaction

◯ Both of the awns show a synergic rotation based on decoiling.

◯ The awns do not touch each other.

◯ Both of the awns show a synergic rotation based on spiralisation. Occasionally they hook together and sometimes start ‘saltatory movements’.

◯ Both of the awns show a synergic rotation based on decoiling. Occasionally they hook together and sometimes start ‘saltatory movements’.

◯ The movement of one awn is based on decoiling, the movement of the other one on spiralisation.

2 (2.2) Observe the awn movement when drying.

(2 pts) **Let the awns dry after the experiment (switch both lamps on full power and use them for heating). It can take 10 to 15 minutes until you can see a reaction. Observe your object. Which of the following statements is correct? Mark with a cross.**

- ◯ Both awns show a synergic rotation, which is based on spiralisation, occasionally they hook together, and sometimes start 'saltatory movements'.
- ◯ Both awns show a synergic rotation, which is based on decoiling. The awns do not touch each other.
- ◯ Both awns show a synergic rotation, which is based on spiralisation.
- ◯ The awns do not hook together.
- ◯ Both awns show a synergic rotation, which is based on decoiling, occasionally they hook together, and sometimes start 'saltatory movements'.
- ◯ The movement of one awn is based on decoiling, the movement of the other awn is based on spiralisation.

II. Evaluation

2 (2.3) Texture and imbibition of cellulose

(3 pts) **On your bench there are two pieces of typing paper. According to the manufacturing process the cellulose fibres are essentially longitudinally orientated.**

2 (2.3a) Give the paper a good spray of water from both sides and decide

(1 pt) **after about 5 minutes whether the paper preferably extents in the longitude of the fibre (A), cross to the fibre direction (B) or in both directions equally (C). Mark with a cross**.

- ◯ A
- ◯ B
- ◯ C

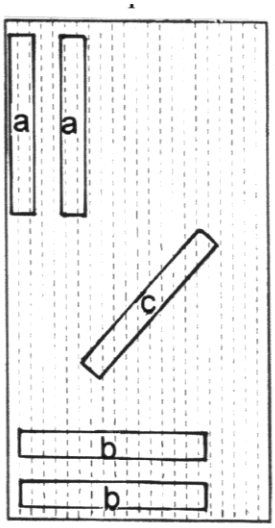
2 (2.3.b)What is the maximum extention given in percent?

(2 pts) **Fill in the result:** 2,3 %

2 (2.4) Perform a mental experiment.

(8 pts) **In figure 1 the fibre direction of a piece of paper is given in dotted longitudinal lines. Stripes of paper are labelled a, b and c. Imagine: The stripes given in figure 1 are cut out, moistened and clued together identically as shown in column 1 of the table 1. For drying the stripes are hung up at the upper end (*).**

Draw the expected form modifications as a side view in column 2 (table 1).



	Column 1	Column 2	
A	a + a	*	1P
B	b + b	*	1P
C	b + a	*	1P
D	a + b	*	1P
E	a + c	*	1P

2 (2.5) Link the observations regarding the awn movement to the result

(2 pts) **of the (4) pilot experiment (mental experiment).**

Which texture are the movements of the awns based on?
Mark with a cross.

◯ (aa)
◯ (bb)
◯ (ba)
◯ (ab)
◯ (ac)

5.2.3 Laboratory 3: Genetically - microbiologically orientated

Task 1: Isolation of bacterial DNA

(12 pts)

Introducing remarks:

DNA should be isolated from cells of a 5-day-old liquid culture of the bacterium *Escherichia coli* K 12. Various biochemical steps have to be done in a certain order under different temperatures and incubation times. The tasks are: (1) to determine the correct order of these steps, (2) to assign a specific temperature and incubation time to these steps and (4,5,6) to select the correct substances or solutions for the relevant steps.

3 (1.1) (4 pts) Determine the correct order of the steps. Write down the code letters of the following steps in the correct order.

A winding up the DNA

B disruption of the cytoplasmic membrane

C precipitation of the uncleaned DNA

D disruption of the bacterial cell wall

Order: D, B, C. A...

3 (1.2) (3 pts) Assign one of the temperatures (T) and incubation times (I) given below to each of the following steps.

- Disruption of the cytoplasmic membran T: .+ 60^0 C I: 2 min..
- Precipitation of the uncleaned DNA: T: . 0^0 C I: 30 sec
- Disruption of the bacterial cell wall: T: . +37^0 C. I: 10 min.

Incubation time: 30 sec, 2 min, 10 min, 15 min, 30 min

Temperature: 0^0 C, room temperature, +37^0 C, +60^0 C, +100^0 C

Realize the following steps in the order you have determined.

3 (1.3) STEP A: Winding up the DNA

(2 pts) **Try to wind up the precipitated DNA strands with a wooden rod.**

Ask the laboratory advisor to score the result.

(The laboratory advisor is going to sign.)

◯ DNA could be wind up

◯ DNA could not be wind up

3 (1.4) STEP B: Disruption of the cytoplasmic membrane.

(1 pt) **To disrupt the cytoplasmic membrane you have to add 0.2 ml of one of the following solutions.**

Mark the correct answer with a cross.

◯ HCl (1 M)

◯ acetone (pure)

◯ glycerine

◯ sodiumdodecylsulphate solution (25 %)

◯ NaOH (1 M)

3 (1.5) STEP C: Precipitation of the uncleaned Dann

(1 pt) **For the precipitation of the uncleaned DNA the lysate has to be overlayed with a liquid. Select the correct one from the following liquids and mark it with a cross.**

Realize the overlaying in the following way: Let the fluid from a beaker slowly run down the wall of the test tube. The well-perceptible whitish strands which separate slowly from the aqueous phase after overlaying predominately consist of chromosomal DNA.

◯ ethanol (96%, denatured)

◯ double distilled water (aqua bidest.)

◯ HCl (1 M)

◯ NaOH (1 M)

◯ glycerine

3 (1.6) STEP D: Disruption of the bacterial cell wall

(1 pt) **To disrupt the bacterial cell wall a tip of a spatula of one of the following substances has to be added to a culture of *Escherichia coli* K12 (in a test tube).**

Mark the correct substance with a cross.

- ◯ penicillin
- ◯ lysozyme
- ◯ urea
- ◯ $CaCl_2$
- ◯ trypsine

Task 2: Investigation of the mitosis in the root meristem of a specimen of the *Magnoliopsida* (*Dicotyledoneae*)

(25 pts)

Introducing remarks:

Young roots were harvested from plants grown in sand and differently treated:

Treatment (1): Incubation (for 4 hours) in the aqueous solution of a substance that inhibits chromosome movement

Treatment (2): Incubation (for 24 hours) in ethanol/glacial acetic acid (3:1)

Treatment (3): Incubation (for 24 hours) in a saturated solution of car mine in 45 % acetic acid

Treatment (4): Heating in a boiling water bath for 5 minutes

On your bench you can find two different samples.

Sample I: Root tips only submitted to treatments (2) - (4)

Sample II: Root tips submitted to treatments (1) - (4)

3 (2.1) Compression preparations

(2 pts) **Make compression preparations of the samples I and II in which as many cells as possible are in the cell cycle, lying in a monolayer and flattened in such a way that the chromosome arms are pushed into a focus layer but are not squash-damaged.**

Apply a technique you are familiar with or follow the procedure given below.

- Separate the apical meristem of a root in a droplet of 45 % acetic acid on the slide.
- Fragmentate the tip by distearing and slight squashing.
- Cover it with a cover glass.
- Disrupt the tissue clumps by gentle hints with the blunt end of a pair of forceps held upright down on the cover glass.
- Adjust the amount of liquid so that the cells glide but do not float.

In case of insufficient spreading add 45 % acetic acid; slightly lift the cover glass with a needle and avoid shifting of the cover glass by a pair of forceps.

When spreading is sufficient the preparate is covered with a tissue and a gentle pressure by a finger is applied in order to flatten the cells. Attention! The danger of squash-damaging is particularly high when the cells are well spread.

Present your preparates (under the microscope) to the laboratory advisor for quality control and scoring at any time.

3 (2.2) Scetches of different cell stages

(8 pts) **Prepare scetches of the stages of the cell cycle using sample I (a), (b), (c), (e), and (f) and a metaphase-like figure of sample II (d) on the following blank page. Note the list of the stages of the cell cycle below. Draw a chromatide and a daughter chromosome only with a line but otherwise corresponding to your preparate; unclear regions may be circled with dotted lines.**

Stages of the cell cyle:

(a) interphase (1 pt)

(b) middle prophase (1 pt)

(c) metaphase plate in side view (3 pts)

(d) metaphase-like figure of sample II seen from above (1 pt)

(e) late anaphase or early telophase (1 pt)

(f) late telophase (1 pt)

Blank piece of paper (task 2). Scetches of cell stages.

3 (2.3) Detailed drawings of chromosomes

(10 pts) **Draw two metaphase chromosomes from sample I, true to nature, and label the drawing.**

3 (2.3a) Draw two significantly different chromosomes.
(2 pts)

3 (2.3b) Characterize the drawn chromosomes by using capital letters
(3 pts) **according to the following terms.**

A: metacentric
B: acrocentric
C: dicentric
D: acentric
E: satellite chromosome

3 (2.3c) Label the parts of the larger chromosome using the code
(5 pts) **numbers of the following terms.**

1. chromosome arm
2. chromatide arm
3. daughter chromosome
4. centromere
5. centrosome
6. satellite
7. nucleolus organisator region
8. nucleosome

Labelled drawings (task 3):

3 (2.4) Chromosome number

(1 pt) **Indicate the chromosome number of sample I. .....12.....**

3 (2.5) Ploidy level

(1 pt) **Indicate the ploidy level of sample I. Consider that a distinctive chromosome type occurs only once in the haploid chromosome set. Mark with a cross.**

◯ haploid (1 n)
◯ diploid (2 n)
◯ triploid (3 n)
◯ tetraploid (4 n)

3 (2.6) **Effects of the treatments (1) - (4) (see introducing remarks p.7)**
(1 pt) **Match the treatments (1) - (4) to the effects you achieved. Write down the numbers of the treatment in the corresponding circles.**

- ◯ inhibition of the centromere fission
- ◯ inhibition of tubuline association
- ◯ fixation of protoplasmic structures
- ◯ shortening of the chromosomes
- ◯ staining of the chromatine
- ◯ staining of the nucleus spindle
- ◯ destruction of the middle lamella
- ◯ destruction of the primary walls

3 (2.7) **Treatment (1)**
(1 pt) **Which substance was used in the treatment (1)?**
Mark with a cross.

- ◯ colchicine
- ◯ bromouracile
- ◯ α- amanitin
- ◯ actinomycine
- ◯ mitomycine

3 (2.8) **Which aim was followed by J.H. Taylor (1958) when he applied**
(1 pt) **the same substance? Mark with a cross.**

- ◯ production of polyploid plants
- ◯ verification of the hypothesis of semiconservative replication in eukaryotes
- ◯ inhibition of mRNA synthesis
- ◯ inhibition of translation
- ◯ investigation of the cytomorphogenesis in *Desmidiacea*

5.2.4 Laboratory 4: Ethologically orientated

Task: Experimental investigation of triad grasp, forceps grasp and tool (grasp of man as functions of primate hands).

(35 pts)

Introducing remarks:

During the evolution of primates the grasping hand has developed in a way that it can be used for locomotion as well as for manipulation of objects. Therefore a differentiated co-operation of hand, eye and brain is necessary.

For grasping or splitting tiny food items the ability to manipulate is particularly important (fine tuned motor function) to get sufficient food energy per unit of time and without foreign bodies.

The required equipment and objects are situated on your bench: 2 Petri dishes, a pair of angle forceps, sea sand (sieved), 20 sunflower seeds and a stopwatch. Precision scales are available for the weighing procedure.

Task:

4 (1) Move your thumb and index finger of one hand without any optical control against each other. In which area do they touch each other? Mark with a cross.

(2 pts)

- ◯ inner side of the thumb and outer side of the finger
- ◯ outer side of the thumb and inner side of the finger
- ◯ outer side of the thumb and outer side of the finger
- ◯ inner side of the thumb and inner side of the finger

4 (2) How is this co-ordination possible? Mark with a cross.

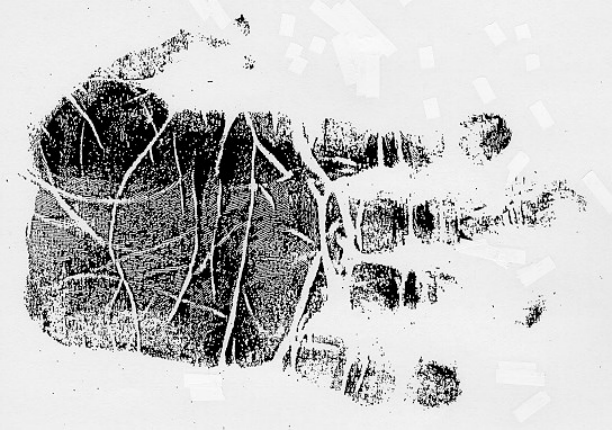
(2 pts)

- ◯ by learning
- ◯ by ontogenetic maturing
- ◯ by the construction of the skeleton
- ◯ by neuronal decisions
- ◯ by flexor and extensor muscles

4 (3) **Figure 1 shows the print of a man's hand (Dr. Lucius), figure 2**
(2 pts) **shows the print of a chimpanzee's hand. How are the recognizable structures on the surface of the inner hand of man and chimpanzee called? S K I P P E D.**

- ◯ capillary ridges in both
- ◯ tactile fields in both
- ◯ prehensile relief of chimpanzees, papillary ridges of man
- ◯ papillary ridges in both

Print of a chimpanzee's hand (figure 1).



Print of a Dr. Eckhard R.Lucius's hand (figure 1).



4 (4) (29 pts) **Investigation of triad grasp, forceps grasp and tool grasp of man: Arrange 20 sunflower seeds in the sand-filled Petri dish I in such a way that they lie flat, istributed over the whole dish, and do not touch each other.**

4 (4a) (5 pts) **Grasp each seed one after the other with your thumb, index finger and middle finger at the same time (triad grasp). All 20 seeds are put individually one after the other in the empty Petri dish II. Measure the required time in minutes and seconds (e.g. 0:49 minutes) with the help of a stop-watch. Smoothen the sand in dish I, transport all the seeds with the help of a pair of forceps from dish II to dish I and weigh the sand (on a filter paper, in mg) that has been transported from dish II when grasping. Repeat the experiment 10 times, write down all data and fill in the results in the table on page 11.**

4 (4b) (5 pts) **Grasp each seed from the smoothened sand with your thumb and index finger only (forceps grasp). Repeat the procedure from task (4.1).**

Determine the time and the transported amount of sand in 10 experiments and fill in the data in the table on page 11.

4 (4c) (5 pts) **Prepare the following experiment as described under (4.1). However, this time a pair of forceps should be used for picking up the seeds (tool grasp). Repeat the experiment 10 times, measure the time and amount of sand and fill in the results in the table on page 11.**

4 (4d) (4 pts) **Decide in which of the experiments the smallest amount of sand (on average) was transported together with the seeds. Mark with a cross.**

◯ smallest amount of sand in (4.1) (triad grasp)

◯ smallest amount of sand in (4.2) (forceps grasp)

◯ smallest amount of sand in (4.3) (tool grasp)

4 (4e) (10 pts) **Calculate the mean and the standard deviation ($x \pm s$) of n = 10 values for the transported amount of sand and the required time in the experiments (4.1) to (4.3). Fill in the results in the table on page 11 and evaluate the significance of the transported sand with the help of the t-test. Mark below which of the differences is (are) significant and which is (are) insignificant.**

experiment 1 versus experiment 2 ◯ significant ◯ insignificant difference

experiment 1 versus experiment 3 ◯ significant ◯ insignificant difference

experiment 2 versus experiment 3 ◯ significant ◯ insignificant difference

Table

	experiment 1		**experiment 2**		**experiment 3**	
exp. no.	time (sec)	sand (mg)	time (sec)	sand (mg)	time (sec)	sand (mg)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
sum						
mean						
standard deviation						

Evaluation:

(1.) experiment 1: experiment 2 (sand)

t =_____; p

(2.) experiment 1: experiment 3 (sand)

t = _____; p

(3.) experiment 2: experiment 3 (sand)

t = _____; p

Appendix to the practical test - ethologically orientated

Test for differences in mean between two measuring series.
It has to be tested whether the difference between the results of the three experiments (amount of sand in mg) is statistically significant.

$n_1 =$ $n_2 =$ $n_3 =$

$\overline{x_1} \pm s_1 =$ $\overline{x_2} \pm s_2 =$ $\overline{x_3} \pm s_3 =$

Degrees of freedom

$m_1 = n_1 + n_2 - 2$ $m_2 = n_1 + n_3 - 2$ $m_3 = n_2 + n_3 - 2$

(1.) experiment 1: experiment 2

$$s_D = \sqrt{{s_1}^2 + {s_2}^2} = \qquad t = \frac{\left|\overline{x_1} - \overline{x_2}\right|}{s_D} =$$

(2.) experiment 1 : experiment 3

$$s_D = \sqrt{{s_1}^2 + {s_3}^2} = \qquad t = \frac{\left|\overline{x_1} - \overline{x_3}\right|}{s_D} =$$

(3.) experiment 2 : experiment 3

$$s_D = \sqrt{{s_2}^2 + {s_3}^2} = \qquad t = \frac{\left|\overline{x_2} - \overline{x_3}\right|}{s_D} =$$

t- table (acc. to STUDENT)

m	probability p for t 0,05	0,01	0,001
18	2,10	2,88	3,92