

SOLUTIONS

Task 13.2.1

- a| See illustration "Breast Muscles of the Pigeon". The large and powerful breast muscle is responsible for the forceful downbeat of the wing, and the small breast muscle is responsible for its upward movement.
 - b| The bones are thin-walled and hollow, resulting in considerable weight savings. This is also important for the ability to fly.
 - c| When gliding, the bird spreads its wings out to their maximal wingspan. The air flow is similar to that of an aircraft wing. In flapping flight, the wing's downbeat increases the air pressure and generates lift. Air resistance is reduced on the upbeat by rotating the wing towards the vertical.
- Task 13.2.2**
- a| The barbs lie close together and can only be separated by pulling hard.
 - b| See photo "Barbs and Barbules"
The hooklets on the barbules of the feather hook onto the barbules of adjacent feathers like a Velcro fastener, giving a stable and smooth wing surface.
 - c| A cardboard strip weighs at least twice as much as a feather of the same size and thickness. The reason is the lightweight construction of the feather (e.g. hollow quill and rachis).

Task 13.3.1

- a| Insect wings (except for the wing covers of beetles) are mostly transparent and membranous (chitin). Mechanical stability is provided by a network of tracheal tubes that are incorporated into the wing. Bird wings have a load-bearing framework made of bones (vertebrates). The wing surface is formed by overlapping feathers.
- b| The basic principle underlying wing movement can be easily demonstrated with a Petri dish, with two plastic strips ("wings") attached to the rim of the lid with adhesive tape. The inner ends that project into the dish are moved up and down by raising and lowering the dish (representing the floor of the thorax), resulting in alternating "wing movements" like those of a seesaw.

Task 13.3.2

Safety advice for experiment 13.3.2: since UV light is a high-energy form of radiation, looking directly at the UV tubes should be avoided!

- a| Flower markings are visible under UV light (as in banknote inspection) even without a UV camera. However, you should do this experiment in a darkened room to avoid interference from stray light.
 - b| Current senior level chemistry and biology books (topics on colour vision and orientation in bees) are sufficient as basic reference material. Students should identify the wavelength range of visible light and the UV vision of bees, see how these correlate with flower markings.
- Task 13.3.3**
- a| This experiment must be replaced in the winter semester by a film (good video clips on YouTube). Use of a zoom camera is recommended in the open to avoid disturbing the bees, which might otherwise become aggressive.
 - b| The pollen is easily picked up from the stigma and stamens with a brush and spread onto the slides. Since flowers are certainly visited by different pollinators, pollen from other species ("foreign pollen") may also be found on the stigma. However, this does not germinate.
 - c| If too many pollen grains are visible, further dilution with water will reduce the concentration to the point where you can easily determine the proportion of foreign pollen.

SOLUTIONS

Task 13.4.1

- a) The rate of descent and the horizontal distance reached depend on wind conditions and are also influenced by vertical updrafts (e.g. over the heated paving of a schoolyard). Velocities for maple and lime seeds are in the region of 0.6 m/s to 1.2 m/s. If the starting point is e.g. ten metres above ground level, one can make a video clip of the flight lasting up to 16 s. If pussy willow or dandelion seeds are available, the rates of descent are even lower (about 0.1 m/s (pussy willow) to 0.4 m/s (dandelion)). The following link leads to an outline of the physical principles of seed flight (especially spiral fliers): www.uni-muenster.de/imperia/md/content/fachbereich_physik/didaktik_physik/publikationen/gefl_gelter_samen.pdf
- b) Example – lime seed: the bract of the inflorescence is fused with the peduncle, and is made to rotate by its shape like a rotor, reducing its rate of descent and expanding its range at the same time.
- Contrary to what its title might suggest, the article below (available at the URL below) provides information on the flight characteristics and rates of descent of numerous seeds and fruits: www.lwf.bayern.de/veroeffentlichungen/lwf-wissen/34/w34-04-zur-windverbreitung-der-esche.pdf
- c) A brief overview of bionics can be found at: www.weltderfinder.de/?s=bionics&x=13&y=7

Task 13.4.2

- a) Two disc-like cotyledons / radicle (embryonic root) / embryonic stem with leaf primordia
- b) Good examples here are pulses (peas, beans), because both germ buds and cotyledons are easy to recognise and dissect.

Task 13.5.1

- a) Pollen nuclei can easily be stained with methylene blue.
- b) Identification guides are needed if the plant of origin is not known.
- c) As long as the pollen is evenly distributed, we recommend counting a smaller sector (e.g. 1 x 1 mm) and extrapolating to one square centimetre.

Task 13.5.2

- a) and b) Hazel: catkins (male) made up of over a hundred individual flowers, each of which has eight stamens under a bract scale. A catkin (inflorescence) can produce over two million pollen grains in its stamens. These pollen grains are released into the air when the stamens ripen.
- c) Shaking can produce a yellow cloud of pollen grains.
- d) The leaves of deciduous trees would not be biologically useful as a landing place for many pollen grains, and would block the way to female flowers.
- e) Since pollen transfer by the wind occurs randomly and is non-directional, successful pollination must be guaranteed by producing appropriate quantities. This is not the case with insect pollination, since insects such as bees usually fly to plants of the same species and transfer pollen to the stigma at the same time. Plants pollinated only by insects do not appear in pollen level alerts.

Sources e.g. pollen alerts in the weather forecasts of daily newspaper, e.g. www.dwd.de/pollen-flug

Task 13.6.1

- The use of several Petri dishes is recommended (see experiment description), since in some cases brief exposure of the first jam sample may already result in fungal growth. The probability of obtaining the expected result increases with the number of dishes. If mostly whitish, round bacteria colonies form next to the mould spots, these dishes should no longer be used. Dishes will be cleaned by the teacher in hot water and detergent (disposable gloves recommended). Important: very high sugar content can delay or even prevent germination of mould spores. This is the reason that diet jam with reduced sugar content is used.
- a) We see hyphae (fungal filaments), sporangia and numerous punctiform spores.
- b) Source: any biology books with an overview of the five kingdoms of living organisms. Expected results e.g. function of spores, air dispersal, ecological role of mould as a decomposer (breakdown of organic substances), pathogenic species (e.g. via production of aflatoxins).
- c) Jam from an unopened jar is generally sterile, so mould growth in the second sample must originate from spores in the air.