Introduction:

This document was originally prepared for the use of members of Mid Bucks Beekeepers Association in their preparation for the BBKA Module 2 examination in 2012.

References:

The Honeybee Inside Out	Celia F. Davis
The Honeybee Around and About	Celia F. Davis
Guide to Bees and Honey	Ted Hooper
BBKA website	
MBBKA Study Group	
MBBKA Basic Course Notes	

Notes updated Summer 2014 by JM
Section 2.29 Added November 2014
Section 2.1 updated 7/11/17

Contents

The Candidate shall be able to give detailed accounts of:-

2.1 the main requirements of the current, United Kingdom statutory regulations affecting the handling, preparation for sale, hygiene, composition labelling and weight of packs of honey;

Lucie Chaumeton and Geoffrye Hood have written an excellent summary of the relevant statutory regulations which can be found here.

There is some regulation on nutritional content labelling, the vast majority of UK Beekeepers are exempt from the regulation. To find out more go here.

There are two Acts of Parliament affecting Honey preparation for sale:

Food Hygiene and Safety Act 1990 with 6 Statutory Instruments

- Food Premises (Registration) Regulation 1991 (superceeded by Regulation (EC) No 853/2004)
    - Premises registration does not apply if the production is small quantities and
        - Primary production is for private domestic use
        - The domestic preparation, handling or storage of food for private domestic consumption
        - The direct supply, by the producer, of small quantities of primary product to the final consumer or to local retail establishments (within 35 miles of producer) directly supplying the final consumer
    - Small quantities has not been defined for honey products
- Food Safety (General Food Hygiene) Regulation 1995
    - Food business includes preparation even if not for profit and hygiene includes measures to ensure safety and wholesomeness of food
    - Requires adequate safety procedures are identified, implemented, maintained and reviewed
    - Requirements for handling and preparing food including; premises have adequate space, clean, ventilated and appropriate lavatories and hand washing facilities.
    - Specifically; all surfaces should be sound and easy to clean and disinfect, outside windows must be inspect proof, windows closed during operation, two sinks with hot and cold water (one for hand washing and the other for food washing), ventil;ated lobby between extraction room and toilet, equipment employed must be clean and where necessary disinfected
    - While processing honey suitable clean protective clothing should be worn, no exposed cuts/wounds and no one should be suffering from any kind of illness
    - Honey should be stored in a hygienic environment isolated from parasites, pathogenic micro-organisms, or decomposed or foreign substances
- Food Labelling Regulations 1996

    - Defines labels to be words and images

- Food (Lot Marking) Regulation 1996
    - All foods must have lot marking indication, either specific identifier beginning with L or Best Before including day and month

- Food Safety and Hygiene (England) Regulation 2013
    - Lists relevant authorities and process for enforcement of Food Safety Act 1990

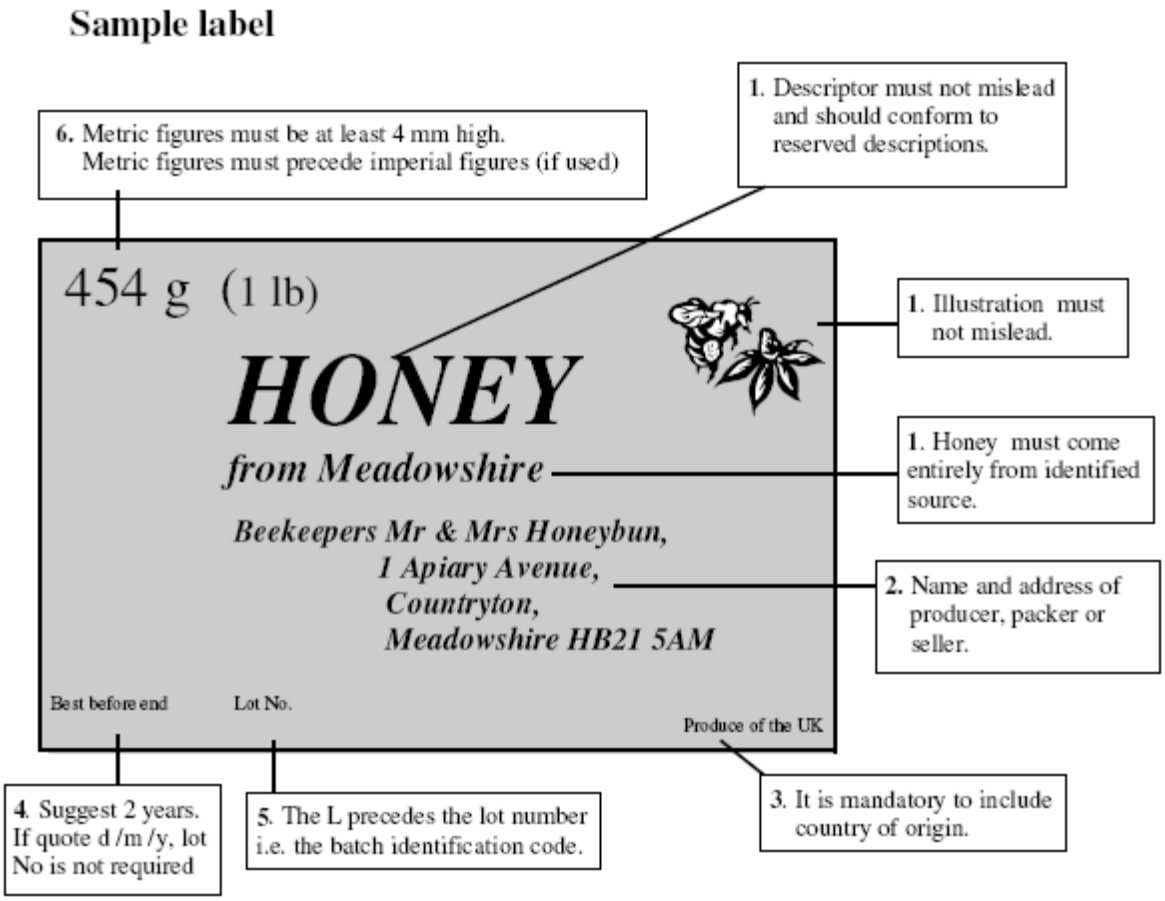
- Honey (England) Regulation 2015
    - Defines descriptors, labelling requirements and composition of honey, see below

Weights and Measures Act 1985

- The Weights and Measures (Quantity Marking and Abbreviation of Units) Regulations 1987
    - Converted UK to metric system

- The Weights and Measures (Packaged Goods) Regulations 2006
    - Defines metric units, font size for weights, abbreviations and tolerances

- The Weights and Measures (Food) (Amendment) Regulations 2014
    - Honey should be sold by net weight, exception chunk and comb honey



Labelling

The label should indicate:

1. The description of the product,

2. The name and address of the producer (within the EU)

3. The country of origin

4. A ‘best before’ date

5. A lot mark

6. The weight

1. **Description of product.**

This must be one of the following reserved descriptions:

- Honey
- Comb honey
- Chunk honey
- Baker’s honey intended for cooking only
- The word ‘honey’ with any other true description, e.g. Honeydew honey, Pressed honey, Blossom honey
- The word 'honey' with a regional, topographical or territorial reference

If there is any reference to a particular plant or blossom (either pictures and words), the honey must have come wholly or mainly from that blossom or plant - i.e. the honey must be characterised by that blossom or plant. If reference is made to a geographical origin the honey must come wholly from that place.

Module 2 Honey Products and Forage

2. **Name and address of producer, importer, packer etc.**

Sufficient information is needed in order to trace the producer by an address within the EU.

3. **Country of origin.**

Honey must be labelled with the country/ies in which the honey was harvested. This may be a member state of the EU. If produced in England should be 'Product of the UK' must be IN ADDITION to the address. Also acceptable blend of EU honeys, blend of EU and non-EU honeys and blend of non-EU honeys.

4. "**Best before" date.**

Honey lasts for many years but an appropriate durability or "best before" date must be given. Two years is reasonable. If "best before" date specifies day, month and year a lot number is not required.

5. **Lot Number.**

A lot means a batch of sales units of food produced, manufactured or packaged under similar conditions. It enables problems to be traced.

The lot number is preceded by the letter **L** to distinguish it from other indicators. The number may be a short code comprising letters and/or numbers identifying the appropriate batch. It is prudent to have small lot sizes.

The beekeeper is required to keep a record of each batch with its provenance and destination and retain this for the shelf life plus 6 months.

Lot numbers and "Best before" date are not needed for direct sales at farmers markets or at the door.

6. The weight.

From April 2008, honey can be sold in any weight, (including the traditional UK ones). Imperial units can be added after the metric ones but must not be in larger type and there must be no other print between them.

The abbreviation for gram is g and for kilogram is kg. An s must not be added. There must be one type space between the numerical value and the unit or its abbreviation.

Printing of labels

Printing must be clearly legible and permanent. Labels should be fixed to the side of the container.

The lettering must be

- 3 mm high for weights between 50 and 200 g,
- 4 mm high for weights between 200 g and 1 kg
- 6 mm high for greater weights

Only the weight declarations have to be a certain size.

The criterion for the size of all the other statutory information is that it must be easy to understand, clearly legible, indelible, not interrupted by other written or pictorial matter and in a conspicuous place such as to be easily visible. The information given on the label must be true in every respect and in no way misleading.

Module 2 Honey Products and Forage

Legal descriptors

Reserved descriptions	***Specified honey product***
1a. blossom honey *or*} **1b.** nectar honey}	honey obtained from the nectar of plants
2. honeydew honey	honey obtained mainly from excretions of plant sucking insects (*Hemiptera*) on the living part of plants or secretions of living parts of plants
3. comb honey	honey stored by bees in the cells of freshly built broodless combs or thin comb foundation sheets made solely of beeswax and sold in sealed whole combs or sections of such combs
4a. chunk honey *or*} **4b.** cut comb in honey}	honey that contains one or more pieces of comb honey
5. drained honey	honey obtained by draining de-capped broodless combs
6. extracted honey	honey obtained by centrifuging de-capped broodless combs
7. pressed honey	honey obtained by pressing broodless combs with or without the application of moderate heat not exceeding 45°C
8. filtered honey	honey obtained by removing foreign inorganic or organic matters in such a way as to result in the significant removal of pollen
9. baker's honey	honey which is - (a) suitable for industrial uses or as an ingredient in other foodstuffs which are then processed; and (b) may - (i) have a foreign taste or odour, (ii) have begun to ferment or have fermented, or (iii) have been overheated

Note 1: The description "honey" may be used for specified honey products specified in column 2 of items 1a, 1b, 2, 5 and 6 of Schedule 1.
Note 2: Where the specified honey product specified in column 2 of item 9 is used as an ingredient in a compound foodstuff, the reserved description "honey" may be used in the product name of that compound foodstuff.
Note 3: Except in the case of products specified in column 2 of items 7 and 8 a specified honey product may additionally be described by –
(i) its floral or vegetable origin, if the product comes wholly or mainly from the indicated source and possesses the organoleptic, physico-chemical and microscopic characteristics of the source;
(ii) its regional, territorial or topographical origin, if the product comes entirely from the indicated source; and
(iii) its specific quality criteria.

Organoleptic properties are the aspects of food or other substances as experienced by the senses, including taste, sight, smell, and touch, in cases where dryness, moisture, and stale-fresh factors are to be considered.

Compositional Criteria

1. The honey consists essentially of different sugars, predominantly fructose and glucose, as well as other substances such as organic acids, enzymes and solid particles derived from honey collection.
2. The colour varies from nearly colourless to dark brown.
3. The consistency can be fluid, viscous or partly or entirely crystallised.
4. The flavour and aroma vary but are derived from the plant origin.
5. No food ingredient has been added, including any food additive.
6. No other additions have been made to the honey except for other honey.
7. It must, as far as possible, be free from organic or inorganic matters foreign to its composition.
8. It must not—
(a) have any foreign tastes or odours;
(b) have begun to ferment;
(c) have an artificially changed acidity;
(d) have been heated in such a way that the natural enzymes have been either destroyed or significantly inactivated.

9. Paragraph 8 does not apply to baker's honey.
10. No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.
11. Paragraph 10 does not apply to filtered honey.

Composition of Honey

1.	Sugar content		
1.1.	Fructose and glucose content (sum of both)	blossom honey	not less than 60g/100g
		honeydew honey, blends of honeydew honey with blossom honey	not less than 45g/100g
1.2.	Sucrose content (*Borago officinalis*)	in general	not more than 5g/100g
		false acacia (*Robinia pseudoacacia*), alfalfa (*Medicago sativa*), Menzies Banksia (*Banksia menziesii*), French honeysuckle (*Hedysarum*), red gum (*Eucalyptus camaldulensis*), leatherwood (*Eucryphia lucida, Eucryphia milliganii*), *Citrus* spp.	not more than 10g/100g
		lavender (*Lavandula* spp.), borage	not more than 15g/100g
2.	Moisture content	in general	not more than 20%
		heather (*Calluna*) and baker's honey in general	not more than 23%
		baker's honey from heather (*Calluna*)	not more than 25%
3.	Water-insoluble content	in general	not more than 0.1g/100g
		pressed honey	not more than 0.5g/100g
4.	Electrical conductivity	honey not listed below and blends of these honeys	not more than 0.8 mS/cm
		honeydew	not less than 0.8 mS/cm
		strawberry tree (*Arbutus unedo*), bell heather (*Erica*), eucalyptus, lime (*Tilia* spp.), ling heather (*Calluna vulgaris*), manuka or jelly bush (*Leptospermum*), tea tree (*Melaleuca* spp.)	not less than 0.8 mS/cm
		chestnut honey	not less than 0.8 mS/cm
		blends of chestnut honey except blends of that honey with bell heather (Erica) honey, eucalyptus honey, lime (Tilia spp.) honey, ling heather (Calluna vulgaris) honey, manuka or jelly bush (Leptospermum) honey, strawberry tree (Arbutus unedo) honey and tea tree (Melaleuca spp.) honey	not less than 0.8 mS/cm
5.	Free acid	in general	not more than 50 milli-equivalents acid per 1000g
		baker's honey	not more than 80 milli-equivalents acid per 1000g
6.	Diastase activity and hydroxymethylfurfural (HMF) content determined after processing and blending		
	(a) Diastase activity (Schade scale)	in general, except baker's honey	not less than 8
		honeys with low natural enzyme content (e.g. citrus honeys) and an HMF content of not more than 15 mg/kg	not less than 3
	(b) HMF	in general, except baker's honey	not more than 40 mg/kg (subject to the provisions of (a), second indent)
		honeys of declared origin from regions with tropical climate and blends of these honeys	not more than 80 mg/kg

Note 1: When placed on the market as honey or used in any product intended for human consumption, honey must not:

(a) except in the case of baker's honey, have any foreign tastes or odours, have begun to ferment or have fermented, or have been heated in such a way that the natural enzymes have been either destroyed or significantly inactivated.
(b) have an artificially changed acidity.

Module 2 Honey Products and Forage

Note 2: No pollen or constituent particular to honey may be removed except where this is unavoidable in the removal of foreign inorganic or organic matter.

Module 2 Honey Products and Forage

2.2 the methods used to uncap honeycombs, and of separating the cappings from honey;

There are 4 main methods of uncapping honeycombs:

1. **Uncapping knife**

- Hold the frame vertically with one lug resting on a bar over a collecting tank
- Warm the knife by dipping it in hot water and then dry it to prevent excess water from diluting the honey
- Remove the cappings by sliding the knife upwards underneath the cappings
- Tilt the frame slightly towards the knife so that the cappings fall away from the frame into the collecting tank
- For larger numbers of frames, use electrically or steam-heated knifes

Advantages	Disadvantages
Quick	Lot of waste if frames not drawn out evenly
Easy to use	Risk of operator cutting himself if used carelessly
Clean – very little mess with drawn combs	

2. **Uncapping fork**

- Hold the frame horizontally over a tray and lift the cappings by sliding the uncapping fork beneath them
- Scrape the cappings off the fork on to the side of the tray
- Scratch the top off cappings that are difficult to get at using the prongs

Advantages	Disadvantages
Easy to use	Slow
Works well with frames that have been drawn out unevenly	More messy
	Sharp prongs can cause injury

3. **Hot Air Blower**

- Hold the frame vertically over a tray and melt the cappings using air from a hot air gun or similar

Advantages	Disadvantages
Very little waste	Slower than knife
Single operation, honey does not need to be separated from cappings	Messy, causes spluttering
	Requires great care to avoid charring the honey
Quicker than fork	Difficult to keep blower clean
	Risk of burning hand holding the frame
	Does not yield any cappings wax which is the best quality for showing and wax products

4. **Flailing**

- Industrial method used to process hundreds of frames
- Equipment consists of a tank with two sets of rotating brushes at the top
- The frame is plunged into the tank between the brushes and immediately withdrawn
- Brushes remove the cappings which fall into the tank

- Another variant of this method employs a single oscillating blade and uncaps one side at a time

Advantages	Disadvantages
Very quick to use	Costly equipment
Consistent uncapping method across frames	Suitable only for large volumes/industrial applications

5. Uncapping Roller (additional)

- Roll the roller over the comb. The sharp spikes pierce the cappings but do not remove them. Most of the wax stays in place until extraction.

Advantages	Disadvantages
Simple	Difficult to pierce cappings on uneven frame
Clean	More wax will end up the honey at extraction time

Separating the cappings from the honey

1. Straining

- Place the wet cappings in a course sieve or muslin bag and allow them to drain for 24 hours
- Filter the honey recovered before adding it to the honey tank
- Residual honey in the cappings can be cleaned up by feeding the cappings back to bees – in the hive that provided the honey. Put the cappings in a rapid feeder with the cover removed or spread them over the cover board.

Advantages	Disadvantages
Does not require heating or special equipment	Slow
Produces better quality wax	Laborious if there are a lot of cappings to process

2. Melting

- Melt the cappings on a heat tray and drain the liquid off through a grid to catch any solid matter
- Leave the resulting liquid to cool; the wax solidifies on the top
- Filter the honey before adding it to the honey tank

Advantages	Disadvantages
Quicker than filtering	Requires heating which can degrade the honey
	Cleaning the uncapping tray can be difficult

3. Centrifuge

- For small quantities, hang cappings in straining cloth securely in extractor and rotate
- For large quantities, employ centrifuge
- Strain honey before adding it to the honey tank

Advantages	Disadvantage
Quick	Costly if employing centrifuge
Efficient recovery of wax and honey	Can be fiddly to set up in extractor, need to ensure secure and in plane of rotation in order to minimise wobble on unit

Module 2 Honey Products and Forage

2.3 the types of honey extractor available and their use in the extraction of honey including ling heather honey from combs;

CENTRIFUGAL EXTRACTORS

The principle of the centrifugal extractor is that the uncapped frame is mechanically rotated, in effect throwing the honey out.

There are two main varieties of centrifugal extractor; tangential and radial.

In both tangential and radial extractors, it should be noted that there is no significance in the direction of rotation. Two-way rotation is not necessary though some electric radial machines have a fast reverse phase to remove a little more of the honey in the base of the cells and "dry" the combs.

Tangential

In a tangential machine the frames lie almost against the barrel of the drum. The outer side of the frame is the one that empties when spinning.

The machine is evenly loaded and spun until perhaps half the outer side is extracted. Flecks of honey will be seen flying from the frame and striking the barrel.

The frames are then turned round so that the other face of the comb is facing outwards, and the machine spun until this side is completely empty. The frame is turned for one last time and the last of the honey removed.

This routine prevents combs breaking as the full, inner side bursts through the empty outer side. Each frame has to be handled four times, i.e. load, turn, turn, unload and the machine has to be started and stopped three times.

The amount of handling and time taken are a disadvantage. On the other hand, extraction can be more thorough than in alternative machines.

lt is also the most compact extractor available, consequently cheaper, and if heather honey is expected, this is the only type to cope with it.

Summary of benefits:

Advantages	Disadvantages
Useful for small number of frames	Limited number of frames (about 6)
Economical on space	Unwired combs can break under force
Value for money	Time consuming

Radial

In a radial machine, the frames sit between inner and outer rings, arranged like the spokes of a wheel with their top and bottom bars parallel to the wall of the drum.

A radial extractor extracts honey from both sides simultaneously, so there is no need to juggle the frames once they have been loaded.

Radial machines tend to be larger then tangential machines, to ensure that frames are far enough from the centre for centrifugal force to be powerful enough drive the honey out.

For a given size, though, they can hold many more frames than a tangential, e.g. a 20-frame radial will take only 8 frames tangentially. Most radial machines can have tangential screens fitted to convert them, in order to be able to handle deep frames, or extract heather honey.

Summary of benefits:

Advantages	Disadvantages
Faster, no need to turn frames	Less efficient in amount of honey extracted per rotation
Frames less likely to break	
More frames can be processed at one time	

MANUAL OR ELECTRIC?

Module 2 Honey Products and Forage

For two or three hives, it is usual to have a manual extractor. With more than twenty hives, manual extraction becomes very tedious and tiring. In between the choice depends on the beekeeper's pocket, stamina and outlook.

Besides the saving in labour, an electric extractor reduces the time taken, as other jobs can be carried out while the extractor is running. Normally, a complete complement of frames would be uncapped while the previous load is spinning.

General Points

- Either model is made of stainless steel or food quality polythene
- Load frames so that there is an equal balance of weight in order to avoid extractor wobble
- If using Manley frames consider the handling of the wider side bars

HEATHER HONEY

Heather (*Calluna Vulgaris*) honey is thixotropic, which means that it becomes temporarily fluid when shaken or stirred but a gel again when left standing.

When a gel it cannot be extracted by centrifugal force. Means of extraction are:

Pressing

- Place frameless combs in a strong straining bag
- Press combs with device similar to apple press or between two pieces of hinged wood (Peebles Press)

Scraping using a Smiths Cutter

- Scrape comb back to septum, place it in a straining bag and then either spin it in an extractor or press it as above
- Insert the tensioned wire into the honeycomb at one end of the frame and draw downwards, then reverse the tool and scrape the comb/honey off.

Perforextractor

- This is a large roller shaped like a rolling pin with needles that perforate the cells after uncapping and agitate the contents rendering them liquid. The honey is then extracted in a tangential extractor
- Hand-held tool with spring-loaded nylon needles that is used to agitate the heather comb on the same principle as the Perforextractor.

Other points

- Bell Heather (*Erica Cincera*) is not thixotropic and may be extracted as for Blossom Honey
- Heather honey has a higher water content (up to 23%) and is more prone to fermentation
- Supers containing heather honey should be stored in a warm place to aid extraction

Module 2 Honey Products and Forage

2.4 the straining and settling of honey after extraction;

Quote from Hooper

> The beekeeper with a very small number of colonies may let his honey settle in the bottom of the extractor in a warm room, leave it overnight, and then run it off directly into containers for use.
>
> The beekeeper with a larger amount of honey to deal with, and particularly one who is going to sell a proportion of his honey, should pass it through a separate tank. This can be a tank of any type, made of tin plate, stainless steel or plastic. The honey can be run out of the extractor into the tank through a tap strainer which will take out most of the bits and pieces. The tin of honey is warmed quickly to about 35°C and the honey is then poured through a cloth strainer in the honey tank. The straining cloth should be about 54 mesh to 1 inch (nylon double strainers 1.5mm for course and .5mm mesh for fine) and nylon is quicker than cotton. The cloth should be allowed to be low in the tank so that the honey can fill up the area around it quickly and so reduce the amount of air incorporated in the honey as it drips from the underside of the cloth.
>
> This sort of straining is efficient when there is no crystallization of honey in the combs. Some Crystallisation can escape notice, and it does not necessarily prevent the honey being spun from the combs, but it will clog the cloths very quickly and straining then becomes far too difficult and time consuming a labour. There are two ways getting over this problem; the honey can be heated sufficiently to get rid of the incipient crystallization or it can be left unstrained and a settling method be used to remove the bits of wax and bee. I would recommend the latter method as being the best for the conservation of the aroma and flavour of the honey.
>
> If you wish to heat the tank, it can be wound around with a flexible heating element such as is found in electric blankets or bought as pipe lagging cable. By experimentation the amount of heat applied to the tank can be adjusted at about 32-33° for about a day to clear the honey. If the honey is left for a further couple of days, and the top froth is carefully skimmed off, the honey is beautifully clean and ready for packing.

Course Filtering: Drain the honey in the extractor off through a double sieve (1,500-2,000 microns) which will remove gross impurities such as bits of bee wings, twigs, leaves, etc.

At this stage the honey is sufficiently pure to be eaten though not good enough to offer for sale.

Second Filtering: Through nylon mesh, mutton cloth or similar material (500 microns) into a container such as a settling tank (honey ripener). Fix straining cloth over container, make a depression in it and pour honey in. Honey needs to be warm to go through cloth and may need to be pumped through. This will produce honey suitable for exhibition.

Ripening Honey should now be left in a warm room for at least 24 hours to allow air to rise to the surface, before being put into jars.

Module 2 Honey Products and Forage

2.5 the storage of honey including the underlying principles of storage;

If the honey has water content >17% and is stored between 10°C and 27°C the yeast will ferment spoiling the flavour and aroma of the honey.

Honey is hygroscopic so will absorb water from a humid atmosphere; at 65% relative humidity honey has a water content of 20.9%w/w

Store honey in air-tight containers at <10°C and at a humidity of less than 65%.

To understand the principles of storage first look at the constituent features of honey:

Constituent	Amount as % of whole
Water	17-19
Fructose (monosaccharides)	38-40
Glucose (monosaccharides)	31-35
Sucrose (disaccharides)	1-3
Other sugars (primarily maltose)	8
Total acids (hydrogen peroxide, gluconic acid)*	0.5
Ash	0.09-0.33
Nitrogen	0.04-0.05
Average pH	3.9
Average diastase	20.8

*Bees add Glucose oxidase to nectar; it produces Hydrogen Peroxide and Gluconic Acid

Things you need to be aware of when storing honey

Feature	Value	Comment
Granulation	>30°C none <10°C slow	Stops altogether below 4.5°C
	Glucose/Water ratio	The higher the ratio the quicker the granulation
	Glucose/Fructose ratio	The higher the ratio the quicker the granulation (Rape honey has a high glucose content)
	Viscosity	Viscosity inhibits granulation, as crystals cannot move easily
	Nuclei promote granulation	Crystals form around impurities
	Stirring	Speeds granulation up
	Speed	Faster granulation smaller crystals and smoother honey
Fermentation	18°-21°	Best temperature for high yeast activity
	Water content	<17% no fermentation >19% high chance
	Temperature	<13°C Honey will not ferment
	Flash heat 71°C	Pasteurises honey kills osmophilic yeasts
	Granulation	Causes water concentration between crystals

Osmomphilic means living or thriving in a medium of high osmotic pressure, such as a solution containing lots of sugars (maple syrup as well as honey).

Store honey in crystallised form in large containers before putting it in jars. For rapid crystallisation into smooth, non-gritty crystals, store it at 14°C (16-18°C according to Hooper).

Thereafter store it in a cool place to prevent fermentation.

Cool storage also maintains Diastase and HMF levels.

Remove impurities before storage or after 24 hours by skimming surface of honey.

Module 2 Honey Products and Forage

2.6 the preparation and bottling of liquid honey, including ling heather honey;

Assuming that the honey had been stored in a crystallised state, the process is:

- Scrape top of honey to remove alien materials
- Heat to 50°C until liquid and clear
    - (This can take from 1 to 3 days depending on the amount and type of honey)
    - For Ling honey heat to 40°C and stir
- Strain through a fine filter (0.5mm mesh)
- Leave to settle, to remove air bubbles and allow remaining alien material to rise to surface
    - (This can take from 1 to 2 days)
- Clean surface with cling film, to remove remaining alien material
- Clean and dry jars and lids
- Bottle into pre-warmed jars
- Heat to 60-62°C for ¾ to 1 hour in water bath after securing lids to remove final crystals and pasteurise

Heat honey for the minimum time in order to preserve the enzymes and Diastase and HMF levels.

In commercial production the honey is heated quickly to 72°C to pasteurise it and remove remaining crystals, and then rapidly cooled to preserve the enzymes and Diastase and HMF levels

Module 2 Honey Products and Forage

2.7 the preparation and bottling of naturally granulated, soft set and seeded honey;

Assuming that the honey has been stored in a crystallised state, the process is:

- Scrape top of honey to remove alien materials
- Heat to 32-35°C to turn the honey into a state where it can be poured
- Leave to settle, to remove air bubbles and allow alien materials to rise to surface
- Clean surface with cling film, to remove alien material
- Clean and Dry jars and lids
- Bottle into pre warmed jars
- Store at 14°C to encourage fine crystal granulation

If the honey does not set to the crystallised state that the beekeepers wishes it can be brought to the liquefied state as above (52°C) and jarred but not pasteurised.

Soft Set honey should be smooth and spread like butter, but when a section is taken from a jar the cut shape should remain firm.

To create **Soft Set** honey, follow the instructions above with the following adaptions:

warm to 32-35°C and stir without breaking the surface and thereby introducing air bubbles

Allow to settle and then jar.

If the crystals are still not to liking of the beekeeper, the honey can be **Seeded:**

First liquefy the honey by heating to 50°C

Heat honey from a source with appropriate crystallisation to 35°C and blend it with the liquefied honey.

The honey used for **seeding** is usually 5-10% of the total weight.

Module 2 Honey Products and Forage

2.8 the preparation of section, cut-comb and chunk honey for sale;

Some overriding rules for the production of section, cut-comb or chunk honey:

- Need strong colony in good flow period
- Use second super, first super is prone to having cells with pollen
- Use un-wired frames, starter strips or wax paint to upper inner surface of frame

Cut-comb

- When comb is fully sealed, remove it from the hive
- There should be no evidence of granulation, fermentation, propolis, Braula or wax moth
- Cut the comb out completely around the wooden frame timber
- Cut comb with sharp knife or shaped cutter
- Lay it on its side on a draining surface over a tray, e.g. a Waldron Queen Excluder (wooden framed excluder)
- Leave the combs on a grid to allow loose honey to drain off and edges to crystallise
- Store in fridge/freezer at <4°C
- The usual container is 8oz/227g,
- Standard labelling rules apply

Chunk Comb

- Preparation as for cut-comb
- Place neatly cut slabs of honey comb in cleaned and dried jars
- Fill jar with cooled liquefied honey prepared as per section 2.7
- The comb should have all the qualities of cut-comb and the liquefied honey should be of the same colour and flavour as the comb honey
- Standard labelling rules apply

Section

- There are two types of section
    - Standard Basswood, with three split sides
    - Round plastic type, which bees seem to prefer because there are no corners to fill and the queen will rarely lay in them
- to prepare square sections (Basswood)
    - warm them prior to painting the inside of the section with molten wax excluding the corners
    - to prevent sagging, using only a thin strip of foundation standing only ¼inch (6mm) proud of the section; insert it with points of the hexagons towards the top
- After carefully removing complete sections, scrape burr comb and propolis off
- Store upright in tins at <4°C
- Prepare rounds in accordance with manufacturer's instructions
- Good sections should weigh about 16oz (454g), have good even cappings with no weeping or granulation and no evidence of Braula or Wax Moth

Module 2 Honey Products and Forage

2.9 the constituents expressed in percentage terms of a typical sample of United Kingdom honey and an outline of the normal range of variation of its main constituents;

Constituent	Typical Amount	Range
Carbohydrate	80%	78 - 86%
Water	17.5%	13 - 23%
Acids	0.5%	0.2 – 1%
Nitrogen	0.04%	0 – 0.13%
Ash	0.2%	0.02 – 1.03%
Enzymes	Not Stated	
Flavour and aroma constituents	Not Stated	
Breakdown Products	Not Stated	

Carbohydrates (sugars):

Taken together, sugars make up between 95 and 99% of the solids in honey.

They can be classified by their chemical complexity into four classes:

Monosaccharides	Fructose and Glucose, in ratio 6:5 except in Rape honey	68 - 72%
Disaccharides	Sucrose 1-3% and Maltose ~7%	8 – 10%
Trisaccharides	15 identified most important Melizitose	1 – 5%
Higher Sugars	A least 2 identified; contain 4 and 5 sugar molecules	< 1%

Acids

Although acids comprise only about 0.5% of honey they have important effects:

- Reduce pH to 3.9
- Contribute to the stability of honey against micro organisms
- Contribute to the flavour of the honey

The main acid is gluconic acid, which is formed by the action of the enzyme glucose oxidase on glucose. The reaction also produces hydrogen peroxide which is not sufficiently stable to remain for any length of time.

19 other acids have been identified, among which are formic acid, acetic acid, citric acid, lactic acid and oxalic acid.

Nitrogen

40 – 65% of nitrogen is in the form of proteins but there are some free amino acids. The proteins originate from pollen and from enzymes and other proteins introduced by the bees themselves.

The presence of proteins lowers the surface tension of honey and causes it to foam and produce scum.

The higher concentrations found in ling heather and manuka honeys produce thixotropic effects.

Free amino acids react slowly with sugars at room temperature, more quickly at higher temperatures. This is thought to cause honey to darken on storage or when heated.

Ash

Ash is material left over when honey is heated to a high temperature and is caused by the presence of minerals. Potassium is usually the largest component but there are very many more.

Module 2 Honey Products and Forage

Enzymes

Invertase (sucrose)	Used by the bees to break sucrose down into glucose and fructose. Some enzyme activity remains in the honey. The reaction is reversible, i.e. invertase can cause glucose and fructose to recombine into sucrose. This may be the reason why all honeys contain a small amount of sucrose.
Glucose oxidase	Breaks glucose down into gluconic acid and hydrogen peroxide and is one of the major factors responsible for the antibacterial properties of honey.
Diastase (amylase)	Breaks starch down to simpler compounds. Its exact function in honey is unknown but bees use the enzyme to break pollen down.

Enzymes start to break down at temperatures above 45°C

Flavour and aroma constituents

Many chemical compounds have been identified which are present in very small quantities but are responsible for giving honey its individual character. They mainly fall into 4 classes of chemical:

- Alcohols
- Aldehydes and ketones
- Acids
- Esters

The more volatile chemicals are lost quite quickly once the honey is removed from the hive and this is the main reason why the flavour of honey tends to decline as it ages.

Breakdown products

The chemical composition of honey slowly changes over time. These changes are accelerated by heating.

The most important breakdown product is hydroxymethylfurfural – HMF (formerly known as hydroxymethylfurfuraldehyde). Allowable limits in honey are 40 ppm (40 mg/kg).

Other breakdown products cause honey to darken slowly.

Module 2 Honey Products and Forage

2.10 methods of determining the moisture content of honey;

1. Is it capped? Bees cap honey when its water content <20%
2. Shake a frame of uncapped or partly capped honey over the hive
3. Measure with a honey refractometer
4. Measure with a hydrometer

If honey comb (of non-heather honey) is sealed the water content is within the range 17-20%.

1. Shake Test

To check whether the water content of honey is low enough for harvesting, shake an inverted frame of partly capped honey over the hive.

As a rule of thumb; if you can't shake any nectar out then the honey is ripe enough to harvest.

If you intend to harvest a significant quantity of uncapped honey (e.g. when harvesting oil seed rape honey) then use a more accurate method of measurement on a sample of the complete batch.

Advantage	Disadvantage
Easy field test at the hive	Not very accurate, indication only
Gives reasonable indication of readiness for extraction	

2. Honey Refractometer

The Honey Refractometer is the most common means of determining the water content of honey accurately.

It is usually a hand-held device.

To use it

- Smear a small sample of honey on the test window and hold the refractometer up to the light.
- Take the reading through the eyepiece; it is given directly as percentage water content.

Precautions

- Instrument must be calibrated (read instructions)
- Readings depend on temperature, so calibrate at ambient temperature or use device with automatic temperature compensation
- Honey must be well mixed before the sample is extracted for measurement.
  Honey at the top of a large container can contain more water than that beneath.
- Honey must be clear and not part granulated.

Advantages	Disadvantages
Easy to use	Cost of purchase
Accurate	
Small sample required	

Module 2 Honey Products and Forage

3 Hydrometer (Specific Gravity)

Not commonly used for honey measurement. Use for honey requires a hydrometer with a suitable scale.

Precautions:

Honey temperature must correspond to calibration temperature of hydrometer (or correction made to measurement)

Advantages	Disadvantages
Measurement could be performed in main storage container (provided scale is visible)	Large sample required
No calibration required	Honey must be well mixed, clear with no granulation, and free of debris
	Not easy to get an accurate reading - need to use look-up table

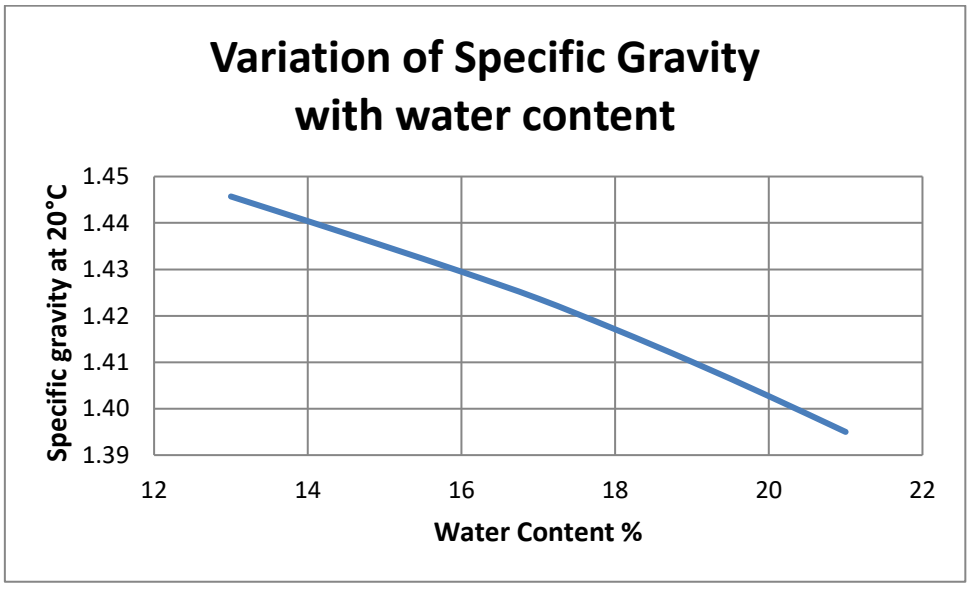
Other related physical Characteristics of Honey:

Density

Another physical characteristic of practical importance is density. It is convenient to express density as Specific Gravity (a.k.a. Relative Density).

The Specific Gravity of a liquid is a dimensionless unit defined as the ratio of density of the liquid to the density of water at a specified temperature. As the basis it is common to use the density of water at 4^oC, the temperature at which it has its highest density ($1000\ kg/m^3$).

The Specific Gravity of honey depends on its water content.



As a result of this effect honey in large storage tanks sometimes stratifies into layers; honey with a high water content settles above honey with a lower water content.

Thorough mixing overcomes such inconvenient separation.

Hygroscopicity

Hygroscopicity means being hygroscopic, absorbing or attracting moisture from the air.

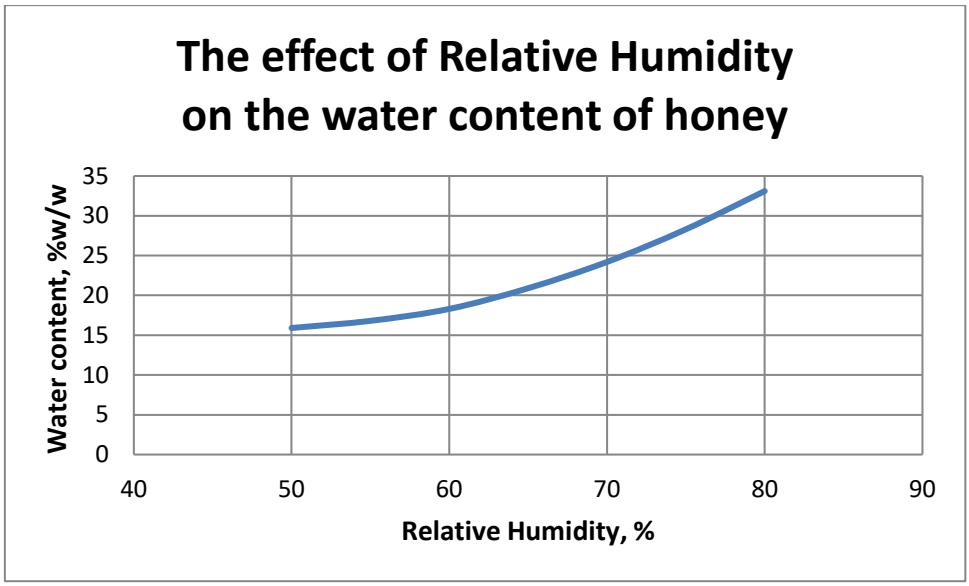
The strongly hygroscopic character of honey is important both in processing and final use.

The tendency to absorb and hold moisture is often desired in end-products containing honey such as

pastry and bread.

During processing or storage however, the same hygroscopicity can cause problems; excessive water content makes preservation and storage difficult.

Normal honey with a water content of 18.3% or less will absorb moisture from the air at a relative humidity above 60%.



Module 2 Honey Products and Forage

2.11 the spoilage of honey particularly by fermentation (including the effect of water content, storage temperature and the presence of yeast);

Spoilage from honey can be through:

- Overheating: prolonged exposure to heat causes enzymes to decay and HMF to form, affecting colour (darkens), aroma and flavour (too much heat gives a toffee flavour)
- Feeding bees foreign substances, e.g. honey not from apiary
- Residues of chemical applications, e.g. supers not removed during application of Apiguard
- Fermentation
- Precautions not taken during storage

Spoilage from fermentation requires one or more of the following conditions:

- The presence of osmophilic yeasts in sufficient quantities in the honey
- Adequate warmth for yeast growth and reproduction
- Sufficiently high water content for yeast to grow

Yeasts are everywhere where honey is, it is impossible to remove them but pasteurisation kills them.

Commercially: raise the temperature to 71°C then cool rapidly,

Non-commercially: raise the temperature to 60° for one hour

Ideal temperature range for yeast growth is 18-21°C although there will be some growth below this range.

Honey will not ferment if its water content is less than 17%; at a water content above 19% honey will eventually ferment under the above conditions.

Fermentation

Yeasts are unicellular organisms that use sugars as a source of energy for growth and cell division.

They break sugars down into alcohol and carbon dioxide

$$C_6H_{12}O_6 \rightarrow 2C_2H_6O + 2CO_2$$

Osmophilic yeasts are those in saturated sugar solutions.

Yeasts are found in the environment in:

- Bodies of bees
- Hives and equipment
- Soil
- Nectar
- Honeydew
- Air

For fermentation to occur ALL of the following are required:

- Osmophilic yeasts
- Temperature 18 – 20 °C
- Water content > 17%

Prevention of fermentation

- Kill the yeasts – honey (heat to 60°C for one hour and cool rapidly)
- Store at temperature below 13°C
- Ensure moisture content < 17%

Hooper describes three types of fermentation and how to treat them

Symptoms	**Treatment**
Wet, dilute layer on surface, smell	Skim layer off and use rest of honey normally
Dry lumpy surface, smell	Skim layer off and use rest of honey normally
Nothing visible but smells when disturbed	Heat to 94°C and feed to bees of same colony/apiary

Module 2 Honey Products and Forage

Honeydew Honey

Does not ferment but the presence of fungus spoils it

Symptoms	Treatment
Frothy surface and smell of stored apples	Skim affected layer off and use rest.

Deterioration during storage

If stored at high temperature and in contact with ferrous metals, honey can deteriorate through chemical reaction.

If stored in air of relative humidity >60%, honey can absorb water from the air; rising water content enables fermentation.

Storing at a temperature of 21-27°C will prevent granulation and deterioration but destroy enzymes and raise levels of HMF

Contamination by foreign materials: containers not sealed or equipment not properly cleaned.
Do not leave the lid off!!

Module 2 Honey Products and Forage

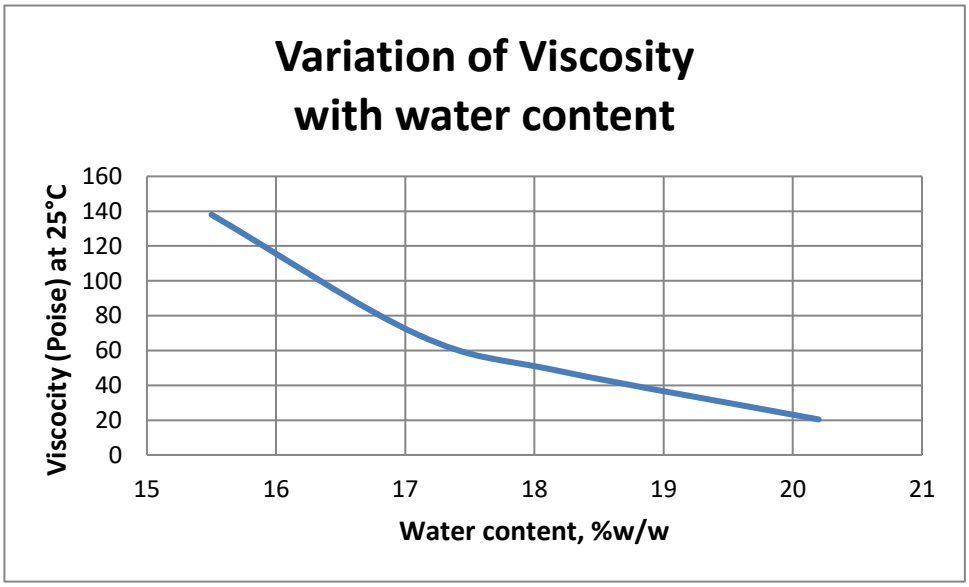
2.12 the physical properties of honey including relative density (specific gravity), refractive index, viscosity, hygroscopicity, reaction to heat and electrical conductivity;

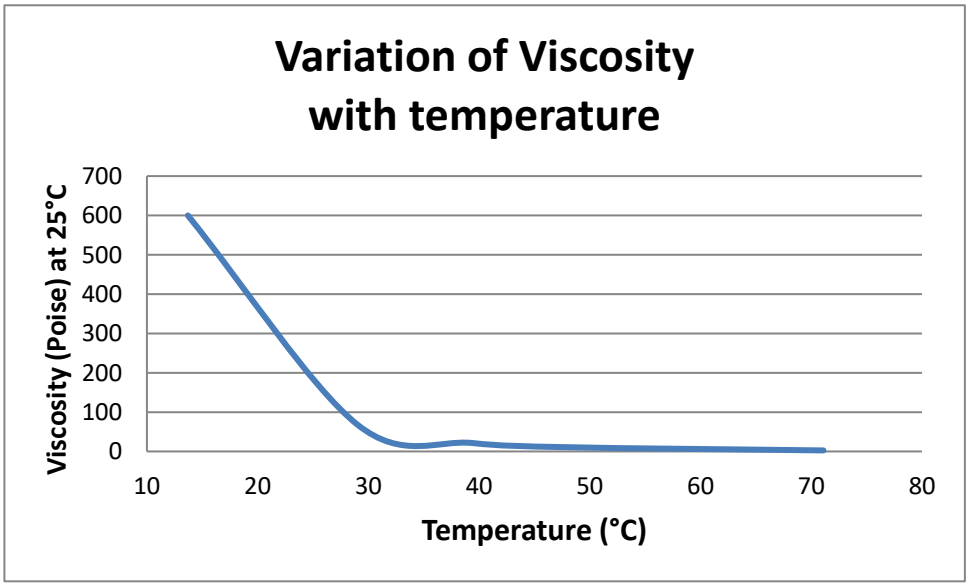
Physical properties of honey:

specific gravity	1.4 (density at 20° compared to water at 4°C)

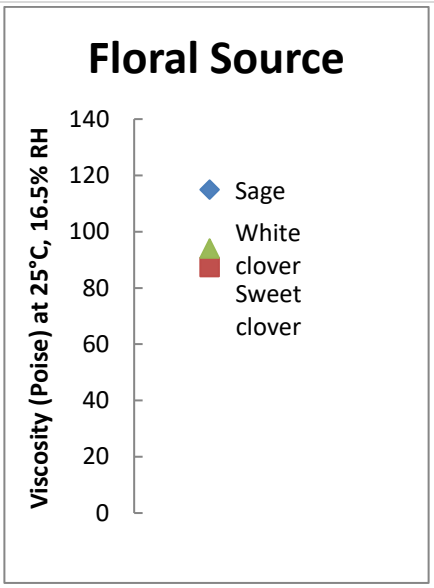
refractive index	Honey, 13% water content 1.504 Honey, 17% water content 1.494 Honey, 21% water content 1.484

viscosity	Viscosity depends on water content, temperature and floral source.





Module 2 Honey Products and Forage



hygroscopicity	Because it is a highly concentrated “sugar” solution rich in fructose, honey can absorb water readily under certain conditions.

reaction to heat	<13°C	honey will not ferment
	14°-18°C	honey will crystallise in best manner
	35°C	granulated honey becomes manageable
	54°C	honey liquefies
	60-70°C	honey pasteurises
	100°C	enzymes break down, honey purified of disease (except AFB) for feeding to same apiary

electrical conductivity	Conductivity is a good indicator of the botanical origin of honey. It is determined in routine honey control instead of the ash content. This measurement depends on the ash and acid content of honey; the higher their content, the higher the resulting conductivity. There is a linear relationship between the ash content and the electrical conductivity: **C = 0.14 + 1.74 A** where C is the electrical conductivity in milli Siemens cm^{-1} and A the ash content in g/100 g. The conductivity of Blossom honeys, mixtures of blossom and honeydew honeys should be less than 0.8 mS/cm. The conductivity of honeydew and chestnut honeys should be more than 0.8 mS/cm. Exceptions are *Arbutus, Banksia, Erica, Leptospermum, Melaleuca, Eucalyptus* and *Tilia* honeys as well as their blends, which have an extremely wide variation in conductivity.

Relative density

Relative Density is the same as specific gravity

The Specific Gravity of a liquid is a dimensionless unit defined as the ratio of density of the liquid to the density of water at a specified temperature. As the basis it is common to use the density of water at 4oC, the temperature at which it has its highest density (1000 kg/m3).

Module 2 Honey Products and Forage

Relative density varies with sugar content of the honey, so this property can be used to measure the sugar content.

It also varies with temperature, so it should be measured at a stated temperature.

Most conveniently measured using a hydrometer.

Refractive Index

Refractive index is calculated from the angle of refraction (bending) of light as it passes into a material, due to the difference in velocity of light in honey compared to air.

Easily measured with a refractometer.

Refractive Index should be measured at the stated temperature for the most accurate result.

Viscosity

A measure of resistance to flow. The more treacly, the higher the viscosity.

- Viscosity declines as temperature increases.
- Viscosity declines as water content increases

Viscosity measurement is not considered to be a satisfactory way to measure water content of honey accurately, but it is important in the handling of honey to understand the effect of temperature and water content on viscosity.

A simple method of measuring viscosity is to:

1. Drop a ball bearing into a jar of honey and time the fall between two points.
2. Calculate the viscosity from standard tables and formula.

The units of Viscosity are Poise.

Some honeys are thixotropic; their viscosity falls when they are stirred, but rises when they are allowed to stand. Heather and Manuka honey are two well known examples.

Hygroscopicity

Honey will absorb water from the air in a damp atmosphere (hygroscopicity)

Conversely, it will lose water in a dry atmosphere.

The property has implications for processing and storing.

Reaction to Heat

Heat is used in processing

- to make honey easier to strain
- to dissolve crystallised honey and reduce subsequent granulation, and
- to kill yeasts and thereby prevent fermentation.

Honey will degrade over time at elevated temperatures:

- HMF content rises
- Enzyme activity falls
- Volatile oils and hence aroma lost
- Colour darkens

60°C for 45 minutes used to retard crystallisation

60°C for two hours causes noticeable degradation.

70°C used momentarily for “pasteurisation” to reduce yeast content and retard fermentation

Module 2 Honey Products and Forage

Electrical conductivity

Conductivity is the ability to pass an electric current, usually measured in milli Siemens/cm.

It is a good indicator of the amount of free acids, proteins and mineral salts in honey.

It is widely used to distinguish between honeydew and blossom honeys and also to characterise unifloral honeys.

The conductivity of Blossom honeys should be less than 0.8 mS/cm whilst the conductivity of honeydew and chestnut honeys should be greater than 0.8 mS/cm. But there are exceptions.

The measurement of conductivity is easy, fast and instruments are inexpensive.

Electrical conductivity is directly related to Ash content and quicker method of determining Ash content.

Other physical properties of interest

Optical rotation, depends on the ratio of glucose to fructose and other sugars.

- Floral honeys often laevorotatory (rotates polarisation of light to the left),
- Honeydew is dextrorotatory (rotates polarisation of light to the right).

Colour, wide range of colour. For show grading glasses are used to establish the class.

Specific heat and thermal conductivity, useful to know when designing industrial processes.

Module 2 Honey Products and Forage

2.13 the main constituents and physical properties of beeswax;

As any product from the bees, the constituency of beeswax depends on where it comes from, the weather and the time of year.

The main constituent is myricyl palmitate, an ester, but there are many other ingredients.

The four main four ingredients and approximate percentages:

esters	70%
hydrocarbons	13%
acids	10%
alcohols	1%

Beeswax Physical Properties

Beeswax is a water-repellent substance of firm but plastic consistency with a low coefficient of friction.

It has a honey-like odour and a faint characteristic taste.

Solubility	Insoluble in water
	Slightly soluble in alcohol
	Soluble in chloroform, ether and benzene
Colour	It is colourless as individual flakes and white when solid
Temperature	Melts at 62 - 64ºC
	Pliable at 32 - 35ºC
	Flashpoint 242 - 250ºC
Relative Density	0.96
Acidity	20
Reactivity	Reacts with Alkalis (used to make soap) and hard water (calcium)
	Use soft water to cleanse

Module 2 Honey Products and Forage

2.14 methods of recovering saleable beeswax from used comb and cappings;

All wax rendering involves melting and straining beeswax. The heat may be applied either directly or by steam or solar energy.

Various grades of beeswax are obtainable.

The best quality comes from the cappings when extracting honey.

Brace comb from spaces in the hives are also of a good quality. This may contain a large percentage of propolis which cannot be removed and is only suitable for re-use as foundation, candles etc after rendering and cleaning. This is only usable for foundation exchange and candles as only commercial suppliers have the facilities to filter and clean efficiently.

The least valuable comes from old combs which is often contaminated with detritus and contains very little wax. Very old combs contain very little wax and it is usually pointless trying to extract wax from them. Good quality used combs may be selected for rendering.

Collection

1. From cappings at time of honey extraction
2. Brace comb at time of hive manipulation

Recovering beeswax from cappings

1. A de-capping tray with a sieve catches the cappings at extraction. The honey drips through the sieve into a tray and the remaining cappings are placed in a fine mesh basket or bag and spun in an extractor.

2. The cappings may be placed in an Ashforth-style feeder and the honey 'fed back' to the bees

3. Once honey has been removed, remove any discoloured pieces of wax.

4. Heat the wax to a temperature of no more than 90ºC and filter it first through lint/nappy liner and then through filter paper as a final cleaning process.

Recovering wax from old comb

The two methods available for the domestic beekeeper are –

1. Solar extractor

   This is a double box three to four feet long and two feet wide externally with an insulating material, preferably a fibre glass blanket, sandwiched between the two wooden skins. The box has a double glazed lid and internally a metal tray emptying into a metal removable container. The box is set at an angle of about 40 degrees from the horizontal and facing the sun. On a sunny day the temperature inside the box may reach 17-88°C and the wax which melts at about 62°C will be rendered down. The molten wax runs down the tray and into the receptacle below.

   A secondary cleaning may be employed by heating the wax in water and allowing the wax and rain water to separate on cooling down. The debris can be scraped off the bottom of the cake of wax when it solidifies

Advantages	Disadvantages
Economical	Messy – as in all methods of wax rendering
Easy to use - If the combs are placed in a muslin bag before being placed in the extractor the wax will be 'sieved' and all debris retained in the bag.	Honey will burn on very hot days affecting its quality.
Kills nosema spores and wax moth eggs and sterilizes the frames	

Module 2 Honey Products and Forage

Hot water and steam processing

1. Steam jacketed tray.

   This is a stainless steel shallow water bath containing an electric heating element covered by a slanted tray. The combs are placed on the tray and melt. The wax runs down the tray and through a metal mesh and out through a spout to be collected in a receptacle below.

2. Steam boiler

   This is a steel boiler with a mesh cage inside and a drain at the bottom for the wax. The combs are placed in the cage and water from the reservoir melts the comb. The melted beeswax rises to the top and is drained off through an outlet tube leaving the dross and dirty water behind.

3. Steam Jacketed Wax press

   The combs are placed in a canvas bags and then into a metal basket. Steam is fed into the drum from below and the wax melts and runs out through an outlet tube. Pressure is gradually applied through a press at the top of the drum extracting the remainder of the wax and leaving the dross behind in the canvas bags.

Advantages	Disadvantages
Efficient	The electrical power required makes this process expensive to use.

Historical note

In the past beekeepers would place old combs in a sack and boil them in rain water in a 50 gallon drum. The molten wax would rise to the surface and separate from the water.

Health and Safety

Remember that beeswax is highly inflammable. Use great caution when using domestic appliances to melt wax, particularly when using direct heat. A water-jacketed heater is far safer.

Cover all surfaces likely to come in contact with molten wax with aluminium foil to catch drips.

To avoid cross infection, incinerate infected combs and do not render them for further use.

Module 2 Honey Products and Forage

2.15 the range of uses for, and preparation of, beeswax;

Uses of Beeswax:

Cosmetics: Creams, Soaps, Lipstick, Mascara, Depilation etc.
Pharmaceutical: Creams, ointments, tablet coatings
Home: Polishes, candles, waterproofing (zips etc.)
Crafts: Encaustic and Batik work, waxing threads, woodworking, modelling, candles
Industrial: Casting (lost wax process) – no longer used
Beekeeping: Wax foundation, showing, trade for new foundation

Consider the application when selecting the Beeswax for use, specifically the colour. A golden yellow may be more suitable for candles - especially church candles, for example - rather than white. Wax recovered from brood can be very dark and may need to be mixed with lighter colours before use.

Preparation of Beeswax

Recovery

- Beeswax can be recovered from scraps of brace comb, the cappings from extracted comb or from old super/brood comb
- Brace comb and cappings can be simply melted down prior to filtering but old (brood) comb may need to be boiled or subjected to team to steam extraction to recover the wax due to absorbtion effect of old cocoons from hatched brood. Solar wax extractors are useful for brood and old super comb
- When using water to extract beeswax from old comb use soft water. Hard water causes saponification (the formation of soaps) which affects the quality and appearance of the wax.

Cleaning/Filtering

- First melt the beeswax, preferably using a double boiler.
- Do not overheat. Prolonged heating at high temperature darkens the wax and destroys aroma properties. Melting point is about 62-64ºC
- Iron or copper vessels discolour the wax; use stainless steel or enamelled pans
- To remove dirt and debris from beeswax:

1. Melt it and then leave it to cool, preferably in a tall thin mould. When it is cool, debris will have settled at the bottom of the block and can be sliced off.
2. Alternatively, filter the wax while molten – nappy liners work well for this.

Module 2 Honey Products and Forage

2.16 the uses of other bee products such as pollen, royal jelly, venom and propolis;

Pollen

Uses

- Food supplement for humans (bee bread)
- Cosmetic preparations
- As a marker for pollution
- Supplement for racehorses and racing pigeons
- To feed bees in pollen patties

Collection

Pollen stripping screen placed between entrance and brood box removes pollen from bees' legs; it falls through a separation screen on to a collection drawer.

The screen stops drones and queens exiting. It can be used all season on a strong and healthy colony.

Pollen must be collected, cleaned and frozen quickly.

Pollens differ by source

Bees treat pollens with nectar and gland secretions to press into corbiculae before returning to hive.

Royal Jelly

Uses

- Cosmetics
- Creams and ointments for healing burns
- Animal nutrition – race horses
- Food supplement

Produced in the hypopharyngeal and mandibular glands of nurse bees

- Contains:
    - 34% sugars, mainly glucose
    - Pantothenic acid, bioterin, plus a lot more

Collection

- Raise Queen cells
- At 4 days open cell and remove larva carefully
- Suck out jelly and refrigerate immediately
- Filter jelly and keep clean

Venom

Uses

- Bee venom therapy
- Arthritis
- Acute chronic lesions
- Scar tissue
- Desensitisation to bee stings

Module 2 Honey Products and Forage

Constituents

- Melittin (polypeptide) 50% dry weight of venom
    - Ruptures blood and mast cells (with release of histamine), depresses blood pressure and respiration
    - Anti-inflammatory, stimulates release of cortisol in body
- Phospholipase
    - Cell break-down, pain and is synergistic with melittin
- Hyaluronidase
    - Enzyme that breaks cell barriers down and allows other poisons to penetrate

Collection

Venom collected on membrane-covered glass plates. Electrical current at 11-14 volts pulsates through metal wires causing bees to sting through membrane.

Propolis

Uses

- Component of varnish
- Chewing gum
- Treatment of arthritis, asthma, bronchitis, psoriasis and eczema, mouth ulcers and gingivitis

Contains 30-50% resin, 30% wax, 10% essential oils, 5% pollen and 5% other organics and minerals

Collection

- Scraping – use a palette knife to scrape frames, walls, entrances and covers
- Traps - sheets of plastic material with holes in them under the cover board or on the sides of hive. Allow light through gap in roof
  When holes have been filled, place sheets in a freezer; granules, which are brittle, will drop off easily.

Module 2 Honey Products and Forage

2.17 the preparation of comb honey, soft set, naturally set and liquid honey, beeswax blocks, beeswax candles and meads for the show bench.

National Honey Show Rules for Comb Honey

Sections approximately 454g (1lb) must be enclosed in cardboard commercial sale section cases. Round sections must have clear covers on both sides.

Cut comb honey must be shown in standard white 227 g (8 oz) containers with transparent snap-on tops and must have a gross weight of between 200g and 255g (7-9oz).

The judge wants:-

- absence of pollen, propolis or other foreign bodies
- no crystallisation whatever
- no fermentation
- no Braula or wax moth markings
- uniformity of honey (combs often have two or more colours in them),
- good taste and scent.

The judge will use a strong torch so check with your own torch, shining it through the comb from behind.

Preparation of Cut Comb

Cut comb is produced from unwired, light, worker based foundation or "starters" ¾" (2cms.) depth in Manley frames.

When the comb is fully sealed, it is removed, cut out completely around the frame timber and laid on its side, on a Waldron queen excluder over a large tray. It is then cut into suitable pieces to fill the plastic container neatly in one piece. The usual container will hold 8ozs/227g of comb honey. Cutting may be done with a sharp pointed knife but preference is for a template obtainable from any bee supplier.

The cut comb sections must be left on a grid to allow any loose honey to drain off. Granulation around the edges of the cut comb will occur quite quickly so the producer should deliver in small lots to ensure a quality product.

Store at 4°C or less (freeze)

Look to ensure no pollen and the comb is not standing in honey as both a viewed badly by judge.

Preparation of Section Crates

There are two types of sections in use

a. the standard Basswood, with three split sides and
b. the round plastic type, which bees seem to prefer because there are no corners to fill and the queen will rarely lay in them

In preparing the square sections for show purposes, before assembly paint the inside of the section with a coat of molten bees' wax using a small paintbrush.

Warm the sections prior to painting with wax but do not paint the corner joints else when folding, the joints will crack. Always use fresh foundation. Bees often refuse to work stale material.

It is always advisable to use a special section-folding block to prevent breakages. When inserting the worker cell based foundation, ensure that the point of the arch of the cell is towards the top.

Also insert the foundation only to within ¼" (6mm) of the base of the section to prevent sagging. Dividers should always be used.

Module 2 Honey Products and Forage

- When they are fully sealed remove the crates very carefully using a clearer board with porter bee escapes.
- Use the minimum of smoke and take the crates indoors the following day.
- Remove any burr comb and store crates in a warm bee-proof room with layers of clean newspapers between them.
- Remove the sections from the crates very carefully to minimise damage.
- Scrape each section free of propolis and wax, including the edges of the timber or plastic.
- Store sections in sealed biscuit tins in a warm room, making sure that each section is placed upright as it was in the crate.

In general, sections should weigh about 16ozs. (454g), and have even cappings with no weeping or granulation. The wood or plastic must be absolutely clean. There must no evidence of Braula or wax moth damage.

When entered in a show, sections should be covered with cellophane wraps to protect against dust and insects. Never glaze sections in storage as contraction of the wrap may cause squeezing and resultant weeping in the sections.

Chunk Honey.

- Good chunk honey has:-
- half and half liquid to cut comb (the biggest bit of comb that will fit in the jar)
- same honey in comb as in liquid
- no crystallisation at all.
- no floating debris or bits of broken wax anywhere.
- very clean clear honey so the comb can bee seen well
- comb cut the right way up - it's a fault to put it in sideways or inverted.

Set honey

The judge will, obviously, test flavour and aroma. However, consistency and texture are important in this class. The honey should be stiff enough not to move when the jar is tilted, but easily spoonable. There should be no grittiness on the tongue. There should be no bubbles or scum on the surface, and of course no visible specks of dust etc. All set honeys are prone to fermentation but there should be no hint of this.

Seeding Honey

Take your bucket of coarsely crystallised honey and heat it to 43°C (112°F) slowly, over a couple of days, until it is liquid again. When it is clear allow it to cool to 18°C (64°F).

Then prepare a sample of fine-grained honey (about 10%). Heat it at about 21°C (70°F) until it has softened, then stir it with a wooden stick or paddle until it has the consistency of porridge. This is the 'seed'.

Pour the seed into the bucket of liquid honey, stirring to distribute the fine-grained honey evenly. Maintain an even but not too quick stirring motion until the seed is well distributed. Set aside for a few days to crystallise.

Heat the bucket of honey again, this time to about 30°C (86°F). When it has softened, stir it until it is again quite mobile, something like porridge. The honey is then ready for bottling.

When you have bottled the honey, put it in a cool place - 12°C (53°F) - for a few days, when it will set to a consistency of firm butter. This is 'set' or 'soft set' or 'creamed honey' and can be spread easily.

Module 2 Honey Products and Forage

Soft set honey does not have the same keeping qualities as naturally crystallised honey unless stored at a controlled temperature of around 12°C (53°F).

If your honey granulates naturally to a fine-grained texture then 'seeding' is unnecessary. To produce soft set honey from it, simply heat it to 30°C (86°F) until it has softened. Then stir it until it can be poured, then bottle.

The secret to a good sample of either natural crystallised or soft set honey is to prevent frosting. This ugly pattern forms on the inside of the jars, mainly under the shoulders of the jar. It is caused by air in the honey being squeezed out as the honey crystallises. It occurs more in naturally crystallised honey than in soft set honey

Honey should be prepared 7 days before a show. Scrape any impurities on top of honey off before showing.

Honey in Jars

Preparing liquid honey

- selection – choose the best for :- clarity, taste, scent, colour, and have enough for 3 jars minimum.
- grading – use a grading glass to be sure which class to enter. The two grading glasses show the boundaries between light and medium and between medium and dark.
- filtering can improve chances. There are many methods, but lint from filters can destroy your chances.
- jar selection. jars must be truly matching (same maker and type – look on the bottom), though the mould numbers on the bases no longer matter, and must be the correct type as specified in the schedule (usually standard 1lb squat with gold lacquered lids).
- lids – must be clean, rust free, honey free, matching. It's surprising how often this is badly done. Do not use second hand lids in a show (if ever). If it says gold lacquered don't use plastic lids!
- getting rid of incipient granulation is best done in bulk. Trying to improve just one jar is often very difficult. The effects of heating can change colour and taste. If you must, try a short time in a microwave rather than longer heating.
- pollen in honey is not a fault and can be a selling point in every day trade, but it can easily be mistaken for granulation by a judge so it's best to put in really clear looking jars for showing. Too much pollen downgrades your entry.
- removing specks: - using a tube or straw they can be sucked out, but it's better they were not there at all. Many specks come from putting perfect honey into dusty jars. It's easy to wash teacloths so use good ones and wipe all jars with care.
- bubble problems – filling with the jars pre-heated helps stop air sticking to the sides. Allowing time for bubbles to escape whilst in the settling tank is the best, so prepare in good time, let the honey settle and fill jars slowly. Bubbles under the shoulder of a jar can easily be dislodged using a clean bent wire, then skimmed off later.
- correct weights – weigh some test jars full and empty so that you know you are giving correct value. Many people fill to just below the "filling line" which gives short measure and eliminates them from the prize list. As a rough guide, no air space should be visible below the edge of the closed lid.

Natural Crystallisation

Hooper Method:

> To provide specimens for such use it is best to choose honey from Oil Seed Rape or Clover. Such honey should be thoroughly strained through nylon organza and allowed to settle in the tank for 48 hours in a warm room to allow air bubbles to reach the top. It is then run into jars and capped securely.

The jars are then placed on the ledge of a window facing North with a mirror placed behind the jars to reflect the light. Turn the jars every four or five days. Stir with a clean paddle occasionally to help form a fine grain and prevent 'frosting'. When granulation is complete, store the jars in a cool dry room until required.

Alternative Method:

Honey extracted, strained and stored in suitable containers that crystallises rapidly with a fine grain is ideal for use as granulation honey for market or the show bench.

In order to get the ideal product proceed as follows.

- Place the containers of selected naturally granulated honey in a thermostatically controlled heating cabinet at a setting of 32°C (90°F) until the honey nearest the sides of the container has been softened.
- Stir the contents with a strong wooden paddle to distribute the heat throughout the mass and obtain consistency. Continue heating and stirring gently and make sure the honey does not liquefy.
- When the honey reaches the consistency of porridge, while still warm pour it slowly into the warmed settling tank down along one side to avoid further air bubbles.
- Finally run it into warm jars straight away.
- Then allow the jars to cool slowly to minimise the risk of 'frosting'. Place them in a dark, cool spot at constant temperature. The ideal temperature for granulation is 14°C (57°F).

Beeswax blocks

Judging Criteria

One block of wax to be submitted

Weight: 200 – 255g (7-9oz)

Thickness: no less than 19 mm

Colour: Pale straw to light orange

Aroma: Pleasant wax aroma

Appearance: smooth, bright shiny surface, non-patterned, no air bubbles, cracks, particulate matter or other blemishes

Preparation:

- Select only cappings or light-coloured comb, avoid comb darkened by propolis or pollen
- Wash with soft cold water to remove residual honey and dry
- Melt in oven or water bath at less than 90°C
- 1st filter through lint, fluffy side up, into a container of clean soft water
- 2nd filter through filter paper supported on nylon stocking into dry container
- Select mould of oven-proof glass, free of internal blemishes and used only for wax
- Place 225g clean soft water into mould and mark level
- Wash and dry mould using unscented detergent
- Add 2-3 drops of water and 2-3 drops of unscented detergent and rub over the entire inside of the mould
- Heat the wax to 70°C ±1° and stand for 1 minute in a shallow tray of iced water to congeal any dirt that remains in the bottom

- Place the mould in a bowl of water at 66°C and pour in the molten wax avoiding any air bubbles
- Cover with a hot plate and allow to cool slowly
- When cold, immerse the mould in cold soft water and allow the wax to float out. If it does not float out add ice to the water
- Remove any flakes of wax around the edge and polish with clean lint soaked in methylated spirt
- Exhibit in a glazed case or other method as specified in the show

Beeswax candles

Judging criteria

- Two candles normally required, one will be lit by the judge
- **Quality of beeswax** must be as high as required for exhibition of wax blocks
- **Colour**: pale straw to light orange
- **Aroma**: pleasant wax aroma
- **Appearance**: smooth surface, clear and bright, no air bubbles, cracks, particulate matter or other blemishes
- Pairs must be a perfect match
- Wicks must be positioned centrally top and bottom
- Wicks must be of the correct size
- Candle must burn correctly without spluttering
- Must give good light
- There should be no join marks from the mould
- Candle should look good
- Candle must be displayed erect in secure holders
- A standard type of holder must be used if specified in the schedule

Preparation

- Prepare wax using steps 1 – 5 of the wax block preparation
- Select the correct diameter of wick for the size of candle
- Prime the wick by immersing in molten wax, temperature less than 90°C. Leave for one minute then remove and hold straight until wax solidifies

Moulding candles

Latex moulds

- The mould must be coated by a releasing agent of unscented washing up liquid or glycerol
- Pour in molten wax ensuring that the wick remains straight and there are no air bubbles
- Wait until wax has solidified but is still warm
- Remove the mould and allow to cool

Silicone rubber moulds

- No releasing agent required
- Ensure mould fits perfectly at the join otherwise a mark will be left
- Fill with molten wax ensuring that the wick remains straight and there are no air bubbles
- Allow to cool completely before removing the mould

Module 2 Honey Products and Forage

Solid moulds

- Use releasing agent as per latex mould
- Fill with wax and allow to cool thoroughly before removing from the mould

Dipped candles

- Repeatedly dip the wick into a pot of molten wax, temperature 70-80°C
- At intervals the candles should be rolled on a sheet of glass to keep them straight and round
- The drip that forms on the bottom must be cut off at intervals

All candles

- After moulding or dipping, the exposed wick should be dipped in molten wax
- The base of the candle should be trimmed to ensure it is smooth and flat

Mead

Judging Criteria

Presentation

Clear colourless round punted bottle, 750 ml capacity, rounded shoulders

No markings of any sort apart from show label

Cork stoppers with white plastic flanges

Bottle filled to within 10 mm of base of the cork

Colour

Light straw to dark amber

Clarity

Completely clear with no sediment visible

Aroma

Pleasant aroma

Taste

In accordance with the class rules *e.g.* sweet or dry

Borderline meads are subject to the opinion of the judge

Preparing for the show

- Unless there are specific classes for Melomel (mead + fruit juice) or Methyglin (mead + spices) the mead must not contain any additives apart from acids, nutrients and tannin.
- Rack until perfectly clear with nothing floating on the surface
- Twist the bottle rapidly, no specs must rise from the bottom
- Fill bottle to 10-12mm below the level of the cork.
- If cork rises, insert a fine thread along with the cork and withdraw slowly
- Wipe the bottle with methylated spirit and polish the surface

Module 2 Honey Products and Forage

The Candidate shall also be able to give:-

2.18 a list of 10 major nectar and/or pollen producing plants of the United Kingdom and their flowering periods together with a detailed knowledge of those in his/her own locality;

Local sources will depend on topography, soil type and land use. In the Chilterns, we have chalk and clay areas, wood and farmland with both pasture and arable use. Woodland, hedgerows and domestic gardens will give a reasonably consistent forage while farmland usage may change from year to year with cereals being sown instead of bee-friendly plants such as borage, oilseed rape and field beans.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
Snowdrop	P	P	P							
Crocus	P	P	P							
Hazel		P	P							
Bluebell		P	P	P						
Willow		P	P	P	P					
Apple, Pear, Plum			(N)P	(N)P						
Dandelion			NP	NP	NP					
Oil seed rape				NP	NP	NP	NP			
Hawthorn				P						
Cherry					NP					
Sycamore					NP					
Holly					N	N				
Birds-foot Trefoil					N	N				
Field beans					NP	NP	NP			
Clover						N	N			
Lime						NP	NP			
Blackberry						NP	NP	NP		
Borage							N			
Old Man's Beard (clematis)							N	N	N	
Cotoneaster						N				
Raspberry						N				
Rosebay willow herb								NP		
Ivy									NP	NP
Runner bean										
Michaelmas Daisy									P	P

N= Nectar, P = Pollen

Siting hives in an area with early pollen sources will help brood rearing to start early, while plants that produce nectar throughout the season should help with a good honey yield.

It is essential to identify what crops are grown if the bees will depend on this for their honey production (or if you are depending on it for yours!).

2.19 an account of the importance of nectary guides to the foraging bee using a named example and describe how the following flowers, having been successfully pollinated, can indicate to bees that their visits are no longer

Module 2 Honey Products and Forage

required – clover, forget-me-not, horse chestnut.

Five ways in which the flowers of plants can communicate with bees that they are ready to provide pollen or nectar.

The following are in order of decreasing distance from the flower that the signals become effective.

Aroma - The bees' sense of smell is better than their vision and will detect flowers from further away.

Colour - Bees have poor vision at the red end of the spectrum but are sensitive to UV light

Shape - many flowers have veins along the petals which show up in the near UV to guide the bees to the nectaries.

Texture - the texture of the petals may influence the readiness of bees to land

Taste - higher sugar contents will be more attractive to bees and will encourage them to visit similar flowers.

All five are liable to change once the flower has been fertilised signalling to the bees that their services are no longer required.

Clover

Florets drop when pollinated.

Field Geranium

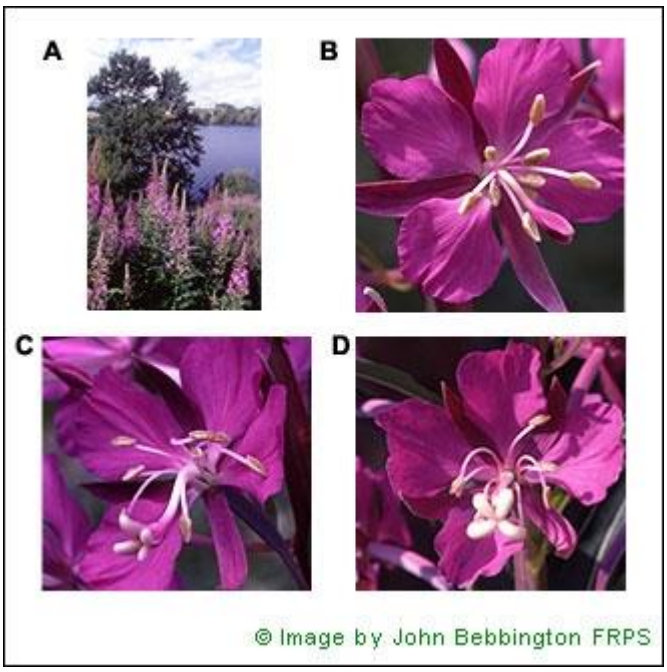
Dark lines on the petals converging towards the centre act as honey-guides, and indicate where the honey-glands lie at the base of the outer stamens.

Rosebay willowherb

Rosebay Willowherb (*Chamerion angustifolium*) is a flower that illustrates protandry (male parts develop

first), as a mechanism that promotes cross pollination. The species is largely visited by bees.

This series of images illustrates the sequence of events taking place within an individual flower, in which stamens mature first, followed by the stigma becoming mature at a later stage. Self-pollination acts as a fallback mechanism.



(A) Rosebay Willowherb (*Chamerion angustifolium*) in its habitat, showing masses of flower spikes.

(B) A recently opened flower, showing the stamens, which have matured first and are fully developed. The stigma remains tucked back.

(C) An older flower, showing stamens from which most of the pollen has been removed. The style is beginning to move upwards and the stigma is beginning to open.

(D) A flower towards the end of its functional flowering period. The stigmatic arms are folding back, ready to collect pollen from the same flower (self pollination).

When this flower opens the antlers are beginning to mature and shed pollen. The style is bent downward and the stigmatic arms are closed. A few hours later most of the pollen will have dispersed the style bends upwards and the stigmatic arms open out ready to receive pollen.

Flowers at the female stage secrete more nectar. These female flowers are the older flowers at the lower end of the flower spike. Bees quickly learn thus and most visit the bottom of the spike first and gradually work their way up it.

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Forget-me-not

These tiny flowers are bee blue in colour and have a yellow corona at the centre. This attracts the bees to the centre of the flower. Once the flower has been pollinated and matures the central yellow corona fades to white.

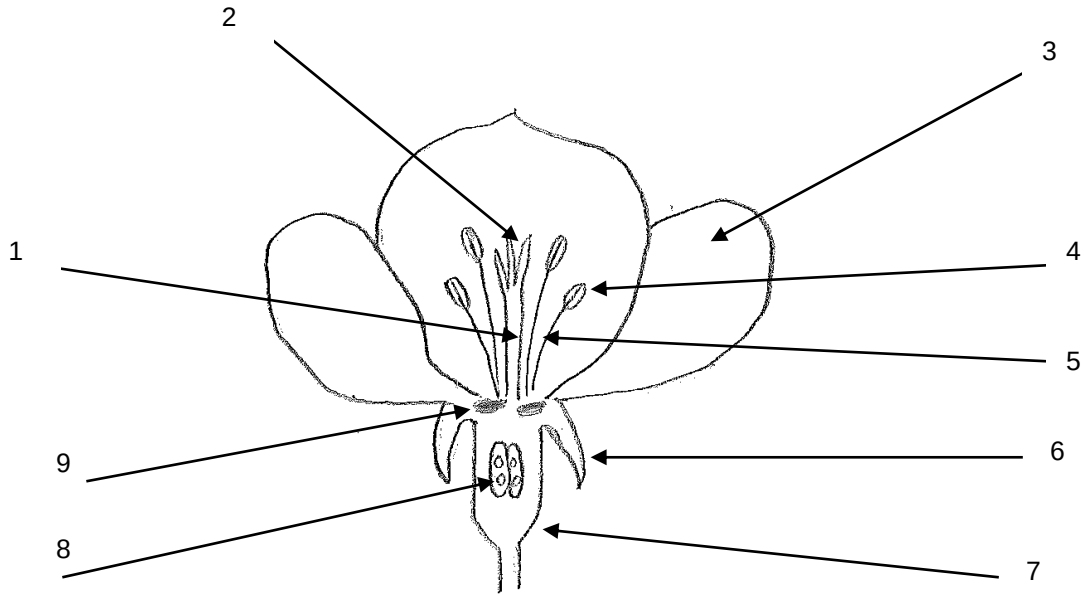

Horse Chestnut



Flowers: it flowers freely; the characteristic "candles" of white flowers, which emerge soon after the leaves, grow up to 20cm tall. Not all the flowers in a spike open at once so that the flowering period is prolonged. Interestingly, once a flower has been pollinated, its colour changes from yellow to red as a warning to visiting bees not to bother with it!

Module 2 Honey Products and Forage

2.20 an illustrated description of the floral structure of apple;



1. **Style** (x5). Stalks holding the stigmas in place ready to receive pollen.
2. **Stigma** (x5). Receptors for pollen.
3. **Petal** (x5). Collectively called the **corolla**. Attractive and distinctive to insects with regard to colour, markings, scent etc.
4. **Anther**, two lobed, within which the pollen grains develop and are presented to insects.
5. **Filamen**t (10+), carrying the anther. Filament and anther together are known as the **stamen**. An inner and outer whorl of stamens surround the female structure. Stamens collectively known as the **androecium**.
6. **Sepal** (x5). Surround and protect the flower when in bud. Collectively known as the **calyx**.
7. **Receptacle (Torus)**. Contains the ovary, and supports the other parts of the flower.
8. **Part of ovary**. The ovary is in five parts each containing two **ovules**. Collectively the ovary, stigmas and styles and known as the **gynoecium**.
9. **Nectary**, at top of receptacle and base of stamens. Produces nectar.

Module 2 Honey Products and Forage

2.21 an account of the processes of pollination and fertilisation;

Pollination is defined as the transfer of pollen from the anther to the receptive stigma

Fertilisation is the fusion of a male gamete (from the pollen) with a female gamete (in the ovule) to produce a single cell called a zygote

The process of fertilisation follows after successful pollination providing that the pollen grain is accepted by the stigma. The pollen grain develops a tube which grows down through the stigma and style using enzymes to digest the tissues. When the tube enters the ovary, it locates a ovule and grows into it through a tiny hole called a micropyle. The male sex cell carried in the tip of the tube fuses with the female sex cell in the ovule forming a zygote which develops into a seed.

Pollination is the transfer of pollen to receptive stigma from anther.

Reproductive parts are

Male: Stamens composed of filament which is the stalk holding anther composed of two lobes each containing pollen sacs holding pollen grains.

Each pollen grain contains only half the no of chromosomes for that plant ie it is haploid.

When ripe the anther bursts releasing the pollen grains to be carried to the female organs by either wind (anemophily)or vector such as bees, flies, beetles etc. (entmophily).

Female: Pistil composed of stigma carried on stem like style which leads to ovary containing ovules. Ovule is also haploid.

Self-fertile plants (such as *Taraxacum officionale*, dandelion, *Brassica napus*, oil seed rape) utilise the pollen from their own flower for fertilisation and do not need a pollinator.

Cross fertilisation requires pollen from another plant of same species to be successful.

Process of pollination

Pollen grain has to be accepted by the stigma (sporophytic compatibility) so it must be

the correct species

From a different plant (for cross fertilisation)

Pollen grain sticks to stigma.

Once accepted the inner skin(intine) of the pollen absorbs moisture from the stigma and swells rupturing the apertures on the outer skin (extine)

The intine now grows through the aperture of the extine and forms the pollen tube which grows rapidly down the stylar canal to the ovary.

The tube carrying two sperm cells, penetrates the ovary and the sperm cells are released.

If pollen not of the same species the sperm will be rejected before it reaches the ovule (gameteophytic incompatibility).

Fertilisation

Fertilisation is the fusion of the male nucleus (from the pollen grain) with a female nucleus (in the embryo sac) to form a single cell (zygote) which has the potential to grow into a new plant.

As it is the product of fusion of two haploid cells the resulting zygote is diploid and carries the full complement of chromosomes for the species.

Process of fertilisation

Inside the ovary the two sperm cells are released from the pollen tube and one fuses with the egg cell nucleus whilst the second fuses with the polar nuclei to form the endosperm.

Together these form the seed which is then enclosed within the receptacle which grows after fertilisation to protect the seed or seeds within it.

Cross-pollination

Provides variation in offspring which enables evolution.

Module 2 Honey Products and Forage

Leads to more vigorous offspring – hybrid vigour

Seed fertility is strengthened

To prevent self fertilisation

Timing - Pollen ripens before the stigma is receptive (protandry) *chamerion angustifolium*, rosebay willow herb, or stigma receptive before pollen ripe (protogyny).

Self-incompatibility stigma will not accept pollen from same plant (sporophytic incompatibility)

Style and stamens at different heights in different plants so pollen is on different part of pollinators body. *Primula vulgaris* has two forms thrum-eyed and pin-eyed with stamens of different lengths and pollen grains of different size.

Monoecious plants - separate male and female flowers on same plant – *corylus avellana*, hazel.

Dioecious plants - separate male and female flowers on different plants - *ilex aquifolium,* holly.

Self-fertilisation

Does not depend on pollinators or presence of other plants of same species

Plants which are not normally self-fertile can utilise their own pollen in extreme circumstances.

Module 2 Honey Products and Forage

2.22 the genetic and evolutionary importance of cross-pollination and an outline of the methods used by plants to favour cross-pollination;

Cross-pollination is very important to the evolution of the plant since each seed has the opportunity to be different and thus evolve and develop to adapt to the plants environment. Self-pollination guarantees that the result seed with be in the image of the plant and therefore not have the opportunity to evolve.

There are five methods used by plants to favour cross-pollination;

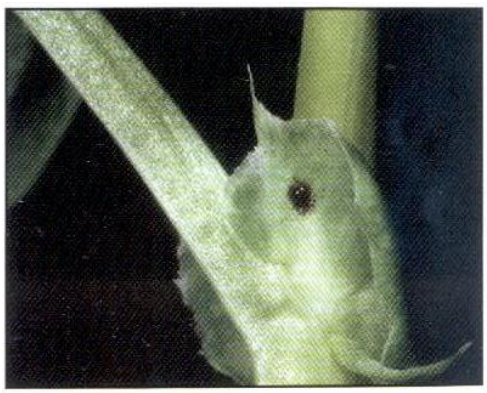
- **Self-incompatibility**; if a pollen from the same plant lands on the stigma the pollen tube will be unable to develop and fertilisation will not occur
- **Protogyny and protandry**; the stigma ripens (receptive to pollen) before the anther (stamen) or more commonly the stamen ripen before the stigma
- **Heterostyly**; the length of the styles and stamen differ in different plants and sometimes the size of pollen can be different sizes as well e.g. primrose
- **Monoecious plants**; separate male and female flowers are found on the same plant e.g. Hazel
- **Dioecious plants**; different plants have flowers of different sexes e.g. Holly

2.23 the location and function of the extra-floral nectaries of broad bean, cherry laurel, cherry and plum;

The generally accepted theory for the extra-floral nectaries, apart from helping to maintain the balance of water and sugars within the plant, is as a defence mechanism. Extra-floral nectaries are attractive to ants, which protect an otherwise vulnerable plant from grazing animals that would eat the leaves.

Broad Bean

Extrafloral nectaries are on the underside of the stipules, the small leaflike parts at the base of the leaf. Koreshkov (1967) showed that these nectaries function throughout the vegetative period of the plant, and that repeated removal of the nectar stimulates further production.



Cherry Laurel

This is an excellent nectar source when in flower and a good one even when it isn't as it has extra-floral nectaries on the underside of the leaves

Module 2 Honey Products and Forage

Cherry

with a green or reddish petiole 2–3.5 cm long bearing two to five small red glands forming extra-floral nectaries

Plum

Along edge of leaf.

Module 2 Honey Products and Forage

2.24 a list of floral sources of unpalatable honey;

This area is a bit vague but the list according to Celia Davis is:

Unpleasant:

- Privet (Ligustrum spp.)
- Common Ragwort (Senecio jacobaea)

Poisonous nectars:

- Ericacae family including
  - Rhododendron spp.
  - Kalmia latifolia (not UK native)

Poisonous to bees:

- Imported limes:
  - Silver Lime (T. tomentosa)
  - Silver pendent/weeping lime (T. petiolaris)
  - T. orbicularis

Matter of taste unpleasant:

- Ivy
- Sweet Chestnut

Module 2 Honey Products and Forage

2.25 an account of the composition of nectar and its variants;

30-90% water

Sugars 5-70%

Rest 3%:

- Vitamins, principally C and B
- Amino acids
- Minerals
- Organic acids
- Pigments
- Aromatic compounds
- Enzymes from the plant
- Occasionally lipids and alkaloids

Module 2 Honey Products and Forage

2.26 an account of the factors affecting nectar secretion and the variations in the composition of nectar in different plant species and differing weather conditions;

In general, a flower's nectarines produce nectar, which is taken by a visiting insect. It then produces more for a length of time. Once the plant has been pollinated, nectar production will cease, but other flowers on the same inflorescence or same plant may continue to produce nectar. The factors affecting the rate of production result from environmental influences and include:

- Temperature – Some plants are unaffected by temperature (Blackberry), others require continuous warmth (lime) some require warm days and cool nights whilst others like it cool (white clover)
- Time of Day – a general rule is nectar is weaker in the very early part of the day and improve as the day dries out and gets warmer. Quantity and quality may peak at different times of day. Bees work different plants at different times.
- Wind and Humidity – light wind and low humidity give best concentrations of nectar and conversely drying wind and very low humidity can cause nectar to dry up.
- Soil Moisture – without moisture the plant wilts and does not produce nectar, in times of drought deep rooted plants fair best
- Nature of soil – the acidity and alkalinity of the soil influences the success of the plant, some are more suited to one or other (Heather to acid)
- Age and Vigour – young healthy plants yield most nectar
- Position of flower on inflorescence – generally lower flowers produce most nectar
- Topography – the situation of the plant, certain plants prefer slopes to flat land and frost pockets can influence the plants success.
- Shading – Some like shade others need direct sun (sedum)

Generally if a plant is in its optimum environment it produces best nectar.

Plants fall into three main categories in terms of Nectar production:

Mostly sucrose	**Equal amounts sucrose/glucose/fructose**	**Low sucrose (most common class)**
Plants with protected nectaries Nectar derived directly from the phloem of the plant		Open flowers, unprotected nectaries Proportion of glucose generally exceeds fructose
Ribes (red and black currants) Some Rhododendrod	Clover	Includes Brassica and aster families

Sugar concentration

Honeybee not interested in sugar concentration < 15%

Most flowers attractive to bees in 20-40% range

Apple good example of low-yielding nectar (25%)

Higher yielding: Borage (Borago officinalis) and rosebay willowherb (Chamaenerion angustifolium)

Large differences of sugar content can be found on same flower and flower to flower. Age of plant has dramatic effect on level of sugars.

Effects of weather

There has been shown a positive correlation between sugar levels and temperature. Sugar levels can vary day to day on same plant. Drought does not affect sugar content, rather it decreases rate of flow.

Module 2 Honey Products and Forage

2.27 an account of the origins and typical composition of honeydew with a brief description of the characteristics of honeydew honey;

Instead of taking nectar, bees can take honeydew, the sweet secretions of aphids or other plant sap-sucking insects.

Aphids have in their mouthparts a set of needles for piercing plant walls and a series of tubes for transporting liquids.

Tubes called Phloem Plants transport dissolved food around plants. An aphid pierces the Phloem and feeds by first injecting saliva into the breach via a duct to start digestion and then using a second duct to extract sap.

The aphid removes the components it requires from the sap and excretes what remains, which is Honeydew. The aphid flicks the honeydew away and it sticks to leaves and other parts of the plant where other insects including ants and bees collect it.

Honeydew comprises mainly water but 90% of its dry matter contains a wide range of sugars, including complex ones, as well as 0.2 – 1.8% nitrogenous substances (amino acids and proteins), organic acids such as citric acid, enzymes and usually mould. The mould comes from exposure on the plant.

Bees usually collect Honeydew in the morning when it is moist from the dew.

Honeydew honey ranges from light to very dark brown in colour and may have a greenish tinge, with a rich fragrance of stewed fruit or fig jam. It is not as sweet as nectar honey and is slow to granulate.

Colour

Usually darker than floral honey: light to dark brown, sometimes almost black, sometimes reddish, or with a red or green tinge.

Odour

Often has a distinctive odour

Taste

A distinctive, stronger taste compared with floral honey. Sometimes malty, treacly, figgy, toffee or nutty.

Viscosity

Often higher viscosity compared with floral

Acidity

Often more acidic than floral honey (esp. citric acid)

Granulation

Often granulates quickly. If melezitose content is significant, granulation is rapid. If erlose content is significant, then granulation is retarded.

Electrical conductivity

High, >8mS/cm

Ash content

Higher than floral honey due to higher mineral content

Optical rotation

Dextrorotatory, due especially to presence of melezitose and erlose. Most floral honey is laevorotatory.

Stringing

Honeydew honey may show stringiness when a stirring rod is removed, due to the presence of high molecular weight polysaccharides.

Foraging

Module 2 Honey Products and Forage

Not easy for bees to forage compared with floral nectar as it is randomly spread around foliage with no guiding stimuli. Easier when dew is present.

Overwintering

Unsuitable for overwintering bees due, among other nasties, to the high mineral content

Microscopy

Contains little floral pollen. Rather, wind blown pollen, fungal spores, soot, algae etc.

Toxicity

May contain substances toxic to bees (e.g. mannose)

Consumer acceptability

Held in high regard in some countries e.g. Germany, but not appreciated in others e.g. USA.

Module 2 Honey Products and Forage

2.28 an account of how the worker honeybees process nectar to change it into honey, including the enzymes and chemistry involved (to include a chemical formula).

Raw nectar will contain 20-70% water and various sugars, mainly sucrose, glucose and fructose, in differing proportions depending upon the source of the nectar. If stored in this form the high concentration of water and the presence of natural yeasts and bacteria would cause the nectar to ferment and grow moulds. There are two principle changes that take place:

- Evaporation of water to reduce the content to 17 – 18%
- Chemical changes due to addition of enzymes

Water is evaporated by the action of the house bees. A bee takes a drop of nectar onto its partly folded proboscis, so exposing it to the air in the next. Other bees create a current of air throughout the nest and evaporation of water from the exposed drops and the surface of nectar in open cells.

The chemical changes are due principally to two enzymes, Invertase and Glucose Oxidase. The enzymes are generated by the hypopharyngeal glands in older bees:

- Invertase is added by the bee which collects the nectar in the crop as it transports the nectar back to the hive. It splits each molecule of sucrose into two smaller molecules glucose and fructose. More Invertase is most probably added by the house bees.

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$

Sucrose Water Glucose Fructose

- Glucase Oxidase acts on glucose, breaking it down to give Gluconic Acid and Hydrogen Peroxide. The hydrogen peroxide is important as it destroys bacteria.

When the water content has been reduced sufficiently, the bees seal over the honey with wax cappings and it will then keep for a very long time. Bacteria and yeasts are unable to grow because of the high concentration of sugar, the antibacterial activity of the hydrogen peroxide and the exclusion of water and air.

Module 2 Honey Products and Forage

2.29 an outline account of the determination of the floral source(s) and geographic origin of honey by analysis of its pollen content and the use of such information in the enforcement of regulations governing the labelling of honey offered for sale

Melissopalynology is the study of pollen contained in honey and, in particular, the pollen's source. By studying the various pollens in a sample of honey, it is possible to gain evidence of the geographical location from the combination of the plants that the honey bees visited, although honey may also contain airborne pollens from anemophilous plants, spores, and dust due to attraction by the electrostatic charge of bees.

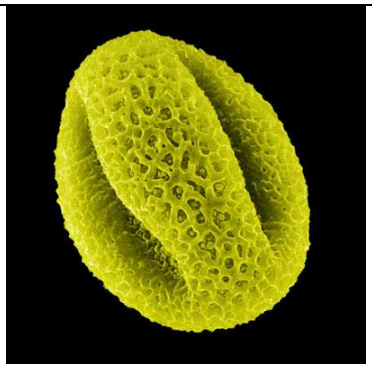
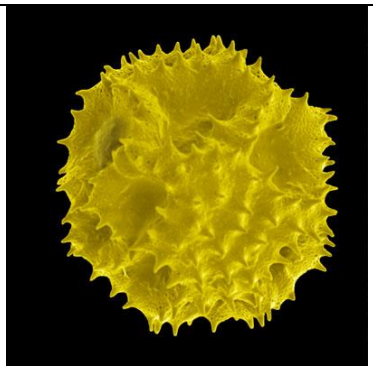
An outline of the technique would be as follows:

- Pollen is obtained by taking 10 g honey and mixing with 20 mls hot water.
- Mix and divide into two centriguge tubes and centrifuge for 10 minutes
- Pour off the liquid from the top of each tube and then pour the contents into one tube.
- Add water to the same level in the second tube and centrifuge for a further 5 minutes.
- Draw the supernatant off using a pipette and make up a pollen slide using warm Fuchsin gel and then magnify to x400 under a compound microscope.
- Compare the pollen grains viewed under the microscope with reference slides.

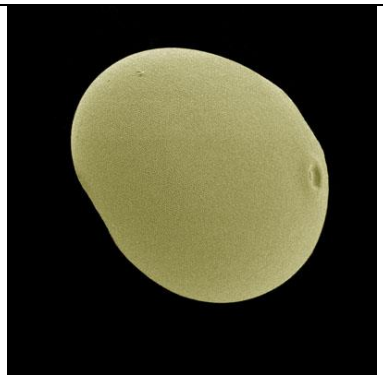
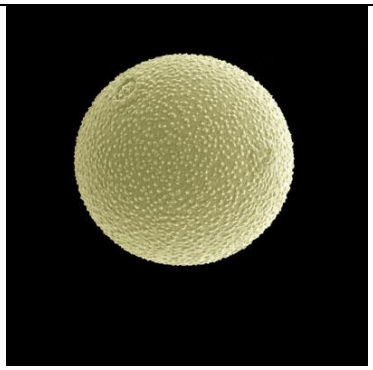
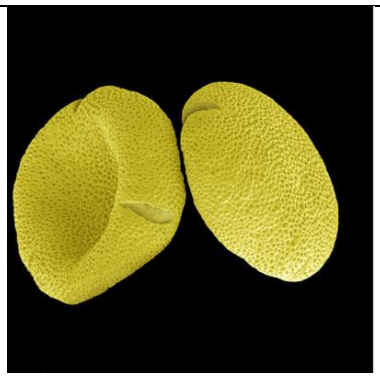
Generally, melissopalynology is used to combat fraud and inaccurate labelling of honey. Information gained from the study of a given sample of honey (and pollen) is useful when substantiating claims of a particular source for the sample. Monofloral honey derived from one particular source plant may be more valuable than honey derived from many types of plants. The price of honey also varies according to the region from which it originates.

Pollen analysis is often used in forensic work to show where people have been by identifying pollen on their clothes.

The table below shows some different pollens.

	Willow. Pollen grains of Willows have an egg shape, 0.016 by 0.030 mm, and three colpi, giving them a slightly triangular aspect. At the surface striking, reticular thickenings. In between these thickenings and in the colpi irregular, rough grains are visible. The outer cell wall is rather thick. The colour of the pollen grains is gold-yellow. Besides being an airborne type, many species of insects contribute to the dispersal.
	Dandelion. Pollen dispersed by insects, like in dandelions, often have a very complex surface with spikes

Module 2 Honey Products and Forage

	Maize. A species with exceptionally large pollen grains with a size of 0.070 by 0.090 mm and an egg shape. Mais has the largest pollen grains among grasses. The operculum on the germination pore is small. The edge around the germination pore is a little elevated, the annulus. The surface is covered with myriads of small extensions. The pollen grain has pale yellowish color. Maize pollen is too big to be travelling a long distance through the air. It falls down from the male tassels on the long female silks of the neighboring plant.
	Stinging Nettle. This species has very small and nearly round pollen grains with a size of 0.015mm by 0.017mm. They have three or four small, round germination pores, each with an own cover, called operculum and a sharp edge, named annulus, which is most evident in dry pollen. The surface is smooth with tiny extensions and the color of the pollen grains is light yellow to whitish. The pollen grains are exclusively dispersed by the wind.
	Linden & Lime. Strongly flattened pollen