

Module 2 Honey Products and Forage

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;

The main UK Statutory regulations are:

Honey Regulations 2003 with 2005 amendments
Food Hygiene Regulations 2006, which rely on Regulation 852/2004 for detail

Other Regulations relating to Honey are:

Materials and articles in contact with food regulations 2005
Plastic materials and articles in contact with food regulations 2008
Food Safety Act 1990
Weights and Measures Act 1985
Weights and Measures (packaged goods) regulations 1986
Food Labelling regulations 1984
Food (Lot marking) regulations 1992

Key Hygiene legislation is **REGULATION 852/2004** which is referenced throughout the 2006 Food Hygiene Regulations. The guidance associated with this legislation comprises three elements:

- Hygiene requirements
- Food Safety
- Registration of premises

BBKA have advised that for small scale honey production for direct sale to consumers is exempt from premise registration. If premises used for 5 days or less in a 5 week period registration is not required. Hygiene regulations still apply – inspections still possible.

Hygiene requirements state that you must make sure that your premises are kept clean and are properly equipped. Foods must be hygienically handled. Staff must be appropriately supervised, and be instructed and/or trained in food hygiene matters so that they can carry out their work hygienically. Measures that need to be taken include:

- Washable surfaces: worktops, walls, floors, ceilings
- Insect and vermin free
- Two sinks, hot and cold water
- Suitable equipment – food safe materials
- Operator hygiene, no smoking
- Appropriate storage facilities
- Hygiene regulations should be followed in all hive related activities, frame making and transportation

Safety requirements state that you need to manage the process in order to protect your customers and your reputation and to comply with the law. The hygiene rules require you to have a procedure in place for doing this which respects certain principles. The procedure

Module 2 Honey Products and Forage

you operate will need to show to your enforcement officer that you have effective food safety management in place. This requires the following;

- Hazards to food safety which might be present within your business are identified (“What can go wrong, when and where?”).
- Controls are in place to deal with these hazards. (“What can I do about it and where?”)
- Controls are carried out and checked. If something goes wrong everyone is clear what to do about it and then does it. (“What is acceptable?” “How can I check?” “What can I do about it?”)
- Procedures are kept up to date (“If I change my way of preparing food, do I need to change my food safety controls?”).
- Documents are kept, which are necessary to show what the procedures are, (“What documents should I keep to show what my procedures are?”)
- Records necessary to show the procedures are working are kept (“What records should I keep to show my procedures are working and any problems have been put right?”)

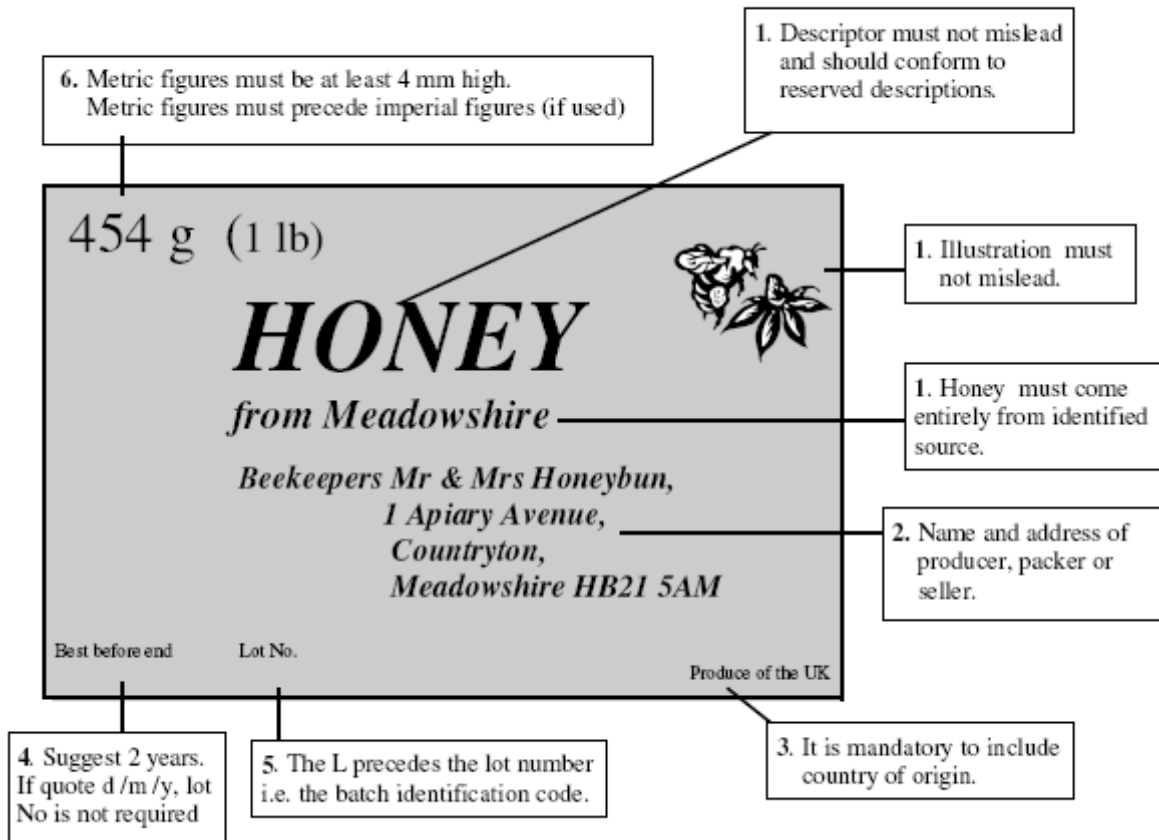
Honey Regulations 2003 Guidance Notes

The honey label must comply with four sets of Regulations, The Honey (England) Regulations 2003, S.I. 2243 or the corresponding Regulations for Scotland, Wales or Northern Ireland if labelled there, The Food Labelling Regulations 1996, S.I. 1499, The Food (Lot Marking) Regulations 1996, S.I. 1502 and the Weights and Measures requirements. The Regulations around these last are rather complicated and are dealt with below.

The label must show the name, the best before date and the weight in the same field of view. Type referring to weight has size requirements but the rest just has to be clearly legible and indelible, also uncluttered. Just the name and country of origin is enough if for direct sale. The names in the Honey Regulations have to be used in order to comply with the Labelling Regulations. The packer’s or seller’s name and address must be on the label, as must for formal statement of the country/(ies) of origin.

Module 2 Honey Products and Forage

Sample label



The regulations specify:-

- **The water content of the honey must be less than 20%.**

If it is higher it is liable to ferment. If you extract only honey from comb that has been capped there should be no problem.

- **The percentages of invert sugars and sucrose must be consistent with that expected from the floral source.**

No problem here if you use your own honey.

- **The honey shall not have been heated in such a way as to significantly destroy enzymes and drive off the volatile aromatic compounds which give each type of honey its unique quality.**

If honey is warmed for extraction and bottling it is advisable to keep the temperature below 35°C and to cool quickly when the job is done. For pasteurisation a temperature of 63°C is needed for 30 minutes followed by rapid cooling. The composition of honey is best preserved by storing at low temperatures.

- **The honey should be free from mould, insects, insect debris, brood and any other organic or inorganic substance foreign to the composition of honey.**

Take care to minimise the introduction of foreign materials from the field into the extraction room. The extraction room and all equipment should be washed thoroughly before extraction. The honey must be filtered to remove these foreign materials. The recommended mesh size is 0.2 mm. which will ensure that some pollen remains.

- **Containers should be made of materials which under normal and foreseeable conditions of use do not transfer their constituents to the honey in quantities which could endanger human health or bring about a deterioration in its aroma, taste, texture or colour.**

Module 2 Honey Products and Forage

Equipment made of food grade stainless steel, food grade plastic and glass meet these criteria.

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 eg 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 (this includes both 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.

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. In our case it could be 'Product of the UK ' or 'Product of England' but must be IN ADDITION to the address.

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 this 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

Module 2 Honey Products and Forage

destination and retain this for the shelf life plus 6 months.

For direct sales like farmers markets or sales at the door Lot numbers and 'Best before' date are not needed.

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 a kg and 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.

Food hygiene.

'Registration of premises does not apply to the direct supply by the producer of small quantities of primary products to the final consumer or to local retail establishments directly supplying the final consumer.'

Composition of Honey

1.	Sugar content	
1.1.	Fructose and glucose content (sum of both) -blossom honey -honeydew honey, blends of honeydew honey with blossom honey	not less than 60 g/100 g not less than 45 g/100 g
1.2.	Sucrose content -in general -false acacia (<i>Robinia pseudoacacia</i>), alfalfa (<i>Medicago sativa</i>), Menzies Banksia (<i>Banksia menziesii</i>), French honey-suckle (<i>Hedysarum</i>), red gum (<i>Eucalyptus camaldulensis</i>), leatherwood (<i>Eucryphia lucida</i> , <i>Eucryphia milliganii</i>), <i>Citrus</i> spp. -lavender (<i>Lavandula</i> spp.), borage (<i>Borago officinalis</i>)	not more than 5 g/100 g not more than 10 g/100 g not more than 15 g/100 g
2.	Moisture content -in general	not more than 20%

Module 2 Honey Products and Forage

	<p>-heather (<i>Calluna</i>) and baker's honey in general -baker's honey from heather (<i>Calluna</i>)</p>	<p>not more than 23% not more than 25%</p>
3.	<p>Water-insoluble content -in general -pressed honey</p>	<p>not more than 0.1 g/100 g not more than 0.5 g/100 g</p>
4.	<p>Electrical conductivity -honey not listed below and blends of these honeys -honeydew and chestnut honey and blends of these except with those listed below -exceptions: strawberry tree (<i>Arbutus unedo</i>), bell heather (<i>Erica</i>), eucalyptus, lime (<i>Tilia</i> spp.), ling heather (<i>Calluna vulgaris</i>), manuka or jelly bush (<i>Leptospermum</i>), tea tree (<i>Melaleuca</i> spp.)</p>	<p>not more than 0.8 mS/ cm not less than 0.8 mS/cm</p>
5.	<p>Free acid -in general -baker's honey</p>	<p>not more than 50 milli- equivalents acid per 1000 grammes not more than 80 milli- equivalents acid per 1000 grammes</p>
6.	<p>Diastase activity and hydroxymethylfurfural (HMF) content determined after processing and blending</p> <p style="padding-left: 40px;">(a) Diastase activity (Schade scale)</p> <p style="padding-left: 80px;">- in general, except baker's honey - honeys with low natural enzyme content (e.g. citrus honeys) and an HMF content of not more than 15 mg/kg</p> <p style="padding-left: 40px;">(b) HMF</p> <p style="padding-left: 80px;">-in general, except baker's honey</p> <p style="padding-left: 40px;">-honeys of declared origin from regions with tropical climate and blends of these honeys</p>	<p>not less than 8</p> <p>not less than 3</p> <p>not more than 40 mg/kg (subject to the provisions of (a), second indent)</p> <p>not more than 80 mg/kg</p>

Module 2 Honey Products and Forage

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.

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.

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

UNCAPPING

There are 4 main methods of uncapping honeycombs:

1. Uncapping knife

Method

- The frame is held vertically with one lug resting on a bar over a collecting tank
- The knife is warmed by dipping in hot water and then dried to prevent excess water from diluting the honey
- The cappings are removed by sliding the knife upwards underneath the cappings
- The frame is tilted slightly towards the knife so that the cappings fall away from the frame into the collecting tank
- For larger numbers of frames, electrically or steam heated knives can be employed

Advantages

- Quick
- Easy to use
- Clean – very little mess with drawn combs

Disadvantages

- Lot of waste if frames not drawn out evenly
- Risk of operator cutting oneself if used carelessly

2. Uncapping fork

Method

- The frame is held horizontally over a tray and the cappings are lifted by sliding the uncapping fork beneath them
- The cappings are scraped off the fork on to the side of the tray
- The cappings that are difficult to get at using the prongs can also be scratched off the top

Advantages

- Easy to use
- Works well with frames that have been drawn out unevenly

Disadvantages

- Slow
- More messy
- Sharp prongs can cause injury

3. Hot Air Blower

Method

- The frame is held vertically over a tray and the cappings are melted using air from a paint stripper or similar

Advantages

- Very little waste
- Single operation, honey does not need to be separated from cappings
- Quicker than fork

Disadvantages

- Slower than knife

- Messy, causes spluttering ??
- Requires great care to avoid charring of the honey
- Difficult to keep blower clean
- Risk of burning hand holding the frame
- Do not obtain any cappings wax which is the best quality for showing and wax products

4. Flailing

Method

- 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

- Very quick to use
- Consistent uncapping method across frames

Disadvantages

- Costly equipment
- Only suitable for large volumes/industrial applications

5. Uncapping Roller (additional)

Method

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

Advantages

- Simple
- Clean

Disadvantages

- Difficult to pierce cappings on uneven frame
- More wax will end up the honey at extraction time

Separating the cappings from the honey

1. Straining

Method

- The wet cappings are placed in a course sieve or muslim bag and allowed to drain for 24 hours
- The honey recovered is filtered before being added to the honey tank
- Residual honey in the cappings can be cleaned up by feeding back to bees (same hive as source of honey only). The cappings are placed in a rapid feeder with cover removed or spread over the cover board

Advantages

- Does not require heating or special equipment
- Produces better quality wax

Disadvantages

- Slow
- Laborious if there is a large number of cappings to process

2. Melting

Method

- Cappings are melted on a heat tray and the liquid drained off through a grid to catch any solid matter
- The resulting liquid is left to cool and wax solidifies on the top
- Honey is filtered before adding to the honey tank

Advantages

- Quicker than filtering

Disadvantages

- Requires heating which can degrade the honey
- Cleaning the uncapping tray can be difficult

3. Centrifuge

Method

- Small quantities, hang cappings in straining cloth securely in extractor and rotate
- Large quantities, employ centrifuge
- Strain honey before adding to honey tank

Advantages

- Quick
- Efficient recovery of wax and honey

Disadvantage

- Costly if employing centrifuge
- Can be fiddly to set up in extractor, need to ensure secure and in plane of rotation in order to minimise wobble on unit??

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:

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. It 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 rings, arranged like the spokes of a wheel with the top bars parallel to the wall of the drum. Honey is extracted from both sides simultaneously, so there is no need to juggle the frames once they have been loaded. Radial machines tend to be larger than tangential machines, to ensure that frames are far enough from the centre to extract properly. For a given size, though, they can hold many more frames than a tangential, e.g. a 20-frame radial will only take 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. 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.

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

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
- Frames must be loaded so that there is an equal balance of weight in order to avoid extractor wobble!
- If using Manely frames consideration needs to be given to the handling of the wider side bars

HEATHER HONEY

Heather (*Calluna Vulgaris*) honey is thixotropic (becomes temporarily liquid when shaken or stirred and returns to gel when standing). Because of its gelatinous feature it cannot be extracted by centrifugal force. Means of extraction are:

Pressing

- Frameless combs are placed in a strong straining bag
- Combs are pressed with device similar to apple press or between two pieces of hinged wood (Peebles Press)

Scraping using a Smiths Cutter

- Comb is scraped back to septum, placed in a straining bag and either spun in extractor or pressed as above
- Insert the tensioned wire into the honeycomb at one end of the frame and draw downwards. Then reverse the tool and scrape off the comb/honey.

Perforextractor

- This is a large roller shaped like a rolling pin with needles which 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 Peforextractor.

Other points

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

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.

Definitions

Course Filtering The honey in the extractor is drained off via a tap at the base of the extractor 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 eat oneself although 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 in honey. Honey needs to be warm in order 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.

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

To understand principles of storage one must 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

*Glucose oxidase is added to nectar by bees and creates HP and GA

Things you need to be aware of when storing honey

Feature	Value	Comment
Granulation	<10°C slow >30°C none	Stops altogether below 4.5°C
	Glucose/Water ratio	Higher ratio quicker granulation (based on above 1.63 – 2.06)
	Glucose/Fructose ratio	More Fructose slower granulation (rape high glucose)
	Viscosity	Higher viscosity less granulation, crystals cannot move easily
	Nuclei promote granulation	Crystals form round impurities
	Stirring	Speeds up granulation
	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
	<13°	Honey will not ferment
	Flash heat 71°C	Pasteurises honey kills osmophilic yeasts
	Granulation	Causes water concentration between crystals

The recommendation for storing honey prior to jarring is in large containers in crystallised form. For rapid crystallisation the honey should be stored at 14°C (16-18°C according to Hooper) creating smooth non-gritty crystals. Thereafter it should be stored in a cool place to prevent fermentation.

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

Cool storage also maintains Diastase and HMF levels.

Inactivation of enzymes in honey at different temperatures. Temperatures listed below reduce enzyme levels to half in the period stated.

Temperature		Half-Life	
°C	°F	Diastase	Invertase
10	50	34 years	26 years
20	68	4 years	2 years
30	86	200 days	83 days
40	104	31 days	10 days
50	122	5 days	1 day
60	140	1 day	5 hours
70	158	5 hours	47 minutes
80	176	1 hour	9 minutes

Time for 30 mg/kg HMF to accumulate (based on 3 samples)

30°C	100-300 days	It can be seen that honey held at an ambient temperature over 30°C for 6 months will accumulate more HMF than the same honey flash heated to 70°C for 5 minutes and then rapidly cooled.
40°C	20-50 days	
50°C	4-10 days	
60°C	1-2.5 days	
70°C	3-5 hours	
80°C	< 2 hours	

Average glucose:water ratio for honeys grouped according to their granulation after 6 months of undisturbed storage at 23-28°C, in ½-lb or 1-lb jars (0.23 or 0.46 kg). The honeys had been pre-treated 'to clarity, as indicated by the polariscope', i.e. all crystals had been dissolved.

Glucose/Water ratio	Granulation after 6 months	# of Samples
1.58	none	96

1.76	few scattered crystals	114
1.79	1.5 - 3mm layer of crystals	67
1.83	6 - 12mm layer of crystals	68
1.86	few clumps of crystals	19
1.99	1/4 of depth granulated	32
1.98	1/2 of depth granulated	19
2.06	3/4 of depth granulated	16
2.16	complete soft granulation	18
2.24	complete hard granulation	28

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 (can take between 1 and 3 days dependent upon amount and type of honey)
 - For Ling honey heat to 40°C and stir
- Strain through fine filter (0.5mm mesh)
- Leave to settle, to remove air bubbles and remaining alien material to rise to surface (can be 1 – 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 $\frac{3}{4}$ to 1 hour in water bath after securing lids to remove final crystals and pasteurise

The honey should be heated for the minimum time in order to preserve the enzymes and Diatase and HMF levels.

In commercial production the honey is quickly heated to 72°C and rapidly cooled in order to remove remaining crystals and pasteurise the honey.

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 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 above instructions with the following adaption's; warm to 32-35°C and stir in a manner not to break the surface and introduce 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

Honey from a source with appropriate crystallisation is heated to 35°C and blended with the liquefied honey.

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

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

Some overriding rules when looking to produce section, cut-comb or chunk honey:

- Need strong colony
- Use second super, 1st super is prone cells with pollen
- Use un-wired frames, strips or wax paint to surface
- Must be in good flow period

Cut-comb

- When comb is fully sealed, remove it from the hive
- Cut out the comb completely around the wooden frame timber
- Lay it on its side on a draining surface over a tray, e.g. a Waldron Queen Excluder (wooden framed excluder)
- The usual container is 8oz/227g, cut comb with sharp knife or shaped cutter
- Leave the combs on a grid to allow loose honey to drain off and edges to crystallise
- There should be no evidence of granulation, fermentation, propolis, Braula or wax moth
- Store in fridge/freezer at <4°C
- 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
 - insert foundation with point of arch to top and to with ¼inch (6mm) of the base to prevent sagging
- After carefully removing complete sections, scrape off burr comb and propolis (carefully)
- Store upright in tins at <4°C
- Preparation of rounds should be in accordance with manufacturer's instructions
- Good sections should weigh about 16oz (454g), have good even cappings with no

weeping or granulation and not evidence of Braula or Wax Moth

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, ratio F/G 1.2 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 (at least 2 indentified, contains 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. 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 be a cause of honey darkening on storage or when heated.

Ash

The ash is the 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.

Enzymes

Invertase (sucrose)	Used by the bees to breakdown sucrose 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 down glucose into gluconic acid and hydrogen peroxide and is one of the major factors responsible for the antibacterial properties of honey.
Diastase (amylase)	Breaks down starch to simpler compounds. Its exact function in honey is unknown but the enzyme is used by bees to breakdown pollen.

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 after the honey is removed from the hive and this is the main reason why the flavour of honey tends to reduce 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 the honey to slowly darken.

2.10 methods of determining the moisture content of honey;

1. Is it capped, honey is capped at <20% water content
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 is sealed the water content is within the range 17-20% if non-heather honey. The bees know best when it comes to honey water content.

If the comb is not sealed and the beekeepers feels the honey is ripe, he should hold the frame horizontally over the top of the super frames and jerk it downwards towards the super. If honey spots appear on the frames then the honey is not ripe, if they do not then the viscosity indicates that the water content is 20% or less.

The scientific method is to use a refractometer, these are simple hand held devices that employ the fact that light bends dependent upon the structure of the medium, this can map back to the water content of a material.

Refraction varies with temperature so some devices automatically compensate the scale based upon ambient temperature, others use a control medium to calibrate the device before testing honey. The method of operation is described below.

Smear a drop of honey onto the lens, close the perspex plate to produce the correct film thickness and hold up to the light. Once focused through the eyepiece, the observer will see a graduated scale against which will be a light/shade area. Read off the water scale on the right where light meets shade. This is the water content of the honey.



John's notes:

1. Shake Test

Shake an inverted frame of partly capped honey over the hive is a useful indicator of whether the water content is low enough to harvest. If no nectar can be shaken out then it's a reasonable indication that it's ripe enough to harvest. If a significant quantity of

uncapped honey is harvested though (e.g. when harvesting oil seed rape) then a more accurate measurement method should be made on a sample of the complete batch to avoid later fermentation.

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

2. Honey Refractometer

The most common technique for determining accurate water content of honey. A small sample is smeared on the test window of a (generally) hand-held device and held up to the light – the reading is taken through the eyepiece. The readout is given directly as percentage water content.

Advantages	Disadvantages	Precautions
Easy to use	Cost of instrument purchase	Instrument must be calibrated (read instructions)
Accurate		Readings are temperature dependent, so calibration in ambient temp or use device with auto temp compensation
Small sample required		Honey must be well mixed before extracting the sample for measurement. Honey at top of bulk container can contain more water.
		Honey must be clear and not part granulated.

3 Hydrometer (Specific Gravity)

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

Advantages	Disadvantages	Precautions
Measurement could be performed in main storage container (provided scale is visible)	Large sample required	Honey temperature must correspond to calibrated temp of hydrometer (or measurement correction made)
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	

Density

Another physical characteristics of practical importance is density. Having density,

expressed as specific gravity is greater than water density, but it also depends on the water content of the honey. Because of the variation in density it is sometimes possible to observe distinct stratification of honey in large storage tanks. The high water content (less dense) honey settles above the denser, dryer honey. Such inconvenient separation can be avoided by more thorough mixing.

Water Content %	13	14	15	16	17	18	19	20	21
Specific gravity at 20°C	1.4457	1.4404	1.4350	1.4295	1.4237	1.4171	1.4101	1.4027	1.3950

Hygroscopicity

The strongly hygroscopic character of honey is important both in processing and for final use. In end products containing honey this tendency to absorb and hold moisture is often a desired effect such as, for example, in pastry and bread. During processing or storage however, the same hygroscopicity can become problematic, causing difficulties in preservation and storage due to excessive water content. Normal honey with a water content of 18.3% or less will absorb moisture from the air at a relative humidity of above 60%.

Air % RH	50	55	60	65	70	75	80
Honey % WC	15.9	16.8	18.3	20.9	24.2	28.3	33.1

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
- Feeding of bees foreign substances, e.g. honey not from apiary
- Residues of chemical applications
- Fermentation

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

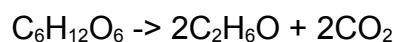
Yeasts are everywhere where honey is, it is impossible to remove them other than killing them through raising the temperature through pasteurisation (71° commercially then rapidly cooling, 60° for one hour non commercial).

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

Moisture content less than 17% honey will not ferment, above 19% and the above conditions the honey given time will ferment.

Fermentation

The breakdown of sugars by yeasts which produces alcohol and carbon dioxide



Yeasts are unicellular organisms which use sugars as energy source for growth and cell division.

Osmophilic yeasts are those which exist 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 11°C
- Ensure moisture content < 17%

Hooper describes 3 types of fermentation

- Wet, dilute layer on surface, smell – skim off layer and use rest of honey normally
- Dry lumpy surface, smell – skim off layer and use rest of honey normally
- Nothing visible but smells when disturbed – heat to 94°C and feed to bees of same colony/apiary

Honeydew Honey

Does not ferment but spoils due to presence of fungus

Symptoms: frothy surface and smell of stored apples, skim off affected layer and use rest.

Deterioration during storage

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

If stored in air of >60% humidity, can absorb water from air and water content rise leading to possibility of fermentation

Storage temperature 21-27°C will prevent granulation and deterioration but destroy enzymes and raise HMF levels

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

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	<p>Honey's viscosity is dependent upon its water content, temperature and floral source:</p> <table border="1"> <thead> <tr> <th>Water Content (%)</th> <th>Viscosity (poise) at 25 °C</th> </tr> </thead> <tbody> <tr><td>15.5</td><td>138.0</td></tr> <tr><td>17.1</td><td>69.0</td></tr> <tr><td>18.2</td><td>48.1</td></tr> <tr><td>19.1</td><td>34.9</td></tr> <tr><td>20.2</td><td>20.4</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Temperature (°C)</th> <th>Viscosity (poise) at 16.1% H₂O</th> </tr> </thead> <tbody> <tr><td>13.7</td><td>600.0</td></tr> <tr><td>29.0</td><td>68.4</td></tr> <tr><td>39.4</td><td>21.4</td></tr> <tr><td>48.1</td><td>10.7</td></tr> <tr><td>71.1</td><td>2.6</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th>Floral Source (examples)</th> <th>Viscosity (poise) at 25 °C, 16.5% H₂O</th> </tr> </thead> <tbody> <tr><td>Sage</td><td>115.0</td></tr> <tr><td>Sweet Clover</td><td>87.5</td></tr> <tr><td>White Clover</td><td>94.0</td></tr> </tbody> </table>	Water Content (%)	Viscosity (poise) at 25 °C	15.5	138.0	17.1	69.0	18.2	48.1	19.1	34.9	20.2	20.4	Temperature (°C)	Viscosity (poise) at 16.1% H ₂ O	13.7	600.0	29.0	68.4	39.4	21.4	48.1	10.7	71.1	2.6	Floral Source (examples)	Viscosity (poise) at 25 °C, 16.5% H ₂ O	Sage	115.0	Sweet Clover	87.5	White Clover	94.0
Water Content (%)	Viscosity (poise) at 25 °C																																
15.5	138.0																																
17.1	69.0																																
18.2	48.1																																
19.1	34.9																																
20.2	20.4																																
Temperature (°C)	Viscosity (poise) at 16.1% H ₂ O																																
13.7	600.0																																
29.0	68.4																																
39.4	21.4																																
48.1	10.7																																
71.1	2.6																																
Floral Source (examples)	Viscosity (poise) at 25 °C, 16.5% H ₂ O																																
Sage	115.0																																
Sweet Clover	87.5																																
White Clover	94.0																																
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 will not ferment =<14° 18°=< will crystallise in best manner 35°C granulated honey becomes manageable 54°C honey liquefies 60-70°C honey pasteurises 100°C enzymes breakdown honey purified of disease (except AFB) for feeding to same apiary																																
electrical conductivity	<p>Conductivity is a good criterion of the botanical origin of honey and today 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:</p> $C = 0.14 + 1.74 A$ <p>where C is the electrical conductivity in milli Siemens cm⁻¹ and A the ash content in g/100 g.</p> <p>Extensive conductivity data on thousands of commercial honeys has been recently published. Based on this data we propose that blossom honeys, mixtures of blossom and honeydew honeys should have less than 0.8 mS/cm and honeydew and chestnut honeys should have more than 0.8 mS/cm. Exceptions are <i>Arbutus</i>, <i>Banksia</i>, <i>Erica</i>, <i>Leptospermum</i>, <i>Melaleuca</i>, <i>Eucalyptus</i> and <i>Tilia</i> honeys as well as their blends, having an extremely high variation in their conductivity (7).</p>																																

Relative density

This is the density (weight/volume) compared with the density of water.

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 due to thermal expansion, 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 the resistance to flow of the honey. The more treacly, the higher the viscosity.

- Viscosity reduces as temperature increases.
- Viscosity reduces as the moisture 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 appreciate the influence of temperature and moisture content on viscosity.

A simple method of measuring viscosity is by dropping a ball bearing into a jar of honey and timing the fall between two points. Calculate the viscosity from standard tables and formula.

Viscosity is often quoted in Poise.

Thixotropy is a time dependent shear thinning property which causes the honey to reduce in viscosity after stirring for a time. Ling heather and Manuka honey are two well known examples.

Hydroscopicity

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

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 for ease of straining, to dissolve crystallised honey and reduce subsequent granulation, and to kill yeasts to prevent fermentation.

Honey will degrade at elevated temperatures over a period of time.

- HMF content increases
- Enzyme activity reduces
- Loss of volatile oils, hence aroma loss
- Darkening in colour

60°C for 45 minutes used to retard crystallisation

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

60°C for two hours causes noticeable degradation.

Electrical conductivity

How easily the honey will 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 contained within the honey. Blossom honeys should have less than 0.8 mS/cm whilst honeydew and chestnut honeys should have greater than 0.8 mS/cm. But there are exceptions. The conductivity measurement is easy, fast and needs only inexpensive instrumentation. It is widely used to distinguish between honeydew and blossom honeys and also the characterisation of unifloral honeys.

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, honeydew is dextrorotatory.

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.

2.13 the main constituents and physical properties of beeswax;

Beeswax Constituents

Beeswax varies a lot, as does any product from the bees, depending on where it comes from, the weather and the time of year. It is mostly made of a substance called myricyl palmitate, which is a type of chemical known as an ester, but there are many other ingredients. These are the main four ingredients and approximate percentages:

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

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 - 64°
	Pliable at 32 - 35°C
	Flashpoint 242 - 250°C
Relative Density	0.96
Acidity	20
Reactivity	Reacts with Alkalis (used to make soap) and hard water (calcium)
	Use soft water to cleanse

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. At the time of extraction a decapping tray with a sieve catches the cappings. 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. After honey has been removed discoloured pieces of wax are removed.
4. The wax is heated at a temperature of no more than 90° centigrade and filtered first through lint and then 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 degrees C and the wax which melts at about 62 degrees 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 of solar extractor

- Economical
- Easy to use - If the combs are placed in a muslin bag prior to being placed in the extractor the wax will be 'sieved' and all debris retained in the bag.
- Kills nosema spores and wax moth eggs and sterilizes the frames

Disadvantages of solar extractor

- Messy – as in all methods of wax rendering
- Honey will burn in very hot days affecting its quality.

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 and disadvantages in using a steam extractor

- Efficient
- The electric 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

It should be remembered that beeswax is highly inflammable and great caution should be used when using domestic appliances when melting wax, particularly when using direct heat. A water jacketed heater is far safer. All surfaces likely to come in contact with molten

wax should be covered with aluminium foil to catch drippings.

Cross infection should be avoided and infected combs should be incinerated and not rendered for further use.

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

Consideration should be given to 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 mixing 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 absorption 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 it's important to use soft water. Hard water causes saponification (the formation of soaps) which affects the quality and appearance of the wax.

Cleaning/Filtering

- The beeswax should first be melted, preferably using a double boiler arrangement.
- Do not overheat. Prolonged heating at high temperature darkens the wax and destroys aroma properties. Melting point is approx 62-64°C
- Do not use iron or copper vessels which discolour the wax, stainless steel or enamelled pans are ideal
- Beeswax can be cleaned of dirt and debris by melting and then leaving to cool, preferably in a tall thin mould. When cool, debris will have settled at the bottom of the block and can be sliced off. Alternatively, the wax can be filtered while molten – nappy liners work well for this.

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

- Royal Jelly - nature's rejuvenator may help in the relief of symptoms of ailments such as PMT and arthritis, may encourage healthy skin, hair and nails and may help with the promotion of overall wellbeing
- Pure Bee Pollen - Bee Pollen is one of nature's most unique and powerful foods. Packed with a wide range of vitamins, minerals, amino acids and enzymes, it can be taken daily to top up those nutrients missing from our diets due to modern day living and intensive farming methods. As well as being an excellent all round food, bee pollen may also help with fertility and weight management issues.
- Propolis - Bees use propolis within the hive for a multitude of purposes. Propolis may help to strengthen the immune system, may give relief from the symptoms of fungal disorders and may relieve various inflammatory diseases. This product is available either as a tincture or as a convenient capsule.
- Bee venom therapy is claimed to be of use in arthritis, bursitis, tendinitis, dissolving scar tissue (e.g. keloids), and [Herpes zoster](#), among other illnesses. The most abundant active component of the venom is [melittin](#), which has a powerful anti-inflammatory action. However, bee venom is a complex mix of a variety of peptides and proteins, some of which have strong [neurotoxic](#) and [immunogenic](#) effects. There is no standardized practice for the administration of bee venom.

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 which removes pollen from bees legs, causing it to fall through a separation screen on to collection drawer. Placed between entrance and brood box. Stops drones and queens exiting. Can be used all season on a strong and healthy colony.

Must be collected, cleaned and frozen quickly.

Pollens differ by source

Pollens collected from bees will already have been treated 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

Constituents

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

Collection

Venom collected on membrane covered glass plates 11-14 volts current 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 – using palette knife to scrape frames, walls, entrances and covers
- Traps – sheets of plastic material with holes in them, placed under the cover board or on sides of hive. Allow light through gap in roof
- When holes filled place sheets in freezer and =granules which are brittle will easily drop off

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" $\frac{3}{4}$ " (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 are 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, paint the inside of the section prior to assembly, 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 $\frac{1}{4}$ " (6mm) of the base of the section to prevent sagging. Dividers should always be used.

When fully sealed the crates should be removed very carefully using the clearer board and porter bee escape. Use the minimum of smoke and take 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 risk of damage. Scrape each section free of propolis and wax, including the edges of the timber or plastic and store in sealed biscuit tins in a warm room, making sure each section is placed upright as it was in the crate.

In general, good sections should weigh about 16ozs. (454g), and have even cappings with an absence of weeping or granulation. Cleanliness of the wood or plastic is absolute while there must not be any 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 be seen well
- comb cut the right way up - it's a fault to put it in sideways or inverted.

Set honey

The judge will be testing flavour and aroma obviously. However, the consistency and texture are important in this class. The honey should be stiff enough not to move when the jar

is tilted, but be easily spoonable. There should be no grittiness on the tongue. No bubbles or scum should be on the surface, and of course no visible specks of dust etc. All set honeys are prone to fermentation and there clearly should be no hint of this.

Seeding Honey

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

You should then prepare a sample of fine-grained honey (approx. 10%) and this should be heated at approx. 21°C (70°F) until it has softened. It should then be stirred with a wooden stick or wooden paddle until it has a consistency of porridge. This is the 'seed'.

It is then poured into the bucket of liquid honey, stirring to evenly distribute the fine-grained honey. Maintain an even but not too quick stirring motion until the seed is well distributed. Set aside for a few days to crystallise. Heat your bucket of honey again, this time to about 30°C (86°F).

When the honey has softened, stir it until it is again quite mobile, something like porridge. The honey is then ready for bottling.

When the honey has been bottled it should be placed in a cool place 12°C (53°F) for a few days, during which time it will set to a consistency of firm butter. This is known as 'set' or 'soft set' or 'creamed honey' and can easily be spread.

Soft set honey does not have the same keeping qualities as naturally crystallised honey unless retained in 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 to 30°C (86°F) until the honey has softened. Then stir until it can be poured and bottle.

The secret to getting 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 show and scrape off any impurities on top of honey 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 tea cloths 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

The small time beekeeper is unlikely to bother with processing granulated honey but may wish to sell to the local shops, some crystallised honey, which has granulated naturally. In fact most honey shows specify a class for Naturally Crystallised honey (not soft set).

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.

However if the honey, extracted, strained and stored in suitable containers crystallises rapidly and with a fine grain it 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 consistency of porridge is reached, while still warm it is slowly poured into the warmed settling tank down along the side to avoid further air bubbles. Finally it is run into warm jars straight away.

The jars should then be allowed to cool slowly to minimise the risk of 'frosting'. Place then in a cool spot where there is no variation in temperature and also ensure that light is excluded. It is generally accepted that the ideal temperature for granulation is 14°C (57°F).

WAX.

Blocks of wax.

First thing the judge looks for is a good colour and clearness of the wax. S/He may shine a torch through it to check for cloudiness due to water content.

Blocks should be:- correct weight; good colour; nice aroma when rubbed; flat topped, well cast with no moulding faults such as adhesions or lines; with no inclusions that show on the base, such as dust, which is easily seen, or water drops which leave little voids in the surface. Watery wax often has a creamy or milky look and may have colour differences in layers. Gently rub off any sharp edges using the palm of your (very clean) hand. Old blocks generally suffer surface damage and they lose their aroma, so cast fresh for each competition or short season.

Try to find a nice presentation box so that your wax looks good – even though this is not supposed to influence the result. Some use special glass topped wooden boxes but a Ferrero Rocher chocolate box is a good substitute.

Try for :-

- selecting your brightest (not necessarily the palest) colour wax but do not overheat it or it will go browner.
- good filtering, although sedimentation over water can be very nearly as good with far less hassle.
- only take wax for the mould from the top layer in the melting pot. Try not to disturb any sediment.
- pre-heat the mould so no lines form on the sides of the wax.
- very slow cooling as it sets, in particular cover the mould so that the wax does not cool from the top surface.

There are all sorts of “tricks of the trade” about wax blocks, mostly to do with very slow even cooling to get a really flat topped block rather than the wavy surface that open-air cooling gives.

Small Blocks

The same rules apply but these must also be well-matched in colour and size. If you make two pourings from the same saucepan, the later one may well be a different colour, so have the full number of moulds. Better still, make too many all at the same time and pick the best.

Candles

The wax must be good quality and colour just as for blocks, and well cast or made.

Present your candles upright in firm fireproof candlesticks unless otherwise instructed as at The National.

The candlesticks should not influence the judge – it's the candle and its performance that count.

The wick must be correct thickness for the size of candle (this puts tapered and fancy shaped candles at a disadvantage).

Wick should be waxed so that it stands well and is easy to light.

Wicks central (look at the base)

Candles are always burned by the judge, so make an extra one and check this yourself. You are looking for a clear light, no tall smoky flames (the wick should self-trim correctly) no deposits collecting on the wick, silence because of no water drops hissing as they boil, no smouldering beyond about 20 seconds when blown out, and ease of re-lighting.

Flame should be clear and still with no spitting due to included water.

A candle should not smoulder more than about 20 seconds when blown out or it may be hard to relight due to shortened wick. This can happen if the wax contains propolis or dust. The judge will re-light candles when cooled, to check this.

Fancy shape candles often have serious faults when it comes to burning, such as bits falling off or tapers, meaning the wick is never the right thickness, Simple candles, well made from clean wax, usually win.

Mead and other drinks

There are often 3 classes:- sweet mead, dry mead, honey wines(including metheglin, cyser, etc)

- make sure your entry is in the right class – often the boundary is set by use of a hydrometer and at about 1,125
- Keep the air out of your preparations so that no acetic acid (vinegar flavour/smell) is formed.
- be prepared to wait a long time for your wines to mature – some take years, so do sample tastings before you pick the ones for the show. I keep mine in plastic bottles (coke, lemonade etc) which do not impart any taste or smell and can have all the air squeezed out before sealing. They are also safer to store as they do not explode or break when dropped. Also, you can fill a 75 cl wine bottle from a 2 l plastic without disturbing the sediment.
- For the show have correct bottles – 750 ml clear glass wine bottles with shoulders, Bordeaux style, and a good punt in the base. You may have to buy some wine and drink it just to get the right bottles !
- Fill to within about 1cm of the cork, which nearly always has to have a white plastic top so that the judge can remove it easily and replace it. Don't put normal wine corks into a show.
- Filter your mead just before the show, with minimum exposure to air, so there is no sediment and not floaters. Wash the outside of the filter paper first in case there is fluff stuck to it. Coffee filter papers do a good job.

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 capings 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 spirit
- 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

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

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;

Snowdrops & crocus	January to March	Useful early pollen source
Hazel	February to March	Pollen only
Willow	February to May	Pollen
Apple, Pear, Plum	March April	Good pollen, nectar is low in sugar
Cherry	May	Pollen & nectar
Hawthorn	April	Good pollen
Oil seed rape	April to July	Good pollen & nectar
Sycamore	May	Good pollen & nectar
Dandelion	March to May	Good pollen & nectar
Cotoneaster & Raspberry	June	Good nectar
Blackberry	June to August	Good pollen & nectar
Lime	June to July	Good nectar
Old Man's Beard	July to September	Pollen
Rosebay Willow Herb	August	Good nectar
Michaelmas Daisy	September October	Pollen
Ivy	September October	Pollen & nectar

	FLOWERING PERIOD	PLANT	NECTAR	POLLEN
1	February-April	Hazel		Y
2	April/May	Dandelion	Y	Y
3	April-July	Oil seed rape	Y	Y
4	May-July	Field beans	Y	Y
5	June/July	Clover	Y	
6	June	Lime	Y	Y
7	June -August	Blackberry	Y	Y
8	July	Borage	Y	
9	August	Rosebay willow herb	Y	Y
10	September/October	Ivy	Y	Y

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

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 previously bee friendly plants such as borage, oilseed rape and field beans.

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!).

	FLOWERING PERIOD	PLANT	NECTAR	POLLEN
	February-April	Hazel		Y
		Bluebell		Y
	May/June	Holly	Y	
		Birds foot Trefoil	Y	
	July-August	Old Man's Beard (clematis)	Y	
	July	Cotoneaster	Y	Y
		Runner bean		

2.19 an account of the information that the following flowers communicate to the honeybee – clover, field geranium, rosebay willowherb, 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

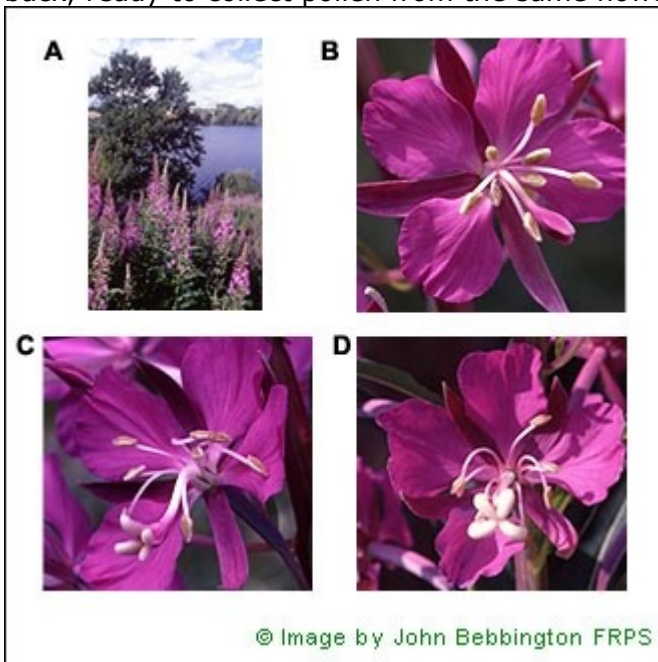
individual flower, in which stamens mature first, followed by the stigma becoming mature at a later stage. Self pollination acts as a fallback mechanism.

(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 anthers 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.

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.

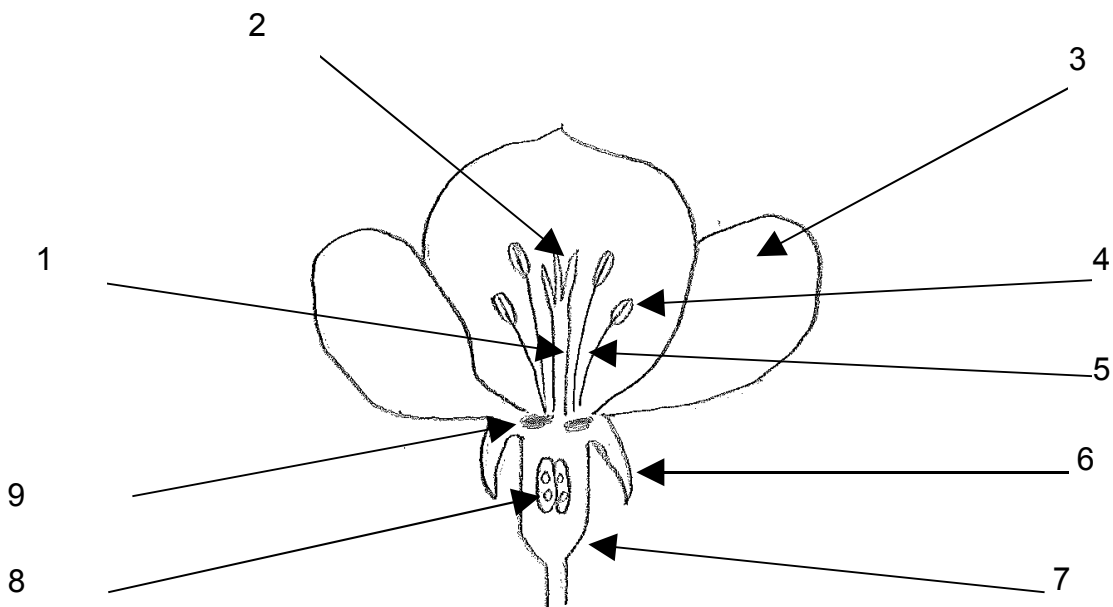
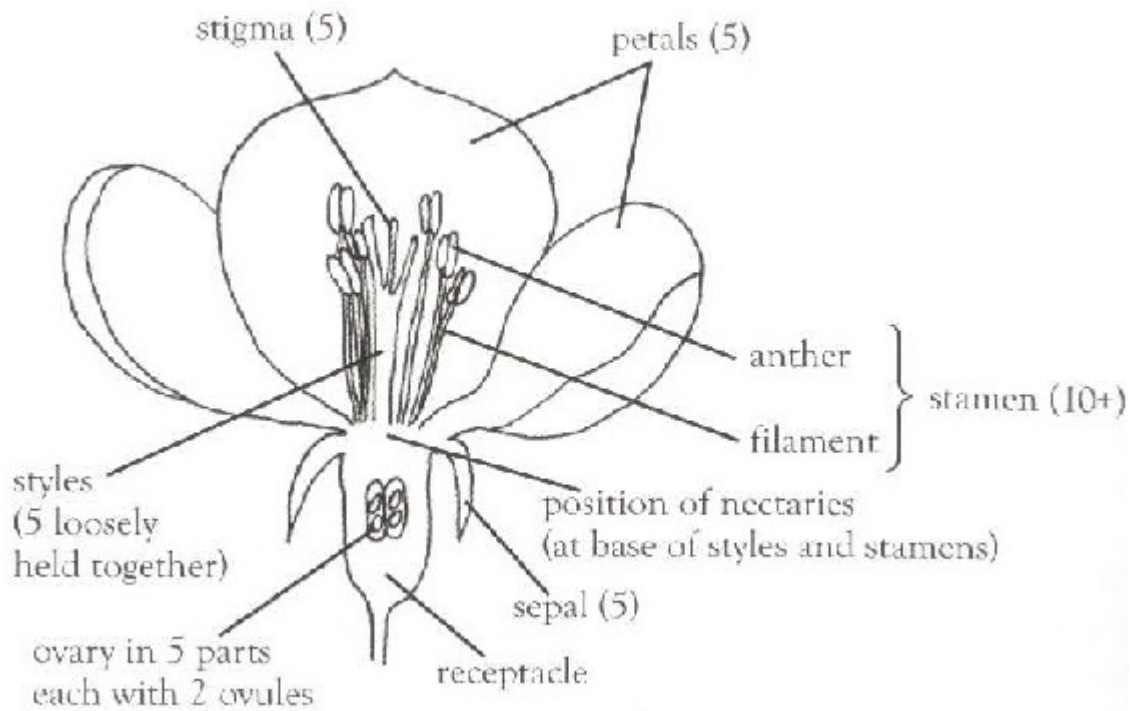


Horse Chestnut



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 red to yellow as a warning to visiting bees not to bother with it!

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. **Filament** (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.

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 officinale*, 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.
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.

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 will 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 will 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



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



Plum

2.24 a list of floral sources of unpalatable honey;

Ragwort
Pivot
Rhododendron
Laurel
Azalea
Ivy

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

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

Plants with protected nectaries

Nectar derived directly from the phloem of the plant

Ribes (red and black currants)

Some Rhododendrod

Equal amounts sucrose/glucose/fructose

Clover

Low sucrose (most common class)

Open flowers, unprotected nectaries

Proportion of glucose generally exceeds fructose

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.

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, which in their mouthparts have a system of needles for piercing and a series of tubes for transporting liquids.

Plants have within them tubes which transport dissolved food around the plant, these tubes are called Phloem. The aphids tap into the Phloem and feed by firstly pouring saliva into the piercing via a duct to start digestion and by using a second duct to extract sap.

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

Honeydew mainly comprises water but 90% of its dry matter comprises a wide range of sugars, including complex ones. As well as Nitrogenous substances (amino acids and proteins) 0.2 – 1.8%. There are always 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 is 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 and is not as sweet as nectar honeys. It 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 acid 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

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.

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).**

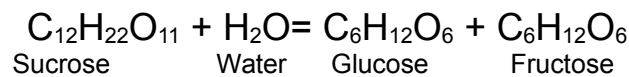
Raw nectar will contain 20-70% water and various sugars, mainly sucrose, glucose and fructose, in differing proportions depending upon the source of the nectar. If stored in this form the high concentration of water and the presence of natural yeasts and bacteria would cause the nectar to ferment and 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.



- Glucose 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.