Pharm.D - Year 2

Pharmacognosy and Phytopharmaceuticals

Complete subject manual: 27 practicals and activities. Each chapter includes a student observation or work record.

Use the PDF bookmarks to navigate. The table gives each practical's content-page count; the combined manual has continuous page numbers.

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Introduction to Practical Pharmacognosy

Experiment 1 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To organise a crude-drug examination and distinguish identity from quality.

Principle

Pharmacognosy establishes the identity and quality of crude drugs using source information, macroscopic characters, microscopy and suitable physical or chemical tests.

Requirements

- Instructor-provided labelled diagrams, traces or data for this activity.
- Calculator, graph paper or spreadsheet, and the activity record.

Procedure

1. Identify the source

Enter the authenticated botanical name, family, plant part and specimen/voucher code supplied.

2. Plan the examination

Choose intact material, transverse section and powder observations as appropriate to the plant part.

3. Use instruments

Identify the microscope, sectioning tools, balance and measurement apparatus; record calibration where a numerical result is required.

4. Document

Keep labelled sketches, actual observations and interpretations in separate record columns.

Observations and Record

Record item	Entry
Activity / material identifier	_____
Measurement or visible feature	_____
Comparison / calculated outcome	_____
Interpretation and limitation	_____

Result

The recorded finding is ____; the supporting observation or calculation is ____. The main limitation is ____.

Precautions

- Use the supplied teaching material; distinguish a measured observation from an assumed value.
- Keep units, axes, labels and measurement conditions consistent.
- Record limitations and seek instructor review before applying a conclusion to a live case.

Viva Questions and Answers

1. What is the main endpoint?

Organise a crude-drug examination and distinguish identity from quality.

2. Does one observed result prove a general conclusion?

No. Controls, repeatability and the limitations of the method must be considered.

Cell Walls and Cell Inclusions

Experiment 2 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To recognise wall types and cellular inclusions in prepared plant material.

Principle

Wall structure and intracellular inclusions can provide microscopic evidence of a plant tissue. Lignified walls, starch and calcium oxalate are different structures and require appropriate comparison.

Requirements

- Instructor-provided labelled diagrams, traces or data for this activity.
- Calculator, graph paper or spreadsheet, and the activity record.

Procedure

1. Locate the structures

Find epidermal, parenchymal, fibrous and vessel elements in the prepared material.

2. Compare wall features

Record thin or thick walls, pits and lignified elements using the assigned stain or image legend.

3. Identify inclusions

Use prepared images to distinguish starch grains, crystals and secretory material; draw each labelled observation.

4. Record limits

Do not name a plant solely because a common inclusion is present.

Observations and Record

Record item	Entry
Activity / material identifier	_____
Measurement or visible feature	_____
Comparison / calculated outcome	_____
Interpretation and limitation	_____

Result

The recorded finding is ____; the supporting observation or calculation is ____. The main limitation is ____.

Precautions

- Use the supplied teaching material; distinguish a measured observation from an assumed value.
- Keep units, axes, labels and measurement conditions consistent.
- Record limitations and seek instructor review before applying a conclusion to a live case.

Viva Questions and Answers

1. What is the main endpoint?

Recognise wall types and cellular inclusions in prepared plant material.

2. Does one observed result prove a general conclusion?

No. Controls, repeatability and the limitations of the method must be considered.

Datura - Macroscopy Powder and Microscopy

Experiment 3 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated leaf material of Datura and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Datura specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Datura stramonium; Solanaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Unequal leaf base and an irregularly toothed margin; record the actual specimen shape. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Epidermal fragments, stomata and covering/glandular hairs; compare the assigned species atlas. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Different Datura species and other hairy leaves require an authenticated comparison. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Datura specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Leaf.

2. Which features support the comparison?

Unequal leaf base and an irregularly toothed margin; record the actual specimen shape. Epidermal fragments, stomata and covering/glandular hairs; compare the assigned species atlas.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Senna - Macroscopy Powder and Microscopy

Experiment 4 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated leaflet material of Senna and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Senna specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Senna alexandrina, including traditional Cassia angustifolia / C. acutifolia names; Fabaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Lanceolate leaflets with an unequal base and entire margin. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Epidermal fragments, stomata, unicellular hairs and calcium oxalate-associated tissues; confirm the assigned atlas. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Compare leaflet base, hairs and stomatal evidence; a green powder alone is not diagnostic. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Senna specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Leaflet.

2. Which features support the comparison?

Lanceolate leaflets with an unequal base and entire margin. Epidermal fragments, stomata, unicellular hairs and calcium oxalate-associated tissues; confirm the assigned atlas.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Cassia Cinnamon - Macroscopy Powder and Microscopy

Experiment 5 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated bark material of Cassia Cinnamon and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Cassia Cinnamon specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Cinnamomum cassia; Lauraceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Thicker curved bark pieces or quills compared with many true-cinnamon specimens. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Cork, phloem fibres, stone cells and secretory cells in the assigned bark section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Record the named species; cassia cinnamon and true cinnamon are distinct materials. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Cassia Cinnamon specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Bark.

2. Which features support the comparison?

Thicker curved bark pieces or quills compared with many true-cinnamon specimens. Cork, phloem fibres, stone cells and secretory cells in the assigned bark section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Cinchona - Macroscopy Powder and Microscopy

Experiment 6 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated bark material of Cinchona and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Cinchona specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Assigned official Cinchona species; Rubiaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Bark pieces with outer fissures and a fibrous inner surface; measure thickness. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Cork and phloem with characteristic thick-walled fibres; compare an authenticated bark section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

The label must state the assigned species or accepted source mixture. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Cinchona specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Bark.

2. Which features support the comparison?

Bark pieces with outer fissures and a fibrous inner surface; measure thickness. Cork and phloem with characteristic thick-walled fibres; compare an authenticated bark section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Ephedra - Macroscopy Powder and Microscopy

Experiment 7 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated stem material of Ephedra and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Ephedra specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Assigned official Ephedra species; Ephedraceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Jointed ridged stems with small scale leaves at nodes. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Ridges, epidermis, vascular bundles and supporting tissues in the labelled stem section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Node and stem evidence should accompany powder observations. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Ephedra specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Stem.

2. Which features support the comparison?

Jointed ridged stems with small scale leaves at nodes. Ridges, epidermis, vascular bundles and supporting tissues in the labelled stem section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Quassia - Macroscopy Powder and Microscopy

Experiment 8 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated wood material of Quassia and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Quassia specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Quassia amara or Picrasma excelsa as assigned; Simaroubaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Pale wood pieces; record growth-ring and vessel appearance on the cut surface. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Xylem vessels, fibres and rays; compare the assigned source wood. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Different accepted source woods can show different anatomical patterns. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Quassia specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Wood.

2. Which features support the comparison?

Pale wood pieces; record growth-ring and vessel appearance on the cut surface. Xylem vessels, fibres and rays; compare the assigned source wood.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Clove - Macroscopy Powder and Microscopy

Experiment 9 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated dried unopened flower bud material of Clove and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Clove specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Syzygium aromaticum; Myrtaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Nail-like bud with a stalk-like hypanthium and rounded head. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Oil glands and floral/pollen fragments in the supplied section or powder. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Compare intact bud shape with powder evidence and detect excessive stalk material. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Clove specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Dried unopened flower bud.

2. Which features support the comparison?

Nail-like bud with a stalk-like hypanthium and rounded head. Oil glands and floral/pollen fragments in the supplied section or powder.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Fennel - Macroscopy Powder and Microscopy

Experiment 10 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated fruit material of Fennel and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Fennel specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Foeniculum vulgare; Apiaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Elongated ridged fruits that can separate into mericarps. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Ridges, vascular elements, vittae and endosperm in a labelled mericarp section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Do not call a fruit a seed in the record; compare with other Apiaceae fruits. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Fennel specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Fruit.

2. Which features support the comparison?

Elongated ridged fruits that can separate into mericarps. Ridges, vascular elements, vittae and endosperm in a labelled mericarp section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Coriander - Macroscopy Powder and Microscopy

Experiment 11 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated fruit material of Coriander and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Coriander specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Coriandrum sativum; Apiaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Rounded fruits with ridges and two joined mericarps. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Pericarp layers and endosperm; compare the section with the authenticated fruit. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Whole-fruit shape differs from the elongated fennel fruit. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Coriander specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Fruit.

2. Which features support the comparison?

Rounded fruits with ridges and two joined mericarps. Pericarp layers and endosperm; compare the section with the authenticated fruit.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Isabgol - Macroscopy Powder and Microscopy

Experiment 12 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated seed / husk as supplied material of Isabgol and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Isabgol specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Plantago ovata; Plantaginaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Small boat-shaped seeds; husk is a separate named commercial material. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Seed-coat/mucilage evidence and internal seed tissue where present. Record only the structures actually observed and the magnification used.

5. Compare and conclude

State whether the material is whole seed or husk before interpreting a powder. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Isabgol specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Seed / husk as supplied.

2. Which features support the comparison?

Small boat-shaped seeds; husk is a separate named commercial material. Seed-coat/mucilage evidence and internal seed tissue where present.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Nux Vomica - Macroscopy Powder and Microscopy

Experiment 13 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated seed material of Nux Vomica and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Nux Vomica specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Strychnos nux-vomica; Loganiaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Disc-like seeds with a silky surface and a depressed central region. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Characteristic seed-coat hairs and endosperm in prepared images. Record only the structures actually observed and the magnification used.

5. Compare and conclude

This toxic material is examined as an authenticated specimen or prepared slide; no tasting or unsupervised powder handling. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Nux Vomica specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Seed.

2. Which features support the comparison?

Disc-like seeds with a silky surface and a depressed central region. Characteristic seed-coat hairs and endosperm in prepared images.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Rauwolfia - Macroscopy Powder and Microscopy

Experiment 14 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated root material of Rauwolfia and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Rauwolfia specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Rauvolfia serpentina, traditional spelling Rauwolfia; Apocynaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Twisted root pieces with longitudinal surface marks; examine fracture. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Cork, narrow bark and a large central wood region in the assigned root section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Confirm root versus rhizome and the authenticated source; anatomy alone may not resolve all related species. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Rauwolfia specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Root.

2. Which features support the comparison?

Twisted root pieces with longitudinal surface marks; examine fracture. Cork, narrow bark and a large central wood region in the assigned root section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Liquorice - Macroscopy Powder and Microscopy

Experiment 15 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated root / stolon material of Liquorice and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Liquorice specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Assigned official Glycyrrhiza species; Fabaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Longitudinally striated pieces with a yellow interior; record peeled or unpeeled condition. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Thick-walled fibres, crystal-associated cells, starch and vessel fragments. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Peeled material may lack cork; root and stolon anatomy can differ. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Liquorice specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Root / stolon.

2. Which features support the comparison?

Longitudinally striated pieces with a yellow interior; record peeled or unpeeled condition. Thick-walled fibres, crystal-associated cells, starch and vessel fragments.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Ginger - Macroscopy Powder and Microscopy

Experiment 16 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated rhizome material of Ginger and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Ginger specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Zingiber officinale; Zingiberaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Branched rhizome pieces with scars and a fibrous fracture. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Starch, secretory cells and vascular elements in the supplied powder or section. Record only the structures actually observed and the magnification used.

5. Compare and conclude

Record peeled condition and processing, which affect appearance and starch. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Ginger specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Rhizome.

2. Which features support the comparison?

Branched rhizome pieces with scars and a fibrous fracture. Starch, secretory cells and vascular elements in the supplied powder or section.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Podophyllum - Macroscopy Powder and Microscopy

Experiment 17 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To describe the authenticated rhizome and roots material of Podophyllum and record supporting identity characters.

Principle

A crude drug is identified from a combination of botanical source, plant part, external morphology and microscopic evidence. Common fragments are not sufficient on their own.

Requirements

- Authenticated Podophyllum specimen and supplied powder or prepared slide.
- Microscope, measuring scale, slide tools and the assigned species atlas.

Procedure

1. Establish source

Record Assigned Podophyllum / Sinopodophyllum source named by the institution; Berberidaceae. State the specimen code and the supplied plant part.

2. Macroscopic study

Rhizome pieces with nodes and root scars; retain the assigned species label. Measure size, colour, surface and fracture without tasting the material.

3. Section study

Orient the prepared section, identify outer and inner tissue regions and draw a labelled outline.

4. Powder study

Starch-containing ground tissue, vascular elements and root/rhizome structures from the authenticated atlas. Record only the structures actually observed and the magnification used.

5. Compare and conclude

The traditional drug name can refer to different source species; do not assign one from an incomplete specimen. Compare the combined evidence with the assigned authenticated specimen.

Observations and Record

Record	Observation
Source / plant part / code	_____
Macroscopic characters	_____
Section tissues and drawing	_____
Powder fragments / magnification	_____
Supported identity and limitation	_____

Result

Podophyllum specimen code: ____. Plant part: ____. Supporting features: ____. Comparison outcome and limitation: ____.

Precautions

- Never taste crude drugs; toxic specimens require the assigned contained handling or prepared material.
- Record botanical source and plant part instead of relying only on the commercial name.
- Distinguish expected comparison characters from features actually seen.

Viva Questions and Answers

1. What is the examined plant part?

Rhizome and roots.

2. Which features support the comparison?

Rhizome pieces with nodes and root scars; retain the assigned species label. Starch-containing ground tissue, vascular elements and root/rhizome structures from the authenticated atlas.

3. Does one common fragment establish identity?

No. Use the combined specimen and microscopic evidence.

Iodine Value of a Fixed Oil

Experiment 18 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To determine iodine value of the assigned oil by the specified iodine-value method.

Principle

The assigned halogen-addition method measures unsaturation through the difference between blank and test titration.

Requirements

- Assigned test material and the prescribed method reagents or standards.
- Calibrated volumetric glassware, appropriate instrument and record sheet.

Procedure

1. Prepare and identify the test

Confirm the analyte, method version, concentration basis and test-portion amount. Prepare the test solution as specified and record any dilution.

2. Set the measurement basis

Check the instrument or standardised titrant. Prepare the specified blank, standard and control so that the test and comparison use the same basis.

3. Make the measurement

Apply the prescribed the specified iodine-value method method and record blank and test thiosulphate titres. Record replicate readings and any interfering appearance.

4. Calculate

Apply the stated equation with the correct blank correction, dilution and unit conversion. Show the substitution and retain the observed readings.

5. Assess the result

Compare replicate agreement and the assigned specification. Record a result with units and the limitations of the method.

Observations and Record

Measurement	Reading
Test portion / dilution	_____
Blank / standard	_____
blank and test thiosulphate titres	_____
Calculated content and unit	_____

Worked Example

The numbers below are illustrative; enter your own observations in the record.

- Iodine value = (B − S) × N × 12.69 / m; B and S in mL, N in equivalents/L, m in g. The unit is g iodine equivalent per 100 g oil.
- Example: B − S = 10.0 mL, N = 0.1 and m = 0.2 g gives 63.45.

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Use the exact method reagents and assigned endpoint; different methods are not interchangeable.
- Record the blank correction and the actual test portion rather than an assumed value.
- Hazardous reagent operations require the specified laboratory facilities and supervision.

Viva Questions and Answers

1. What produces the analytical signal?

The assigned halogen-addition method measures unsaturation through the difference between blank and test titration.

2. Why include a blank or control?

It identifies contributions unrelated to the analyte or checks that the measurement system performed appropriately.

3. What must accompany the result?

Units, method, dilution basis, relevant control performance and any limitation.

Saponification Value and Unsaponifiable Matter

Experiment 19 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To calculate saponification value and unsaponifiable content from an assigned oil analysis.

Principle

Saponification consumes alkali in hydrolysis and neutralisation. The unsaponifiable fraction is material recovered by the prescribed separation that does not undergo the defined saponification reaction.

Requirements

- Assigned oil, prescribed supervised saponification method, standardised titrant and supplied extraction/constant-mass records.

Procedure

1. Record the oil

Enter test mass, method and blank basis.

2. Saponification measurement

Follow the assigned supervised method and record the blank and residual-alkali back-titration.

3. Unsaponifiable record

Read the specified separation and residue data, including blank correction and dry/constant-mass basis.

4. Calculate separately

Express alkali consumption as mg KOH per g and unsaponifiable matter as a mass percentage.

5. Conclude

Compare replicate findings with the assigned oil specification.

Observations and Record

Measurement	Value
Oil mass	_____
Blank / test titre	_____
Corrected residue mass	_____
Saponification value / unsaponifiable %	_____

Worked Example

The numbers below are illustrative; enter your own observations in the record.

- Saponification value = (B − S) × N × 56.1 / m, in mg KOH/g, with mL titres and mass m in g.
- Example: 8.0 mL × 0.5 × 56.1 / 1.0 g = 224.4 mg KOH/g.
- Unsaponifiable matter (%) = corrected dry residue mass / oil mass × 100. Example: 0.012 g / 2.0 g × 100 = 0.60%.

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Use the prescribed blank and account for residual solvent in weighed material.
- Apply supervised solvent and hot-alkali handling; no unapproved extraction is performed.

Viva Questions and Answers

1. What does saponification value include?

The alkali equivalent consumed by the defined method, including ester hydrolysis and free-acid neutralisation.

2. Why weigh a dry residue?

Residual solvent would overestimate the unsaponifiable fraction.

Ester Value of an Oil or Fat

Experiment 20 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To determine ester value by calculation from matched saponification and acid determinations.

Principle

Ester value represents the alkali equivalent attributed to esterified acids and is derived from matching saponification and acid values.

Requirements

- Assigned test material and the prescribed method reagents or standards.
- Calibrated volumetric glassware, appropriate instrument and record sheet.

Procedure

1. Prepare and identify the test

Confirm the analyte, method version, concentration basis and test-portion amount. Prepare the test solution as specified and record any dilution.

2. Set the measurement basis

Check the instrument or standardised titrant. Prepare the specified blank, standard and control so that the test and comparison use the same basis.

3. Make the measurement

Apply the prescribed calculation from matched saponification and acid determinations method and record saponification value and acid value on the same basis. Record replicate readings and any interfering appearance.

4. Calculate

Apply the stated equation with the correct blank correction, dilution and unit conversion. Show the substitution and retain the observed readings.

5. Assess the result

Compare replicate agreement and the assigned specification. Record a result with units and the limitations of the method.

Observations and Record

Measurement	Reading
Test portion / dilution	_____
Blank / standard	_____
saponification value and acid value on the same basis	_____
Calculated content and unit	_____

Worked Example

The numbers below are illustrative; enter your own observations in the record.

- Ester value = saponification value − acid value, in mg KOH/g.
- Example: 190 − 2 = 188 mg KOH/g. A negative value suggests an inconsistent method basis or erroneous result.

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Use the exact method reagents and assigned endpoint; different methods are not interchangeable.
- Record the blank correction and the actual test portion rather than an assumed value.
- Hazardous reagent operations require the specified laboratory facilities and supervision.

Viva Questions and Answers

1. What produces the analytical signal?

Ester value represents the alkali equivalent attributed to esterified acids and is derived from matching saponification and acid values.

2. Why include a blank or control?

It identifies contributions unrelated to the analyte or checks that the measurement system performed appropriately.

3. What must accompany the result?

Units, method, dilution basis, relevant control performance and any limitation.

Acid Value of a Fixed Oil

Experiment 21 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To determine acid value of an oil by the assigned acid-value titration.

Principle

Titration measures free-acid neutralisation in the prescribed solvent system and expresses it as KOH equivalent per gram.

Requirements

- Assigned test material and the prescribed method reagents or standards.
- Calibrated volumetric glassware, appropriate instrument and record sheet.

Procedure

1. Prepare and identify the test

Confirm the analyte, method version, concentration basis and test-portion amount. Prepare the test solution as specified and record any dilution.

2. Set the measurement basis

Check the instrument or standardised titrant. Prepare the specified blank, standard and control so that the test and comparison use the same basis.

3. Make the measurement

Apply the prescribed the assigned acid-value titration method and record blank-corrected alkali titre. Record replicate readings and any interfering appearance.

4. Calculate

Apply the stated equation with the correct blank correction, dilution and unit conversion. Show the substitution and retain the observed readings.

5. Assess the result

Compare replicate agreement and the assigned specification. Record a result with units and the limitations of the method.

Observations and Record

Measurement	Reading
Test portion / dilution	_____
Blank / standard	_____
blank-corrected alkali titre	_____
Calculated content and unit	_____

Worked Example

The numbers below are illustrative; enter your own observations in the record.

- Acid value = (S − B) × N × 56.1 / m, in mg KOH/g.
- Example: 0.5 mL × 0.1 × 56.1 / 1.0 g = 2.805 mg KOH/g.

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Use the exact method reagents and assigned endpoint; different methods are not interchangeable.
- Record the blank correction and the actual test portion rather than an assumed value.
- Hazardous reagent operations require the specified laboratory facilities and supervision.

Viva Questions and Answers

1. What produces the analytical signal?

Titration measures free-acid neutralisation in the prescribed solvent system and expresses it as KOH equivalent per gram.

2. Why include a blank or control?

It identifies contributions unrelated to the analyte or checks that the measurement system performed appropriately.

3. What must accompany the result?

Units, method, dilution basis, relevant control performance and any limitation.

Acacia - Chemical Identification

Experiment 22 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To record physical and chemical identity evidence for Acacia.

Principle

Dried gum exudate; gum/mucilage properties and the assigned carbohydrate identity tests.

Requirements

- Authenticated teaching material, prescribed identity reagents, comparison material and clean glassware.

Procedure

1. Describe

Record appearance, source type and specimen code.

2. Study behaviour

Apply the authorised dispersion, swelling or gel demonstration appropriate to the material.

3. Apply identity tests

Use the assigned monograph tests with comparison or blank, recording the actual response and its timing.

4. Combine findings

Compare physical behaviour, chemical response and microscopy where applicable; note conflicting evidence.

Observations and Record

Observation	Finding
Material / code	_____
Dispersion / swelling / gel behaviour	_____
Assigned chemical response	_____
Control / comparison	_____
Identity conclusion	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Do not apply one gum test as a universal test for every carbohydrate.
- Record the exact assigned material and test; visual behaviour alone can be non-specific.

Viva Questions and Answers

1. Why use more than one observation?

Materials may share a carbohydrate response but differ in source and functional behaviour.

2. What must accompany a positive test?

The method, actual response and valid control or comparison.

Tragacanth - Chemical Identification

Experiment 23 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To record physical and chemical identity evidence for Tragacanth.

Principle

Gum with swelling and water-dispersion behaviour; compare soluble and swollen fractions in supplied observations.

Requirements

- Authenticated teaching material, prescribed identity reagents, comparison material and clean glassware.

Procedure

1. Describe

Record appearance, source type and specimen code.

2. Study behaviour

Apply the authorised dispersion, swelling or gel demonstration appropriate to the material.

3. Apply identity tests

Use the assigned monograph tests with comparison or blank, recording the actual response and its timing.

4. Combine findings

Compare physical behaviour, chemical response and microscopy where applicable; note conflicting evidence.

Observations and Record

Observation	Finding
Material / code	_____
Dispersion / swelling / gel behaviour	_____
Assigned chemical response	_____
Control / comparison	_____
Identity conclusion	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Do not apply one gum test as a universal test for every carbohydrate.
- Record the exact assigned material and test; visual behaviour alone can be non-specific.

Viva Questions and Answers

1. Why use more than one observation?

Materials may share a carbohydrate response but differ in source and functional behaviour.

2. What must accompany a positive test?

The method, actual response and valid control or comparison.

Agar - Chemical Identification

Experiment 24 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To record physical and chemical identity evidence for Agar.

Principle

Algal-derived gelling material; study the assigned gel-forming and identity observations.

Requirements

- Authenticated teaching material, prescribed identity reagents, comparison material and clean glassware.

Procedure

1. Describe

Record appearance, source type and specimen code.

2. Study behaviour

Apply the authorised dispersion, swelling or gel demonstration appropriate to the material.

3. Apply identity tests

Use the assigned monograph tests with comparison or blank, recording the actual response and its timing.

4. Combine findings

Compare physical behaviour, chemical response and microscopy where applicable; note conflicting evidence.

Observations and Record

Observation	Finding
Material / code	_____
Dispersion / swelling / gel behaviour	_____
Assigned chemical response	_____
Control / comparison	_____
Identity conclusion	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Do not apply one gum test as a universal test for every carbohydrate.
- Record the exact assigned material and test; visual behaviour alone can be non-specific.

Viva Questions and Answers

1. Why use more than one observation?

Materials may share a carbohydrate response but differ in source and functional behaviour.

2. What must accompany a positive test?

The method, actual response and valid control or comparison.

Starch - Chemical Identification

Experiment 25 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To record physical and chemical identity evidence for Starch.

Principle

Granular carbohydrate; iodine response and microscopic grain shape are complementary identity evidence.

Requirements

- Authenticated teaching material, prescribed identity reagents, comparison material and clean glassware.

Procedure

1. Describe

Record appearance, source type and specimen code.

2. Study behaviour

Apply the authorised dispersion, swelling or gel demonstration appropriate to the material.

3. Apply identity tests

Use the assigned monograph tests with comparison or blank, recording the actual response and its timing.

4. Combine findings

Compare physical behaviour, chemical response and microscopy where applicable; note conflicting evidence.

Observations and Record

Observation	Finding
Material / code	_____
Dispersion / swelling / gel behaviour	_____
Assigned chemical response	_____
Control / comparison	_____
Identity conclusion	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Do not apply one gum test as a universal test for every carbohydrate.
- Record the exact assigned material and test; visual behaviour alone can be non-specific.

Viva Questions and Answers

1. Why use more than one observation?

Materials may share a carbohydrate response but differ in source and functional behaviour.

2. What must accompany a positive test?

The method, actual response and valid control or comparison.

Chemical Tests for Castor Sesame and Shark Liver Oils and Beeswax

Experiment 26 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To compare the identity and quality evidence of the assigned lipid materials.

Principle

Fixed oils and waxes differ in chemical composition. Source-specific tests and general analytical values answer different questions.

Requirements

- Authenticated castor oil, sesame oil, shark liver oil and beeswax teaching materials or supplied test records.
- Assigned monograph tests and suitable controls.

Procedure

1. Record source and state

Distinguish liquid oils from a wax and record the assigned source material.

2. Castor oil

Review the prescribed identity evidence linked to its characteristic fatty-acid composition and physical properties.

3. Sesame oil

Record the assigned source-specific colour reaction and control; the reaction must use the institution-prescribed method.

4. Shark liver oil

Interpret the assigned oil identity and unsaponifiable/vitamin-related evidence; do not infer potency from colour alone.

5. Beeswax

Compare melting behaviour, physical appearance and the prescribed wax identity/analytical records.

6. Conclude

State identity evidence separately from acid, iodine or saponification quality values.

Observations and Record

Material	Physical observation	Assigned identity / quality evidence
Castor oil	_____	_____
Sesame oil	_____	_____
Shark liver oil	_____	_____
Beeswax	_____	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Use authenticated materials; do not ingest teaching oils or crude drugs.
- Source-specific colour reactions do not replace a complete quality assessment.

Viva Questions and Answers

1. How does a wax differ from a triglyceride oil?

Its major ester composition and physical behaviour differ; the assigned material must be assessed by its own method.

2. Does an identity test establish vitamin potency?

No. Potency requires the appropriate quantitative method.

Gelatin - Chemical and Physical Identification

Experiment 27 - Practical Notes

Name: _____ Roll no.: _____ Date: _____

Aim

To record identity evidence and gel-forming behaviour of gelatin.

Principle

Gelatin is a protein-derived material that can be examined through protein reactions and physical gel behaviour under specified conditions.

Requirements

- Assigned gelatin sample, authorised protein-test reagents and prepared comparison material.

Procedure

1. Describe

Enter the material code, appearance and assigned source information.

2. Dispersion and gel

Follow the assigned warming/cooling demonstration and record dispersion, setting and reversal behaviour.

3. Protein evidence

Perform the prescribed protein identity reaction with a valid comparison; record the visible response.

4. Report

Combine physical and chemical evidence and note that gel strength requires a separate defined quantitative method.

Observations and Record

Record	Entry
Material / code	_____
Dispersion and setting observations	_____
Assigned protein reaction	_____
Control and identity conclusion	_____

Result

Record the completed observations, calculations and conclusion with units. State any limitation of the observation.

Precautions

- Control the stated temperature and concentration when comparing gels.
- A positive protein reaction is not specific to gelatin without the remaining evidence.

Viva Questions and Answers

1. Why can gelatin gel behaviour change?

Concentration, temperature and material properties affect the observed gel.

2. Does gel appearance measure gel strength?

No. Strength requires a defined quantitative test.

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