South Valley University

Faculty of Science
Zoology Department

# Cell & Histology, Embryology and Michrotechnique

## Code: Zoo 307

## Part1:- Michrotechnique

### Practical

**Prepared by**

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**South Valley University**

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## Course Information

**Title:** Part1:- Michrotechnique

**Students**:- 3rd year- **Zoology and chemistry**

Faculty of Science. South Valley University

**Date:- First semester 2022-2023**
**Number of pages:- 56**

**Lecturer: Prof. Dr. Abdel-Nasser Ahmed Hussein**

**Zoology Department, Faculty of Science**

**South Valley University**

# PRACTICAL SYLLABUS

| Number/ Date | | Topic |
|---|---|---|
| 01 | | Introduction.<br>Safety rules.<br>Light microscopes.<br>Preparation of some biological stains. |
| 02 | | Project no. (1) blood smears |
| 03 | | Project no. (2) blood smears |
| 04 | | Project no. (3) squashes |
| 05 | | Project No. (4) whole mount |
| 06 | | Project No. (5) whole mount |
| 07 | | Project No. (6) whole mount |
| 08 | | Project No. (7) whole mount |
| 09 | | Project No. (8) whole mount |
| | | Short exam |
| 10 | | Project No. (9) sections |
| 11 | | Project No. (10) sections |
| 12 | | Project No. (11) Visit to:-<br>Museum at Zoology Department<br>Central Lab. at SVU<br>Discussion and remarks |
| | | **Final Practical Exam.** |

## THE LIGHT MICROSCOPE

**MICROSCOPE** is an available tool to biologists for examination of the specimen during and after preparation.

**MAGNIFICATION**

**Power of ocular lens X Power of objective lens**

**MICROSCOPIC MEASUREMENTS** include; eyepiece micrometer and vernier scale.

**TYPES:**

In biological laboratories, students use mainly **TWO** main types of light microscope, **STEREO MICROSCOPE** and **COMPOUND MICROSCOPE**.

**A- THE STEREO MICROSCOPE**

A low power or stereo microscope typically employs objective lenses of 50X or less. It is used to view specimens that are visible to the naked eye such as insects, crystals, circuit boards and coins.

The basic stereo (dissecting) microscope parts and functions of each part are:-

**STEREO HEAD:** Two eyepieces - looking through them is something like looking through a pair of binoculars, with similar controls for eye strength correction settings.

**EYEPIECE OR OCULARS:** The part of the microscope that you look through at the top of the microscope. Eyepieces in stereo microscopes, as in most compound microscopes,

typically have a lens with a 10X magnification level. Optional eyepieces of varying powers are available, typically from 5X-30X. Both eyepieces have the same magnification on stereo head microscopes.

**EYEPIECE TUBE** holds the eyepieces in place above the objective lens.

**EYEPIECE DIOPTER SETTING:** Compensates for focusing differences between your eyes, allows for the possible inconsistencies of our eyesight in one or both eyes. Binocular microscopes also swivel (Interpupillary Adjustment) to allow for different distances between the eyes of different individuals.

**OBJECTIVE:** The second lens of the microscope. The objective lens together with the lens of the eyepiece makes up the microscope's magnification. Stereo microscopes can have a fixed single objective, a rotating multiple lens turret (such as the one pictured) or ideally a zoom. All of these allow you to change the magnification level for different applications. Stereo head microscopes actually have two separate objectives so that each eye is looking through an eyepiece lens as well as an objective lens.

**FOCUS KNOB:** Moves the head of the microscope up and down to bring the object sharply into view. Most stereo microscopes have only one focus knob.

**RACK AND PINION FOCUSING:** Most stereo and dissecting microscopes have standard "rack and pinion" focusing. Turn a knob to slide the head of the microscope up and down (closer or farther from the specimen).

**STAGE CLIPS:** For holding microscope slides or other thin objects in place on the stage.

**STAGE PLATE:** Where the specimen is placed for viewing; located directly under the objective lens.

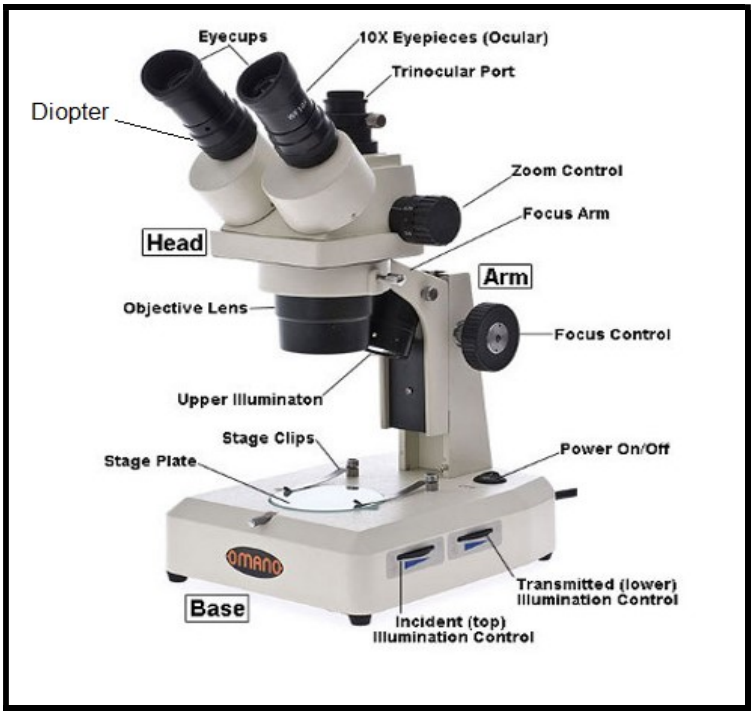
**LIGHTING:** Top lighting shines down and reflects off opaque or solid specimens; bottom lighting shines up through transparent objects. The microscope pictured below has top and bottom lighting, though not all microscopes will have both.

## OPERATING TIPS

1. Set the stereo microscope on a flat surface in a stable and comfortable position.
2. Turn on the Transmitted/Oblique illuminator.
3. Place a specimen.
4. Turn the Magnification adjustment knob to the lowest power and bring the image into focus using the focus control.
5. Adjust the eyepieces for the correct interpupillary distance to suit you. Do this by moving the eyepieces closer together or farther apart until a single field of view is observed.

Now, set the dioptric adjustment rings on both eyepieces to the zero position.

6. Use the Magnification adjustment knob to set the highest magnification. Bring the image into focus with the focusing knob. Center the image on some clear point of detail on the specimen.
7. Adjust the microscope down to the lowest magnification using the magnification adjustment knob. The image could be slightly out of focus. Adjust the focus for each eye separately using the eyepiece dioptric adjustment rings. Your microscope is now "parfocal". This means that as the microscope is zoomed from high to low magnification the image will stay in focus throughout the entire range. Each individual will have a different setting.



## B- THE LIGHT MICROSCOPE

The first light microscope was made by Janssen and Hans in 1590. The light microscope can magnify objects up to 2000 times. Its limits of resolution are about 0.2 μ, about one-half the wavelength of the light used. The wavelengths of the visible spectrum of light are ranging from 4000 Å to 8000 Å. The resolving power of light microscope can be 3000 Å if 6000 Å is taken as an average wavelength.

The **MAGNIFICATION** of a lens or of a system of lenses, such as a microscope, is simply the factor by which the image is made larger than the original object.

The **RESOLUTION** or **RESOLVING POWER** of a microscope lens is defined as the ability of the lens to separate two tiny spots of light in a dark field. More specifically, the limit of resolution is dependent upon the ability of the lens system to collect light and the wavelength of light utilized. **THESE** two properties, **MAGNIFICATION** and **RESOLUTION**, are independent of one another in the sense that magnification may be attained without resolution. The limit of the resolving power of the best compound light microscope is about 0.2μm.

In the compound light microscope, the quality of image (**ITS CONTRAST**) depends primarily upon differences in the absorption of light by various regions of the object. Since, living cells are largely transparent, it is not always easy to see much

internal structure. Consequently, various staining methods have been developed that use colored dyes having affinity for specific cellular structures.

## LENS SYSTEM IN LIGHT MICROSCOPE:

The compound light microscope uses visible light for illuminating the object and contains lenses that magnify the image of the object and focus the light on the retina of the observer's eye. In its simplest form, the compound microscope consists of two lenses, one at each end of a hollow tube. The lens closer to eye is called the **eyepiece,** and the lens closer to the object being viewed is called the **objective.** The object, supported by a glass slide under the objective lens, is illuminated by light beneath it.

In practice, the eyepiece and objective lenses are each composed of a number of lenses that are combined in such a way as to overcome certain optical aberrations that occur when single lenses are used. The **LENS** systems parts are as follows:-

1. **CONDENSER:** It collects and focuses light on the material.
2. **OBJECTIVE LENS:** It produces and magnifies the image.
3. **EYEPIECE OR OCULAR LENS:** It forms the image of the image formed by the objective lens and thus magnifies the image again.

## STRUCTURE OF LIGHT MICROSCOPE

A modern compound microscope has following structural components:-

### NON-OPTICAL COMPONENTS

1. **BASE (FOOT):** It is **U** or horseshoe-shaped metallic structure that supports the whole microscope.
2. **PILLAR:** It is a short upright part that connects to base as well as arm.
3. **ARM (LIMB):** It is a curved metallic handle that connects with the arm by inclination joint. It supports stage and body tube.
4. **INCLINATION JOINT:** It is used for tilting the microscope if required for observation in sitting position.
5. **STAGE:** It is a metallic platform with a central hole fitted to the lower part of the arm. Microscopic slides held on the stage by either simple side clips or by a mechanical stage clip.
6. **BODY TUBE:** It is meant for holding ocular and objective lenses at its two ends. The end holding ocular lens is called head while the end containing 3-4 objective lens is called nose piece. The body tube has an internal pathway for the passage of light rays which form the enlarged image.
7. **DRAW TUBE:** It is a small tube that remains fixed at the upper end of the body tube. It holds eyepiece or ocular lens.

**8. RACK AND PINION:** The microscope has a rack and pinion attached either to body tube or the stage for bringing the object under focus.

**9. ADJUSTMENT SCREWS:** There are two pairs of screws for moving the body tube in relation to stage, larger for coarse adjustment and smaller for fine adjustment. In fine adjustment the body tube or stages moves for extremely short distances. In coarse adjustment the body tube or stage can move up and distance. Fine adjustment is required to obtain sharp image.

**10. AUTOMATIC STOP:** It is a small screw fitted at lower end or rack and pinion. It is meant for stopping the downward sliding of the body tube so as to prevent the damage of objective lens and the slide.

**OPTICAL COMPONENTS**

**11. DIAPHRAGM:** It is flitted just below the stage for regulating the amount of light failing on the object. Diaphragm is of two types, disc and iris.

**12. CONDENSER:** It is attached below the diaphragm. Condenser can be moved up and down to focus light on the object.

**13. REFLECTOR (MIRROR):** It is attached just above the base. Both its surface bear mirrors, plane on one side and concave on other side. Plane side is used in strong light and concave

side in weak light. Reflector directs the light on the object through the condenser and diaphragm system.

**14. OBJECTIVE LENSES:** They are fitted over the nose piece. Objective lenses are of two 10 three types – low power (commonly 10X or 5X), high power (commonly 45X) and oil immersion (commonly 100X, can be more). An objective lens is not a simple lens but compound lens. It forms real inverted image of the object inside the body tube.

**15. OCULAR LENS OR EYEPIECE:** It is lens through which image of the microscopic object is observed. It also takes part in magnification. Depending upon magnification, the eye piece is of four types- 5X, 10X, 15X, and 20X.

## PREPARING LIGHT MICROSCOPE FOR USE

To prepare the microscope for viewing with any of the objectives place a slide on the stage with the cover slip up and follow these steps, in sequence:-

**1.** Swing the 16mm objective (10X) into position.

**2**. Raise the condenser to its highest position.

**3.** Place a slide on the stage, center the object over the condenser lens with the stage control knobs and turn the lamp on. If your microscope.

**4.** With the coarse adjustment, bring the object to within a few millimeters of the front of the 16mm objective.

**5.** Looking into the oculars, use the coarse adjustment to move the specimen away from the front of the objective until the specimen comes into focus.

**6.** If you are using a binocular microscope, adjust the interpupillary distance and compensate for any difference which might exist in the focal length of your two eyes.

**7.** If your microscope is equipped with a centerable lamp and/or field diaphragm, check the instruction manual, or with an instructor, for proper positioning.

**8.** With the specimen in focus, vary the condenser height until you can see the image of the frosted glass in sharp focus on the specimen.

**9.** If greater resolution and magnification are desired, swing aside the 4mm objective, place a single drop of immersion oil on the coverslip at the illuminated area, and swing the 1.8mm objective (longest, 97X) into position in the oil drop. Bring the specimen into focus with the fine adjustment only.

**10.** When finished, clean oil from the objective with clean lens tissue, from the slide with lens tissue or a cloth. A little toluene will help to clean the slide.

## HOW TO STUDY A PREPARED SLIDE

### I. EXAMINATION OF A SLIDE:

**1.** Hold the slide up to the light and examine with the unaided eye and/or with an inverted ocular to bring out more detail.

**2.** Your 4X scanning objective will be very useful.

**3.** The 10X objective is the most important lens for general histological examinations.

**4.** The high dry objective (40X) is more than sufficient to study most detail such as cell structure and type, interstitial material, etc.

## II. DESCRIPTION OF A SLIDE:

It is important that you learn to write a description of what you see. Your description should be as accurate, systematic, and brief as possible your observations. The description might proceed as follows:-

**1.** Name of organ or tissue.

**2.** General architecture, e.g., normal, altered, etc.

**3.** Cells of the tissue. Note their arrangement, size, shape, staining reaction, foreign contents, etc.

**4.** Your remarks.

## III. DRAWING OF SLIDE:

This is not emphasized as a means of providing busy work for students, but rather to train you to see better what it is you are viewing.

## STUDENT PROJECTS OF MICROSCOPIC PREPARATIONS

**The students are carrying out to achieve the following project categories:-**

1- SMEARS

2- SQUASHES

3- WHOLE MOUNTS

4- SECTIONS.

## PROJECT NO (1):- BLOOD SMEARS

**Name of the project: -**

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**Explain how to prepare the blood source?**

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**Explain how to spread the blood?**

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**Explain how to fix the blood smear?**

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**Explain how to stain the blood smear?**

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**Explain how to dry the blood smear?**

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**Explain how to mount the blood smear?**

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**Explain how to label the blood smear?**

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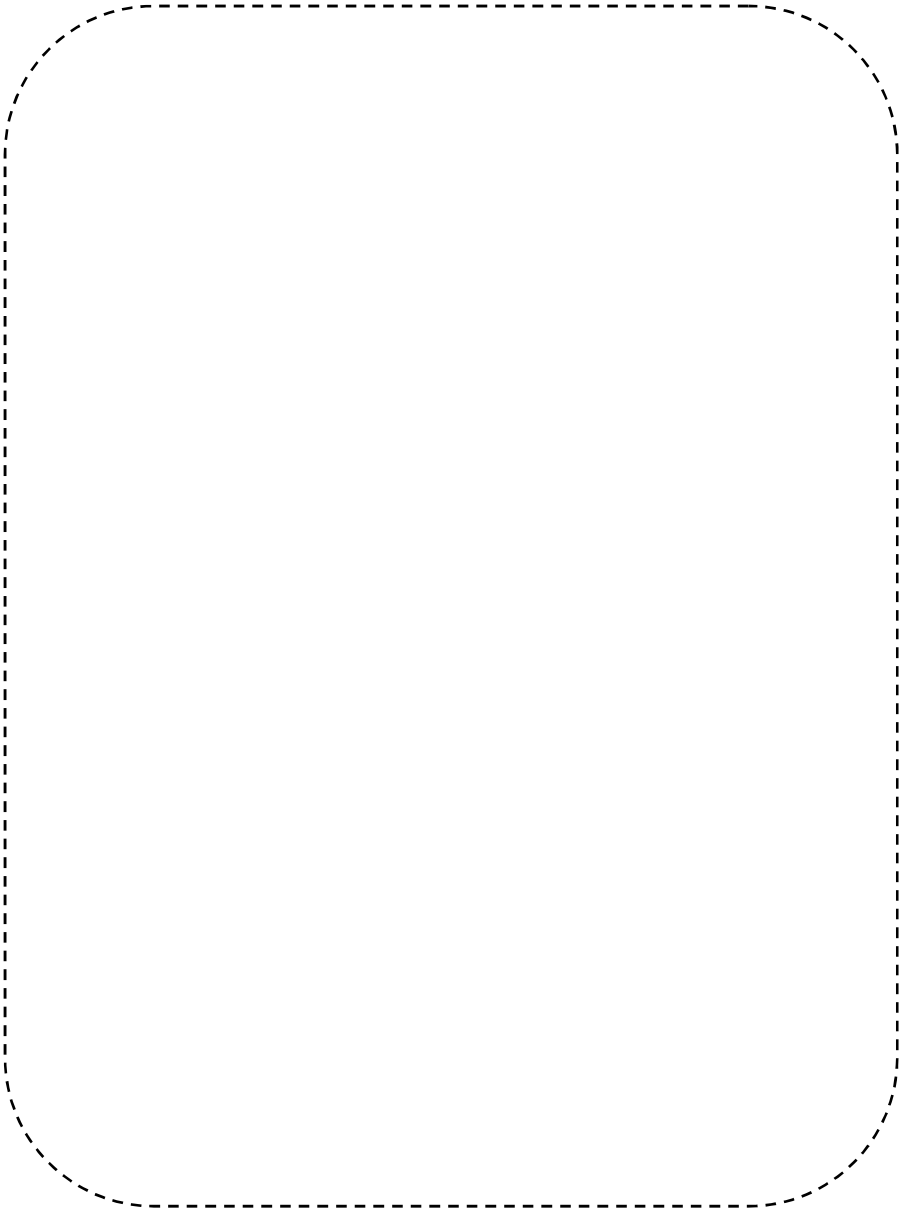
## Drawing of the blood smear



**[19]**

## PROJECT NO (2):- BLOOD SMEARS

**Name of the project: -**

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**Explain how to prepare the blood source?**

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**Explain how to spread the blood?**

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**Explain how to mount the blood smear?**

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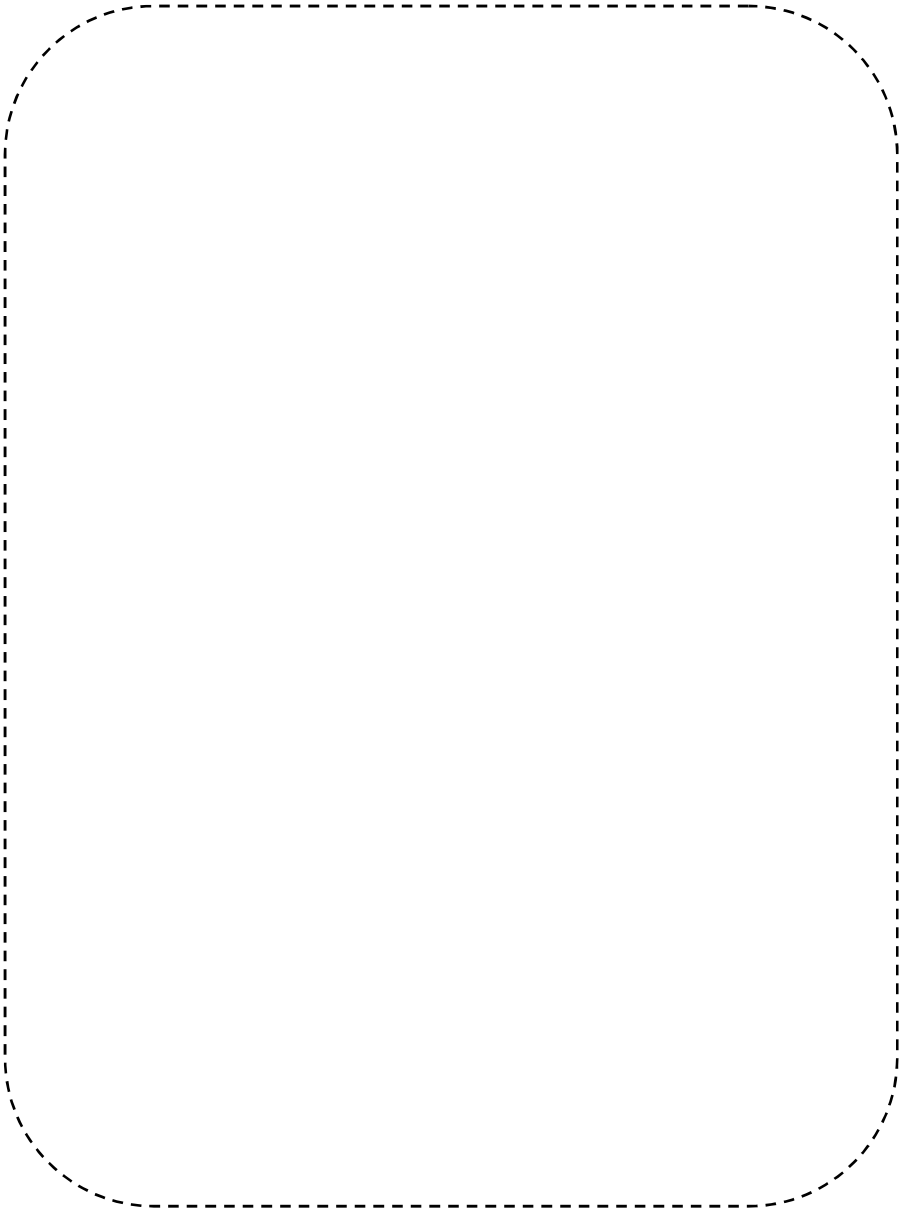
## Drawing of the blood smear



## PROJECT NO (3):- SQUASHES

**Name of the project:-**

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**Explain how to prepare the squashes?**

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**Explain how to fix the squashes?**

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**Explain how to stain the squashes?**

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**Explain how to label the squashes?**

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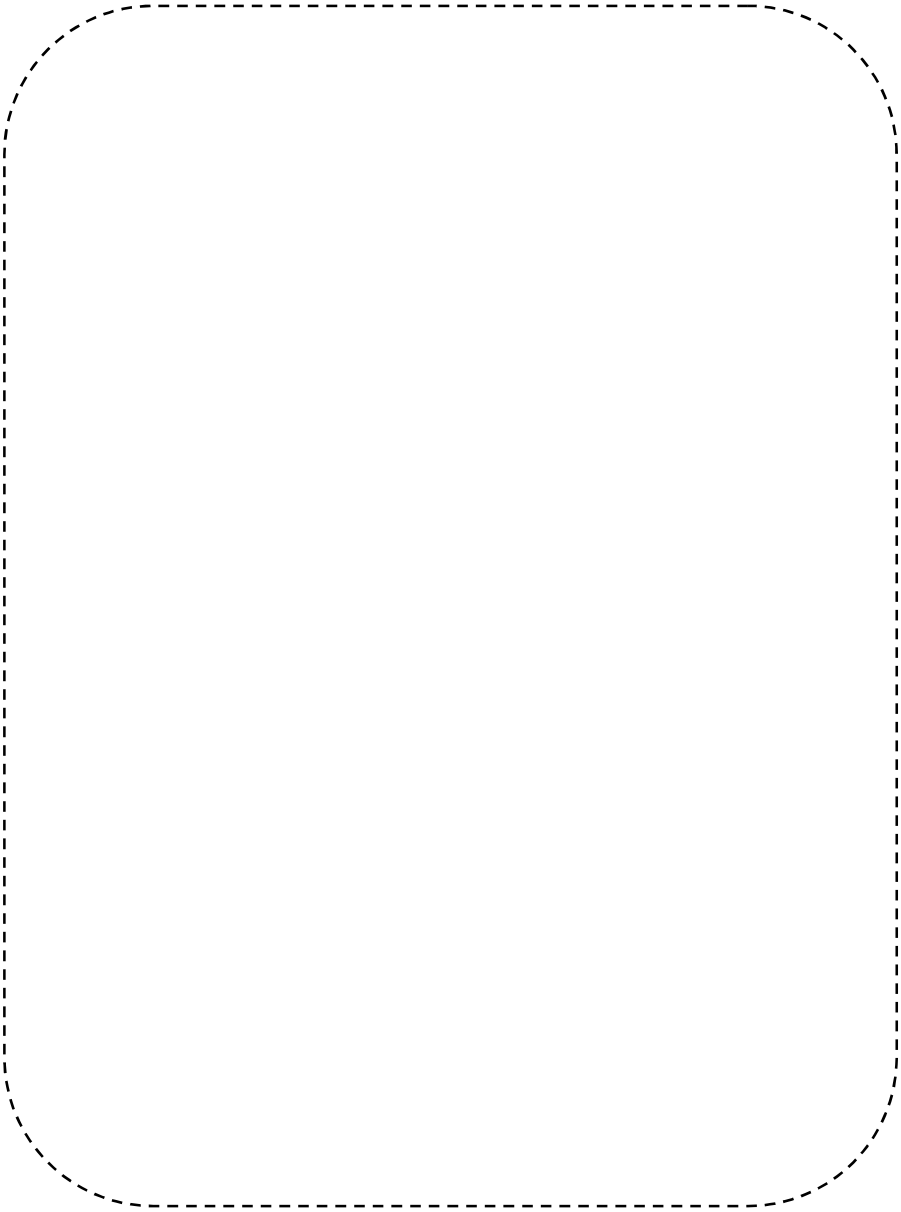
## Drawing of the squash



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## PROJECT NO (4):- WHOLE MOUNT

**Name of the project:-**

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**Explain how to prepare the whole mount?**

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**Explain how to fix the whole mount?**

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**Explain how to stain and differentiate the whole mount?**

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**Explain how to dehydrate and clear the whole mount?**

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**Explain how to mount the whole mount?**

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**Explain how to label the whole mount?**

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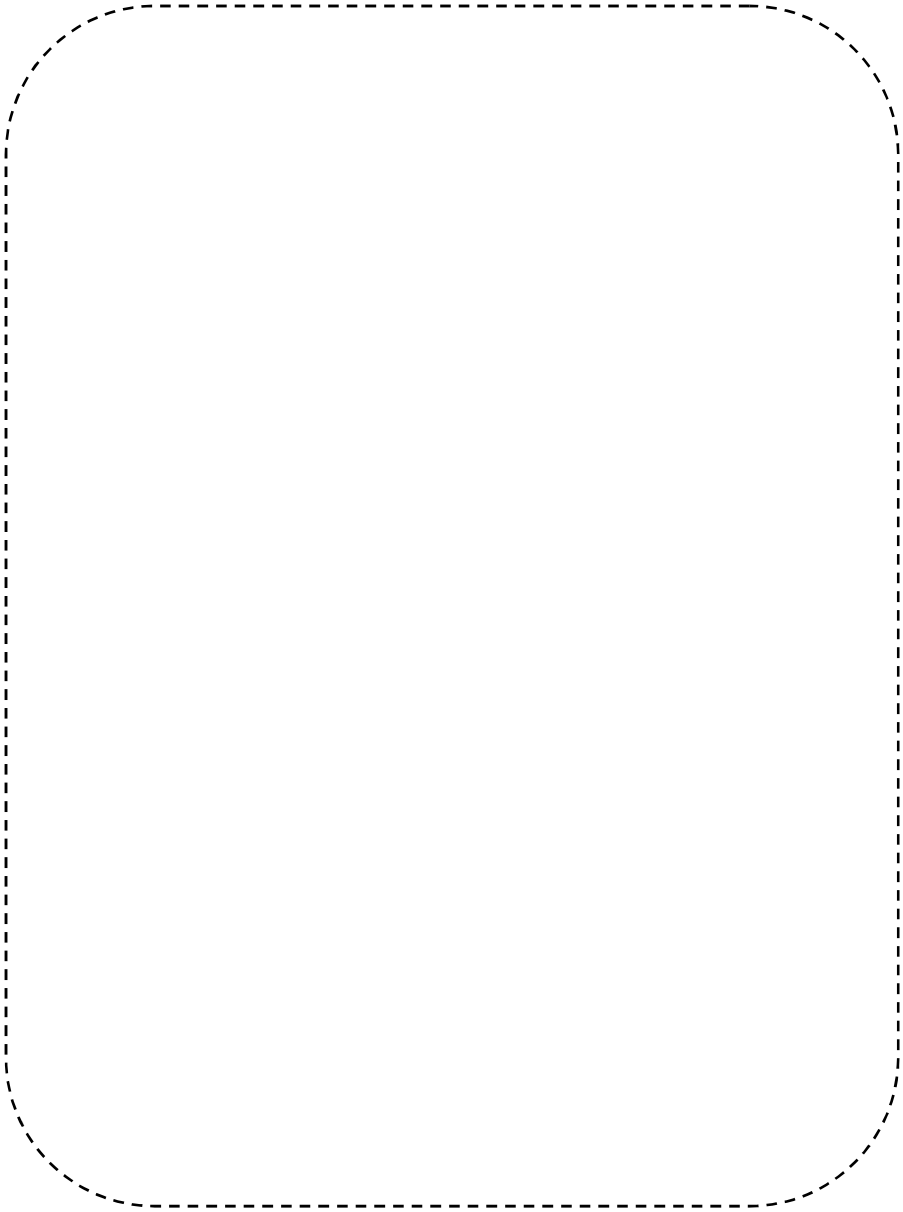
## Drawing of the whole mount



## PROJECT NO (5):- WHOLE MOUNT

**Name of the project:-**

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**Explain how to prepare the whole mount?**

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**Explain how to fix the whole mount?**

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**Explain how to stain and differentiate the whole mount?**

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**Explain how to dehydrate and clear the whole mount?**

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**Explain how to mount the whole mount?**

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**Explain how to label the whole mount?**

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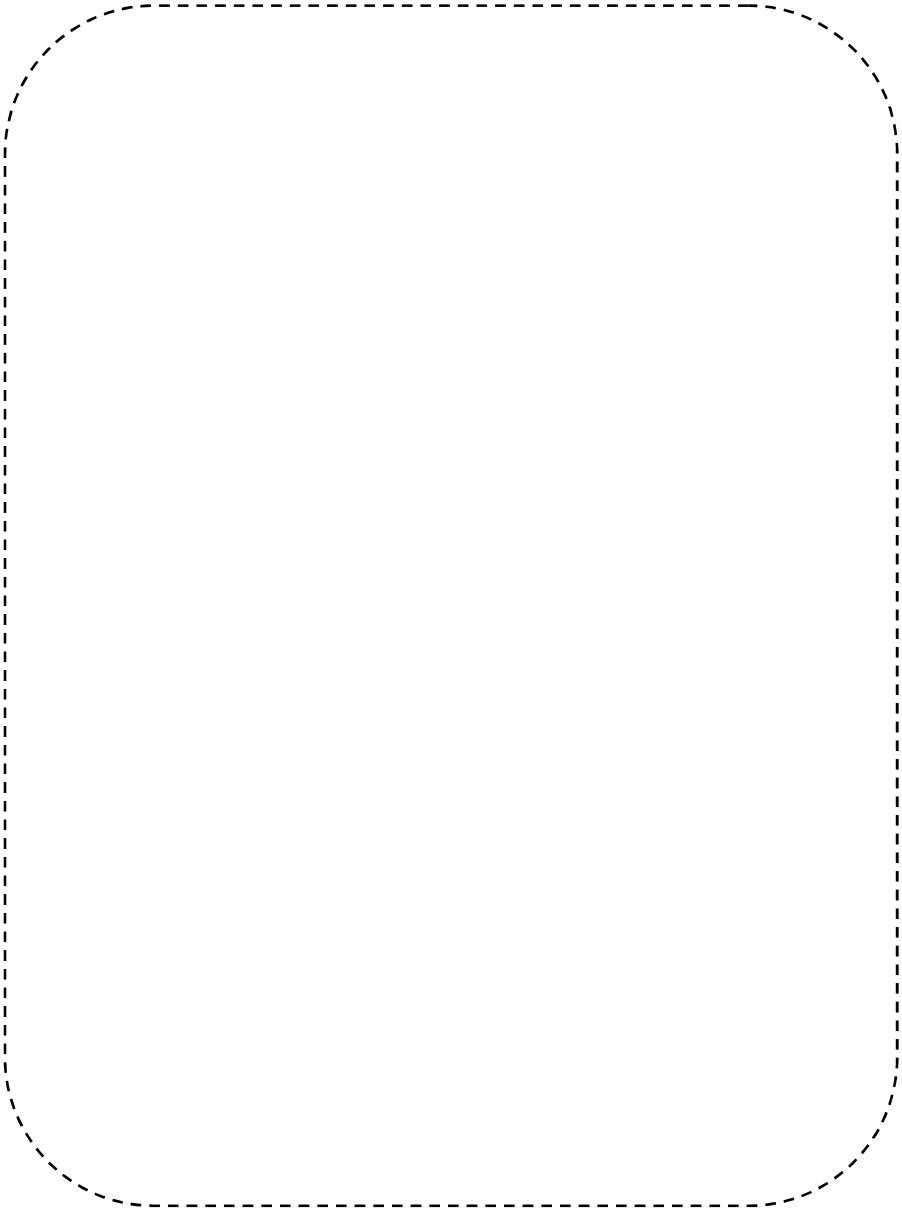
## Drawing of the whole mount



## PROJECT NO (6):- WHOLE MOUNT

**Name of the project:-**

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**Explain how to prepare the whole mount?**

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**Explain how to fix the whole mount?**

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**Explain how to stain and differentiate the whole mount?**

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**Explain how to dehydrate and clear the whole mount?**

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**Explain how to mount the whole mount?**

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**Explain how to label the whole mount?**

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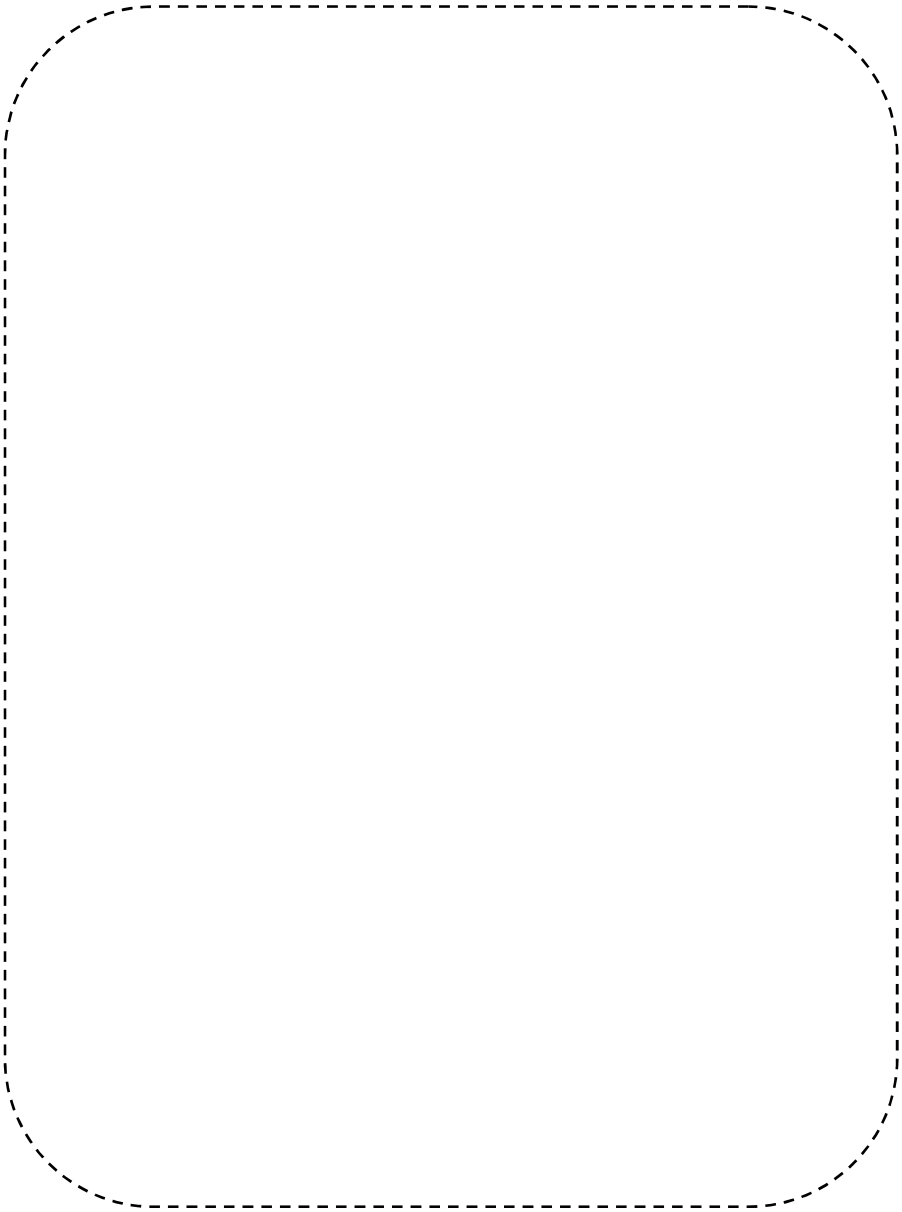
## Drawing of the whole mount



## PROJECT NO (7):- WHOLE MOUNT

**Name of the project:-**

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**Explain how to prepare the whole mount?**

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**Explain how to fix the whole mount?**

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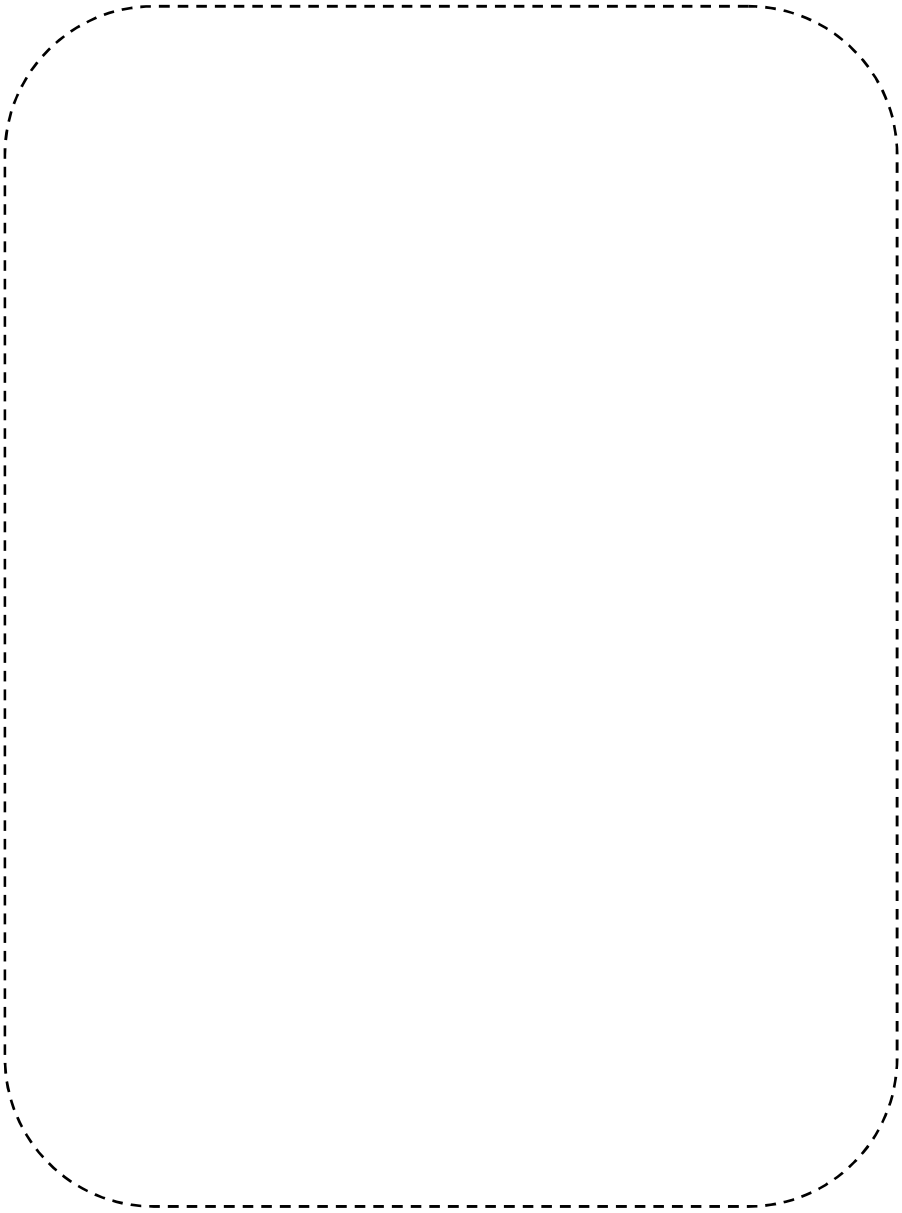
## Drawing of the whole mount



## PROJECT NO (8):- WHOLE MOUNT

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**Explain how to prepare the whole mount?**

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**Explain how to fix the whole mount?**

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**Explain how to stain and differentiate the whole mount?**

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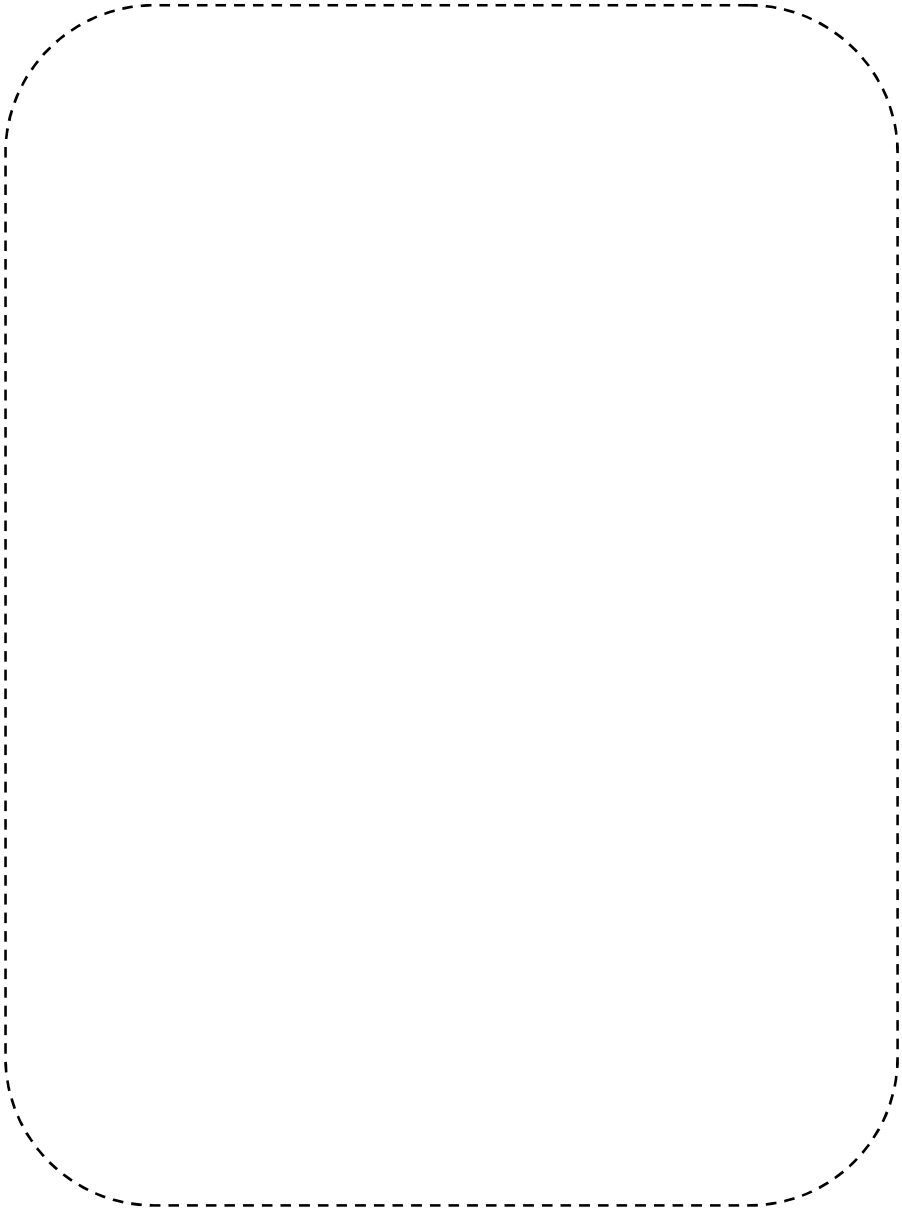
## Drawing of the whole mount



## PROJECT NO. (9):- SECTIONS

## (USING PARAFFIN TECHNIQUE)

**Name of the project:-**

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**Explain how to prepare the animal, separate the organ and cutting the organ into pieces (specimens)?**

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**Explain how to fix the specimens?**

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**Explain how to dehydrate and clear the specimens?**

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**Explain how to impregnate and embed the specimens?**

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**Explain how to cut the specimens into sections?**

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**Explain how to dissolve the paraffin wax and hydrate the sections?**

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**Explain how to stain and differentiate the sections?**

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**Explain how to dehydrate and clear the sections?**

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**Explain how to mount, clean and label the sections?**

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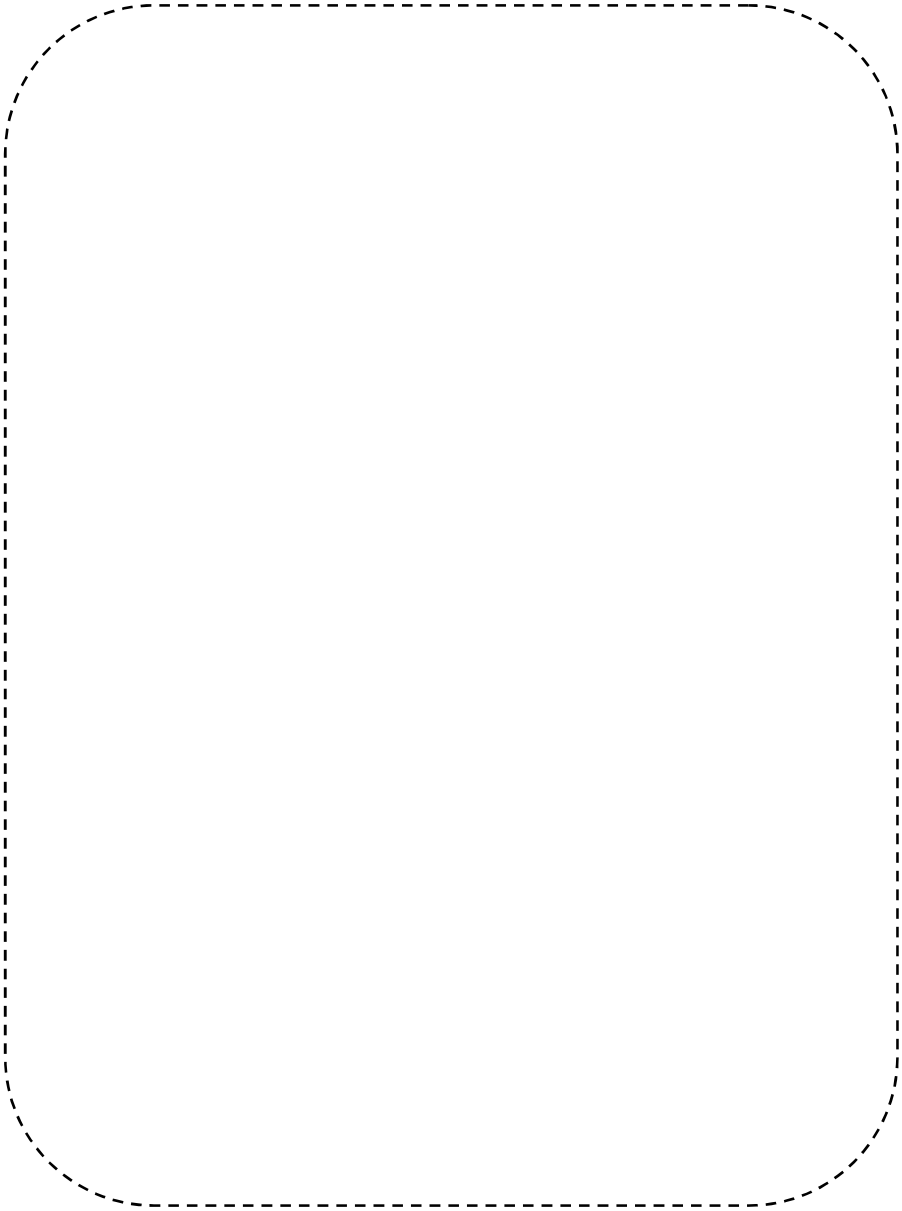
## Drawing of the section



## PROJECT NO. (10):- SECTIONS

## (USING PARAFFIN TECHNIQUE)

**Name of the project:-**

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**Explain how to prepare the animal, separate the organ and cutting the organ into pieces (specimens)?**

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**Explain how to fix the specimens?**

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**Explain how to dehydrate and clear the specimens?**

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**Explain how to impregnate and embed the specimens?**

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**Explain how to cut the specimens into sections?**

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**Explain how to dissolve the paraffin wax and hydrate the sections?**

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**Explain how to stain and differentiate the sections?**

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**Explain how to dehydrate and clear the sections?**

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**Explain how to mount, clean and label the sections?**

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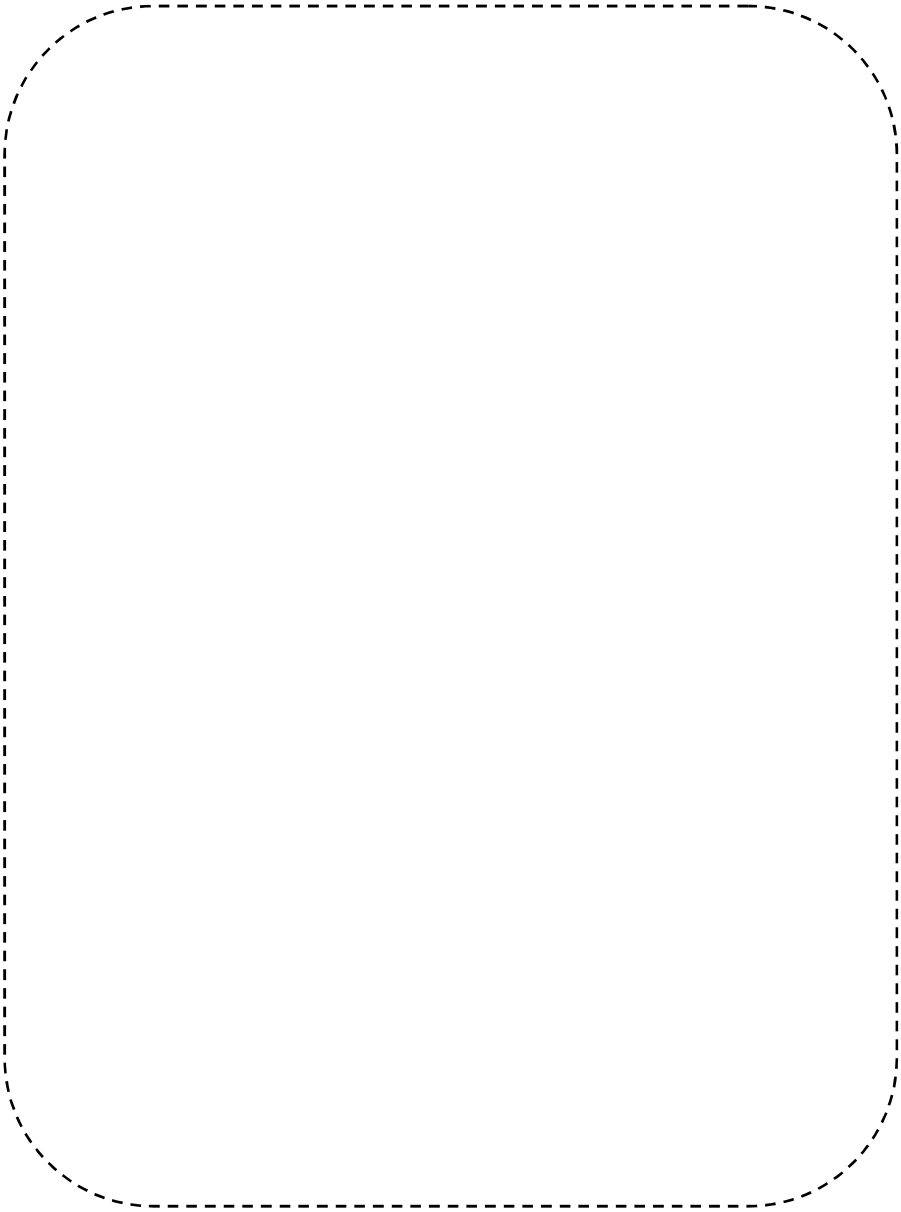
## Drawing of the section



## PROJECT NO. (11):- VISIT TO:-

## MUSEUM AT ZOOLOGY DEPARTMENT

## CENTRAL LAB. AT SVU

### 1- Museum at Zoology Department


It contains huge number of preserved specimens.

### 2- Central Lab at SVU


Find out the followings:-

Transmission Electron Microscope

Scanning Electron Microscope

Image analysis system research microscope

**Laboratory aids**

**ارشادلت معملية**

# Safety is not negotiable

## تعليمات معملية عامة

1. ارتداء الملابس المخصصة للمعمل.
2. يجب ان تعلم بمكان ونوعية معدات الاسعافات الاولية وكيفية استعمالها.
3. اتبع الارشادات المكتوبة او الشفهية فى المعمل.
4. يمنع الاكل او الشرب فى المعمل.
5. انتبه باستمرار للعلامات التحزيرية فى المعمل.
6. يجب ان يكون المعمل جيد التهوية والابتعاد عن استنشاق ابخرة المواد الكيميائية.
7. عند دخول المعمل لاول مرة، لا تلمس الادوات او الكيمياويات قبل معرفة تعلميات وشروط ذلك. يجب اعتبار ان كل كيمياويات المعمل خطرة، تجنب لمسها او شمها او تذوقها.
8. يفضل ان لا تعمل وحيدا فى المعمل "عند غياب المسئول عن المعمل".
9. اقرأ طريقة استعمال الالات وما هو مدون عليها بدقة قبل الاستخدام.
10. قم بعمل التجارب المطلوبة منك فقط.
11. يجب متابعة تجربتك بنفسك.
12. إن العلامة المميزة لعمل الطالب الجيد تلاحظ دائما من خلال مكان عمله. لذلك احرص دائما على نظافة معملك وحسن ترتيبة وخطط لعملك المختبري بحيث يتوفر لديك الوقت الكافي للتنظيف.
13. الادوات الزجاجية وغيرها لابد ان تكون نظيفة وموضوعة فى اماكنها الخاصة.
14. حافظ على الموازين فى المعمل نظيفة ومعايرة.
15. ابعد يديك عن الوجه، العيون، الفم والجسم ككل عند استخدامك الادوات او الكيمياويات فى المعمل.
16. لا تتعامل مع الزجاج المكسور باليد المجرده.
17. ابعد المحاليل القابلة للاشتعال بعيد عن مصدر اللهب.

**18.** تعامل مع الاحماض والقلويات بمنتهى الحرص.

**19.** يجب فصل الكهرباء عن الاجهزة التى ليست فى حالة عمل.

**20.** احرص على استخدام كبماويات من نوعية ممتازة.

**21.** يجب وضع بيانات كاملة وواضحة على زجاجيات الكيماويات والمحاليل.

**22.** يجب ان توضع انية الصباغة فى ترتيبها الصحيح وان البيانات تكون على الانية نفسها وليس الاغطية.

**23.** لا تسرف في صرف المواد الكيميائية وحاول استخدام الكمية المناسبة التي لا تزيد عن حاجتك.

**24.** لا ترجع المواد الكيميائية الفائضة إلى الحاويات الأصلية. ويمكن التخلص من المواد الفائضة بطريقة عملية مناسبة وحسب توجيهات المختصين.

**25.** يجب على الطالب أن ينظم وقت عمله في العمل مثلاً زمن إجراء التجربة كتابة التقرير الخاص بها ، الشروع في إجراء تجارب أخرى.

## تحذيرات العمل في المختبرات

**حاول تطبيق تعليمات السلامة التي تخصك , وكن حذراً في عملك ومستعداً لتفادي المخاطر والحوادث أن حدثت واتبع الإرشادات التالية في حالة الطوارئ.**

1- **الحرائق:-** أطفئها بسرعة بالماء أو الرمل أو البطانية الخاصة بالحرائق إذا كانت صغيرة واستخدم آلة إطفاء الحريق إذا كانت كبيرة وسوف يتم دراسة الحرائق لاحقاً.

2- **الملابس المحترقة:-** كن شجاعاً في إخمادها ولا تدعها تنتشر أكثر واستخدم القوة لإنقاذ زميلك في المعمل أو المختبر بطرحه أرضاً ولفة ببطانية الحريق أو إسعافه بالطرق المتوفرة الأخرى.

3- **الحروق:-** لفها بلفافة معقمة إذا كانت بسيطة أما الحروق الكبيرة فحاول تهدئة الشخص المتأثر وأخطر أقرب وحدة طيبة حالاً . كذلك سوف يتم تناول هذا الموضوع في باب الإسعافات الأولية.

4- **الجروح:-** حاول غسلها بالماء وتعقيمها ثم لفها بلفافة معقم إذا كانت بسيطة وإذا حصل نزيف حاول أن تبعد الزجاج المكسور والملوثات الأخرى بملقط معقم وأضغط بقماش نظيف على الجرح ثم لفه بلفافة معقم أما الحروق الجسمية فأبلغ أقرب وحدة طبية عنها حالاً.

5- **ملامسة المواد الكيميائية:-** أغسل الجلد بكمية وفيرة من الماء أو استخدام محلول بيكربونات الصوديوم المخفف في حالة التعرض للأحماض أو محلول حمض الخليك المخفف في حالة التعرض للقواعد.

6- **دخول المواد الكيميائية في العين:-** أغسل العين جيداً بكمية وفيرة من الماء بنافورة غسل العيون أو وعاء نظيف أو في راحة اليد (لمدة 20 دقيقة) وحاول استخدام محلول مخفف جداً من حمض البوريك في حالة القواعد وأبلغ أقرب وحدة طبية حالاً.

1- عند تخفيف الاحماض اضف الحامض الى الماء وليس العكس، ويجب ان تضيف الحامض ببطء.

2- استخدم ادوات قياس صغيرة لتقدير كميات صغيرة من السوائل ضمانا للدقة.

3- محلول الفورمالين يحتوى على 40% غاز الفورمالدهيد ولكنه يعامل كأنه 100 %. عادة يطلب فورمالين متعادل، ولتنفيذ ذلك توضع فى زجاجة الفورمالين كمية من كربونات الكالسيوم (او بعض قطع الطباشير الابيض) الذى يعادل حامض الفورميك المتكون، ولكن فى هذه الحالة لا يستعمل الفورمالين قبل 24 ساعة من وضع الكربونات كما يجب ترشيحه قبل الاستعمال.

4- عند تحضير تركيزات مختلفة من الكحوليات لا يفضل تحضيرها من الكحول المطلق لارتفاع ثمنه عن كحول تركيزه 95%، وانما تحضر من كحول تركيزه 95%.

**بهتان الصبغة Fading of stain**

من المفروض الا تبهت صباغة القطاعات الا بعد مرور عشرات السنين بسبب الاكسدة البطيئة للصبغ بالهواء. الا اننا نفاجأ بهتان الصبغة بعد اشهر قليلة او سنوات، وذلك للاسباب التالية:-

ا- تعرض الشرائح للضوء لفترات طويلة.

ب- سائل الترويق clearing agent حامض او به شوائب.

ج- صمغ التكميل mounting medium حامض او به شوائب.

ويمكن اعادة صباغة الشرائح التى بهتت بالطريقة الاتية:-

ا- ازل الاغطية الزجاجية بوضع الشرائح فى الزيلول حتى تنفصل الاغطية مع عدم محاولة نزع الاغطية بالقوة حتى لا تتمزق القطاعات.

ب- تترك الشرائح فى الزيلول لازالة الصمغ تماما.

ج- ضع الشرائح فى الكحول المطلق ثم فى سلسلة هابطة من التركيزات من الكحول حتى الماء.

د- يفضل وضع الشرائح فى 0.5% برمنجنات البوتاسيوم لمدة دقائق.

ه- اعسل فى ماء جارى.

و- بيض القطاعات فى 0.5% حمض اوكساليك.

ن- اغسل الشرائح جيدا فى ماء جارى.

ل- اعد صباغة الشرائح بالطرق المطلوبه.

**ازالة الاصباغ من الايدى والاوانى الزجاجية:-**

ا- لازالة الكارمين من اليد او الاوانى الزجاجية استخدم امونيا مركزة ثم حامض الايدروكلوريك المخفف.

ب- لازالة الهيماتوكسيلين من اليد او الاوانى الزجاجية استخدم الحامض المخفف او عصير الليمون.

ج- لازالة حمض البكريك من اليد او الاوانى الزجاجية استخدم كربونات الليثيوم او ايودات الليثيوم.

د- لازالة المثيل الازرق من اليد او الاوانى الزجاجية استخدم كحول حامضى.

**وحدات القياس:-**

معظم الاجهزة تستخدم درجات الحرارة بالتدريج المئوى حيث تكون درجة التجمد صفر ودرجة الغليان 100°م. بعض الاجهزة تستخدم التدريج الفهرنهيتى (Fahrenheit) الذى تكون فيه نقطة التجمد تقابل درجة 32 مئوية ونقطة درجة الغليان تقابل 212 مئوية. وبذلك فان درجة مئوية تكافئ 9\5 الدرجة الفهرنهيتية، للتحويل:-

الدرجة بالفهرنهيتية = (الدرجة المئوية x 9\5) + 32

الدرجة المئوية = (الدرجة الفهرنهيتية – 32) x 5\9

**وحدات قياس الاطوال:-**

الميكرون ( µ) = 1\1000 من المليمتر

النانوميتر (nm ) = 1\1000000 من المليميتر

الانجستروم (A° ) = 1\ 10 مليون من المليميتر