Laboratory 10 – Fruit and Vegetable Anatomy Project[7]

NOTE: **REMEMBER TO BRING YOUR DISSECTING KIT! (A LAB COAT IS RECOMMENDED)**

Objective

To explore the anatomy of a fruit or vegetable, research its economic importance and its nutritive value.

Method

You will be responsible for selecting and analyzing an intact fruit or vegetable: Describing its morphology, anatomy and any specialized anatomical features that affect its function.

You must provide your TA with your selection and a one page description of its nutritional information before the lab exercise[8].

This exercise provides you with the opportunity make your own analysis, your own description and your own conclusions about the form, function and nutritive value of the fruit or vegetable you select. You should be able to obtain a diverse range of fruits and vegetables from a local supermarket. In selecting your fruit or vegetable you should bear in mind the following points:

- Because the laboratory exercise involves dissection, you should obtain multiple specimens, and store them as appropriate so that they will last the full duration of the lab exercise. You may wish to obtain non-ripe specimens, since they will be easier to section for your anatomical explorations.
- Fruits and vegetables fulfill a variety of functions (food storage, seed dissemination, etc.). In addition, any fruit or vegetable has evolved under severe selective pressure by humans for an extended period of time (up to 15,000 years!). Thus, some adaptations are in no way related to the survival of the plant species, but instead to human requirements. Some fruits or vegetables have been so modified that they barely fit the normative definition of a plant. Think of some of the *Brassica* spp. Cauliflower and broccoli are severe modifications of the flowers, yielding something good for you, but not for survival in the absence of human intervention. If you choose grapes, selecting a seeded variety is more sensible than a seedless variety! Dissecting a seed to observe the embryo is also a fascinating option. All worth thinking about when you select your fruit or vegetable.
- You will need the correct Latin name (genus and species) of the crop plant that produced the fruit or vegetable.
- Small fruits or vegetables are easier to transport and analyze (watermelon is an example of a fruit that is large and bulky).
- Dissecting the fruit or vegetable will probably prove fatal to it. Eating the dissected remains is not acceptable. Remember you are working in a laboratory with chemicals —some hazardous— that can easily cross-contaminate your specimens.
- By way of introduction, it will be useful to provide a drawing of your entire fruit or vegetable so that you can show what its grosser morphological features are like. It may be a good idea to prepare this before you bring your specimen into the lab.

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[7] Special thanks to Chris Luszczek, Ahmed Hamam and Debbie Freele for their assistance developing the lab exercise.

[8] (http://www.yorku.ca/plants/lab_information.html#Fruit%20and%20Vegetable%20Nutrition)

A botanical definition of a fruit is "a mature, ripened ovary (or group of ovaries), containing the seeds, together with any adjacent parts that may be fused with it at maturity" (Raven et al., 2005[9]). Vegetable is not a botanical term. Dictionary definitions will describe a vegetable as a plant or part of a plant used as food. Vegetables arise from a bewildering array of anatomical structures of the plant. Food storage by plants can use corms, bulbs or tubers (amongst other things). A corm is a fleshy food-storing underground stem (sometimes with small, thin leaf structures). A bulb is also a modified stem, with food-containing leaves. Tubers are short fleshy underground stems. Potatoes are an example of a tuber, which can develop from stolons (slender stems that grow along the soil surface) or rhizomes (underground stems). Sweet potato is an example of a tuberous root. Carrots and beets are taproots. Many of the foods that we would describe as vegetables are in fact seeds or fruits from a botanical perspective. A key to the diversity of fruits is provided at the end of the exercise.

During your lab periods you should cut freehand sections of the various parts of the fruit or vegetable. Be judicious in your selection. You should prepare diagrams and/or accurate drawings to illustrate the overall organization and details of specific cell types characteristic of each part of the fruit or vegetable. Remember that all drawings and diagrams must contain an accurate indication of scale (i.e. magnification). Your illustrations must be clearly labeled. All of the cell types should be given their correct names. You can check the characteristics of each cell type, and thus the correct name, from your textbook. The following techniques may help you analyze your plant when used in conjunction with freehand sections.

- Epidermal peels —many fruits have a waxy coating (to minimize drying out) with well-defined features. Peel the epidermis by hand and mount on the microscope to observe these structures if they are present. Transverse sections will reveal the nature of the structural 'coat' on the fruit (or vegetable) surface.
- Ruthenium Red —pectin should stain pink to red when stained with Ruthenium Red (0.05% in H_2O), thus showing pectin-rich tissue (often found in the cell walls).
- Iodine —mount fresh sections in iodine solution (0.5% in 5% aqueous KI) for 2 min., rinse with H_2O and mount in H_2O. Starch stains deep blue (long chain molecules) or red-brown (short chain molecules). Good for possible storage tissue (decrease the staining time for tissues that are very rich in starch).
- Sudan IV —fix sections in 10% formalin for 10 min., then replace formalin with 50% ethanol for about 1 min. Stain in Sudan IV (saturated in 70% ethanol) for 30 min. Rinse in 50% ethanol and mount in 75% glycerol. Stains fats and oils red, good for possible oil storage tissue.
- Toluidine blue 0 (TBO) —mount fresh sections in TBO (0.05% in H_2O) for 10 sec. to 1 min., rinse in H_2O for 1 min and mount in H_2O. Lignified walls (e.g. xylem) stain navy to greenish blue, phloem vessels stain purple and phloem fibers stain sky-blue.

At the end of the lab your demonstrator MUST initial your diagrams and notes.

[9] Raven PH, Evert RF, Eichhorn SE (2005) Biology of Plants. 7th edition. WH Freeman and Company. Glossary (page G-9).

Lab report

Your report should be in the form of 1) an introductory description of the nutritional value of the fruit or vegetable you selected (prepared before the lab). 2) An accurate and concise annotation of the anatomy of your fruit or vegetable based on your dissection, staining, and drawings. You will be given an overall mark for the accuracy, detail, logic and understanding of your text, and the quality of your description and your illustrations. You should reference any books that you use to: a) identify the nature of your fruit or vegetable and its economic importance, and b) to describe its nutritive value. Please hand in your report and annotated drawings made during your lab session.

Fruit Key[10]

Dry and dehiscent[11], monocarpellary[12] (without persistent septum)
- dehiscent along 1 edge —**follicle**— milkweed, magnolia
- dehiscent along 2 edges (Legume Family) —**legume**— peanuts, all beans

Dry and dehiscent, bi-pluri-carpellary (with persistent septum)
- derived from several fused carpels, opening by slits, pores or a cap —**capsule**— cotton, poppy
- long and thin, dehiscent by two valves —**silique**— mustard
- short and broad silique —**silicle**— shepherd's purse

Dry and indehiscent
- Winged —**samara**— ash, maple, tulip tree
- Wingless:
  - With a thin shell (pericarp)
    - pericarp fused entirely to seed coat (Grass Family) —**caryopsis (grain)**— all cereals
    - pericarp not fused entirely to seed coat —**achene**— sunflower
  - large, with a hard shell (pericarp) —**nut**— acorn, macadamia

Fleshy and indehiscent
- Heterogenous in texture, having
  - One seed enclosed within a bony endocarp —**drupe**— peach, cherry, plum, olive, coconut
  - Papery or cartilaginous carpels in an inferior ovary[13] —**pome**— apple, pear
  - A hard or firm rind (exterior) and soft interior
    - From an inferior ovary —**pepo**— cucmber, watermelon, pumpkin, squash
    - From a superior ovary —**hesperidium**— all citrus fruits, noted for their leathery skin with oils
- Homogeneous, fleshy throughout —**berry**— tomato, grape, coffee

Compound fruit
- Derived from more than one pistil —**aggregates**— strawberry, rose hip, raspberry

[10] Source: modified from Asa Gray (1879) Gray's Botanical Textbook (Sixth Edition). Volume 1: Structural botany or organography on the basis of morphology to which is added the principles of taxonomy and phytography. Ivison, Blakeman and Company. pp. 304.

[11] dehiscent: seeds are released by the opening of a pore, slit or valve.

[12] monocarpellary: derived from a single carpel, which may contain multiple ovaries (and thus many seeds). The presence of a single or multiple carpels can be deduced from the persistence of septa separating the carpels.

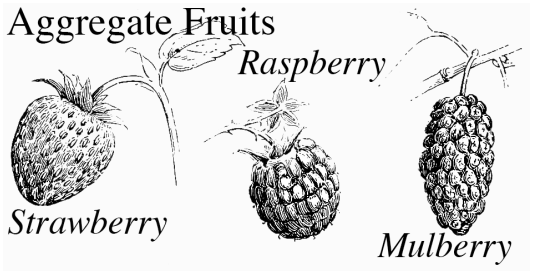
[13] Inferior (and superior ovary) refers to the location of the ovary within the flower, subtending the flower, (or above it).

Examples of Fruits and Vegetables for Dissection

This list is by no means exhaustive, but gives examples of commonly available fruits and vegetables. Please don't be constrained by the list when you select your fruit or vegetable.

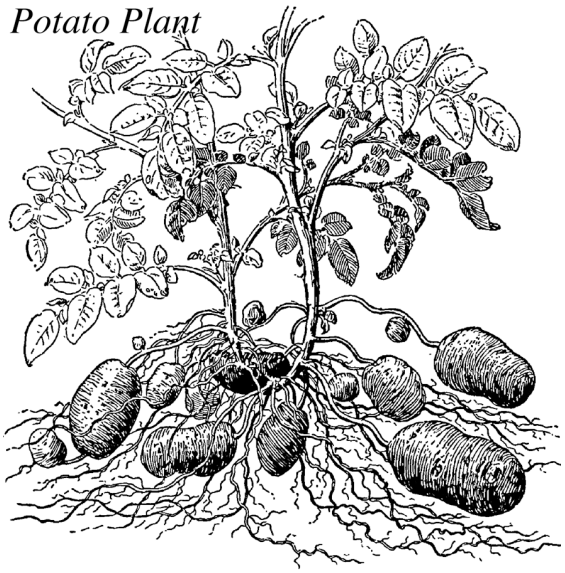
Fruits

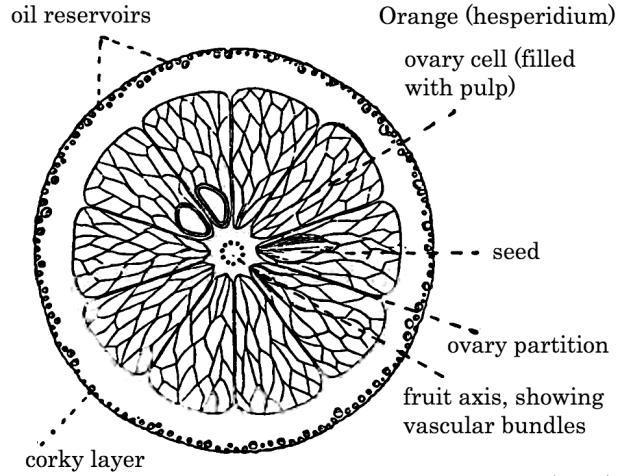
drupe— peach, cherry, plum, olive, coconut, avocado
true berries— tomato, grape, coffee, eggplant, pomegranate
hesperidium— all citrus fruits
pepo— cucmber, watermelon, pumpkin, squash, zucchini
pome— apple, pear
aggregates— strawberry, rose hip, raspberry
multiple fruits— pineapple, fig
nut— macadamia, chestnuts
caryopsis (grain)— all cereals
achene— sunflower
legume— peanuts, all beans



Vegetables

corms— water chestnuts, taro
tubers— potato, sweet potato, ginger
bulbs— onions, leeks, garlic
taproot— carrots, turnips, radish, beet
petioles— celery, rhubarb
leaves— cabbage, spinach
leaf buds— Brussels sprout





Bergen: High School Botany (1904)