



Cape Breton-Victoria
Regional Centre for Education

Using language to deconstruct barriers to science literacy.

**DR. ERIN ROBERTSON, DR. KATHY SNOW,
MS. JILLIAN POLEGATO & MS. DARLENE BERETA**



Acknowledgements

- ▶ Co-authors Dr. Kathy Snow and Darlene Bereta
- ▶ Students and staff from our participating school
- ▶ CB-VRCE
- ▶ Inter-University Research Network
- ▶ Conference Organizers



Background and Goals

Background

- ▶ Complexity of science instruction in middle school
- ▶ Role of vocabulary in science comprehension
- ▶ Socioeconomic barriers

Background

- ▶ Disciplinary literacy
- ▶ Fundamentals of literacy acquisition – all disciplines

Scarborough's Reading Rope



This interpretation of the Reading Rope incorporates Gough & Tunmer's (1986) Simple View of Reading.

Background

- ▶ Morphemes – smallest meaningful units in words
unbreakable: un + break + able
- ▶ Morphologically complex words are abundant in science
- ▶ Morphological awareness

Background

- ▶ Morphological awareness
 - ▶ Predicts gains in reading skills over time even when the usual predictors are controlled (Deacon et al., Under revision; Levesque et al. 2017)
 - ▶ Can be incorporated into science instruction.

Background

- ▶ Greek and Latin roots in science terms
- ▶ E.g. “Biology”:
 - ▶ **Bio** (alive/living) (Greek) + **logy** (study of) (Middle English)
- ▶ Biology – study of living things

Chloroplast

Chloro - green colour

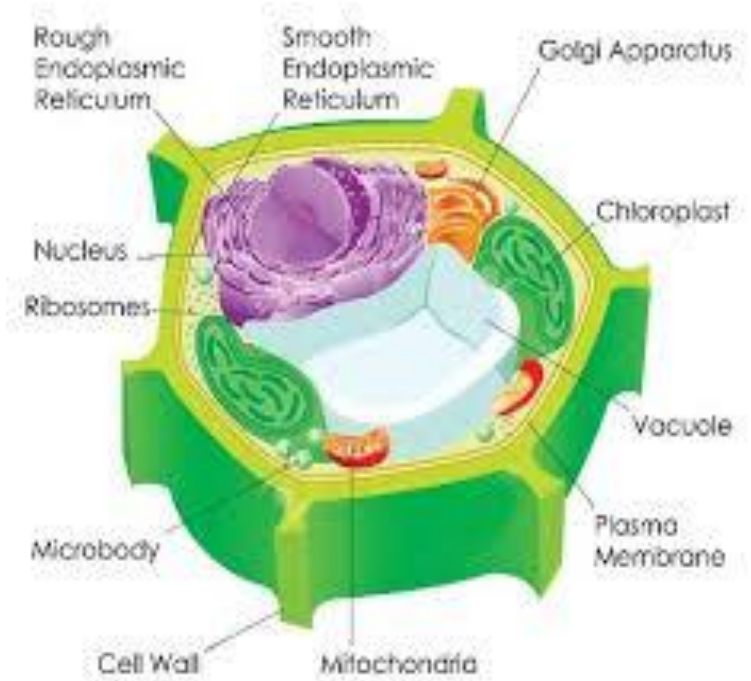
↑
Greek (khloros)

+

plast - living substance in the cell

+

↑
Greek (Plastos)



- **Chloroplasts are organelles that contain a green pigment called chlorophyll.**
- Chlorophyll allows plants to make their own food.
- It is like a kitchen it prepares its own food when water, sunlight and oxygen are present
- Are commonly found in the leaves of plants.
- Chloroplast are necessary for photosynthesis, allowing plants to make their own food.

2 approaches to science literacy

- ▶ 1. Separation of language and content (traditional)
- ▶ 2. Integration of language and content

1. Traditional approach (separation of language and content)

- ▶ Whole word/term – then definition
- ▶ Graphic modelling to help with rote memorization (Jones, 2018).

2. Integration of language and content

- ▶ Integrating parallel language and science instructional objectives (Wessels, 2013)
- ▶ Recognition on interdependence of scientific language and scientific thinking (Edmonds, 2009)
- ▶ Deconstructing and reconstructing words to build meaning

Rationale

- ▶ Science terms are long and morphologically complex
- ▶ But they can be broken down into smaller, meaningful parts
- ▶ Students can use this as a strategy to understand new terms.

Rationale

- ▶ To **introduce a method** informed by the **integrated** approach that:
 - ▶ addresses literacy skills in **science (vocabulary intensive)**
 - ▶ is grounded in **word analysis** and transferability of **word parts**
 - ▶ supports **growth for all students** – including those who struggle with language and/or skills and who face (economic) barriers to literacy.

Goal

- ▶ To determine if the **science literacy improvements** are **greater** with the **integrated approach** compared to the **traditional approach**.



Method

Participants and Classroom Instruction

- ▶ Partner teacher's Grade 8 classes (5 classes over 2 years)
- ▶ 72 students (down from 75)
- ▶ Instruction method: consistent within classes but varied across classes

Intervention Design

- ▶ Each class was instructed with 2 units (Cell and Microscope)
- ▶ Unit 1 – Traditional and Unit 2 – Integrated (or vice versa)
- ▶ All students received both instructional methods
- ▶ Unit Knowledge (Cell and Microscope) tested before and after intervention.

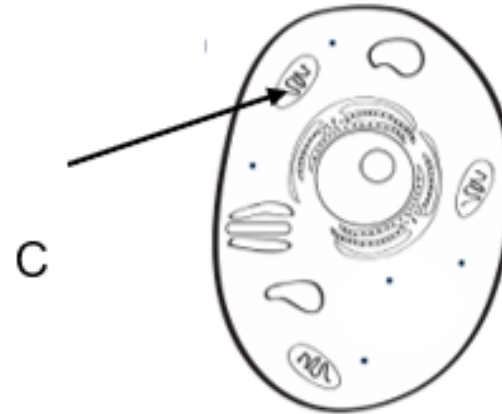
Example of pre/post test questions (Cell)

What is the function of the lysosomes?

Example of pre/post test questions (Cell)

The organelle **labeled C** in the diagram is which of the following?

- A. Cytoplasm
- B. Mitochondria
- C. Chloroplast
- D. Nucleus



Example of pre/post test questions (Microscope)

What is the difference between ocular and objective lenses?

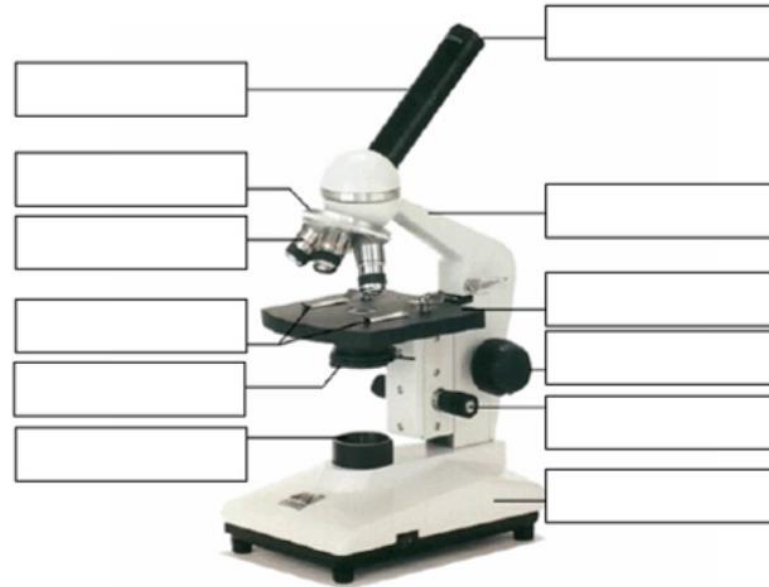
Part two: Label the following diagram

Use the word list to help you label the microscope.

Arm
Base
Body Tube
Coarse Adjustment Knob

Diaphragm
Fine adjustment knob
Light Source
Nosepiece

Objective Lenses
Ocular Lens
Stage
Stage Clips





Traditional Instruction Protocol

WHOLE WORD/TERM, THEN DEFINITION

Separation Instructional Protocol: The Cell

Present the new vocabulary as words to memorize.

Create word list and present the definitions.

***** Do not talk about the meaning of the words.**

Use recall/ drill practice methods. You can use games, labelling and anything you would normally use.

Vocabulary List:

1. Mitochondrion
2. Ribosome
3. Golgi Apparatus (body)
4. Lysosome
5. Endoplasmic Reticulum
6. Nucleus
7. Vacuole
8. Cytoplasm
9. Cell wall
10. Cell membrane
11. Chloroplast
12. Amyloplast
13. Permeable
14. Selectively

Definitions:

Chloroplast: Only found in green plant cells and some unicellular organisms. It is the structure in which photosynthesis takes place.

Separation Instructional Method Protocol: The Microscope

Present the new vocabulary as words to memorize.

Create word list and present the definitions.

***** Do not talk about the meaning of the words.**

Use recall/ drill practice methods. You can use games, labelling and anything you would normally use.

Vocabulary List:

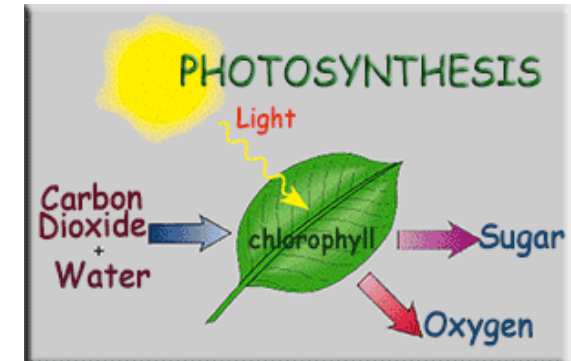
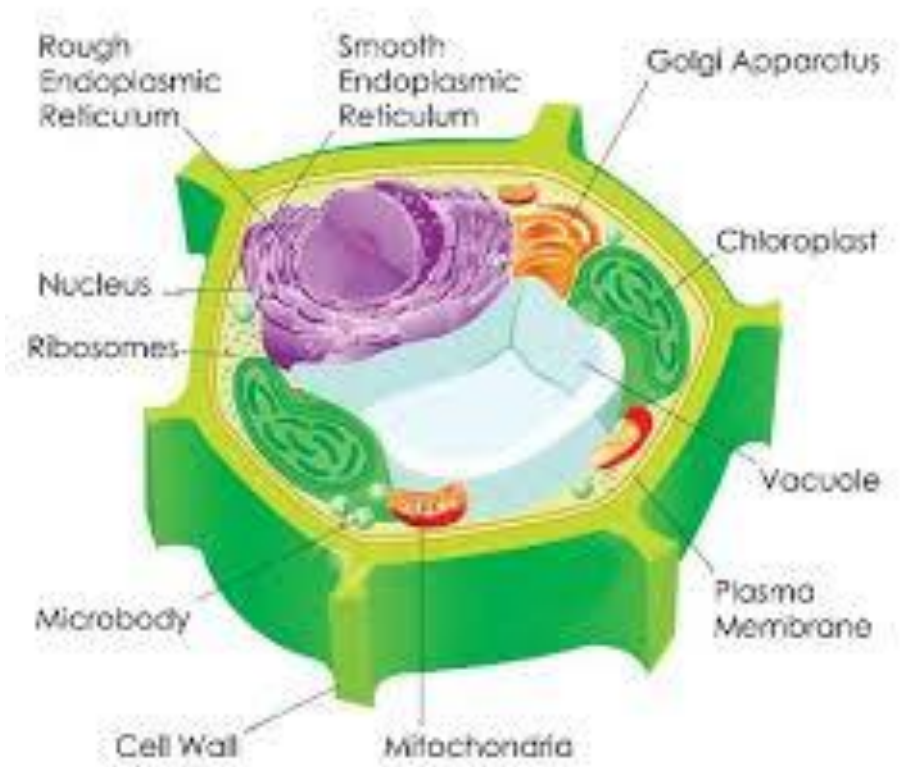
1. Revolving Nose Piece
2. Objective Lens
3. Stage
4. Stage Clips
5. Diaphragm
6. Light source
7. Ocular Lens
8. Coarse-adjustment knob
9. Fine-adjustment knob

Definitions:

Ocular lens (eyepiece): The part of the microscope that you look through to view the specimen.

Chloroplast

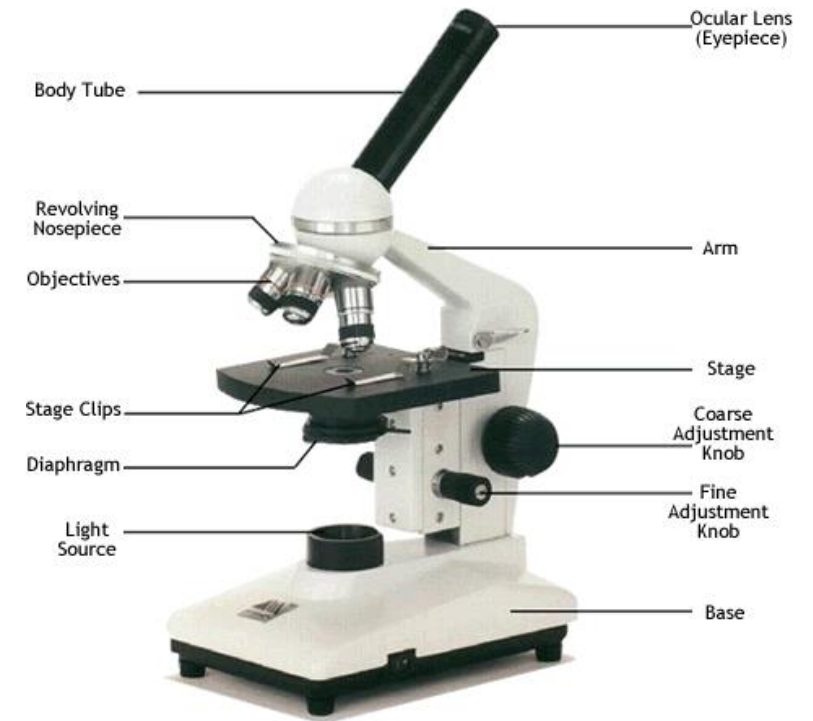
- Chloroplasts are organelles that contain a **green pigment called chlorophyll**.
- Chlorophyll allows plants to **make their own food**.
- It prepares its own food when water, sunlight and oxygen are present
- Are commonly found in the **leaves** of plants.
- Chloroplast are necessary for **photosynthesis**, allowing plants to make their own food.



What is the **ocular lens** on a microscope?

Definition: The part of the microscope that you look through to view the specimen.

- It is also known as the eye piece.
- Has a magnification of either 10x or 15x power lens
- The lens the viewer looks through to see the specimen.



Integrated Instruction Protocol

Break words/terms down into their smaller meaningful parts

Deconstruction, then reconstruction of words/terms

Discuss the origins of the word (E.g. Greek and Latin roots).

Chloroplast:

Deconstructed

Chloro- (from Greek Khloros) referring to the colour green.

-plast / Combining form indicating a living substance, organelle, or cell

Definition: Only found in green plant cells and some unicellular organisms. It is the structure in which photosynthesis takes place.

Ocular lens (eyepiece):

Deconstructed

Ocular- From Latin (oculus) meaning an eye.

Lens- (from Latin lens) meaning glass to regulate light.

Definition: The part of the microscope that you look through to view the specimen.

Selection of slides - Integrated Instruction

You are going on an adventure into the scientific community to learn how science words (**parts of a cell**) were created and developed. You will learn how **root words, prefixes and suffixes** were used to create science words.

When learning new science words it is important to pay attention to the parts of science words. The **parts** of science terms **give you clues** to the **meaning** of the science word you are about to learn.

Selection of slides - Integrated Instruction

Prefixes and suffixes have helped scientists over the years develop science words to help them express and explain their new knowledge to the scientific community.

In the following slide show you will learn how science words are constructed.

You will learn how the **Latin, Greek and French language** influenced the creation of science terms.

Selection of slides - Integrated Instruction

- ▶ Greek and Latin roots in science terms
- ▶ E.g. Biology:
 - ▶ Bio (alive/living) (Greek) + logy (study of) (Middle English)

Chloroplast

Chloro - green colour

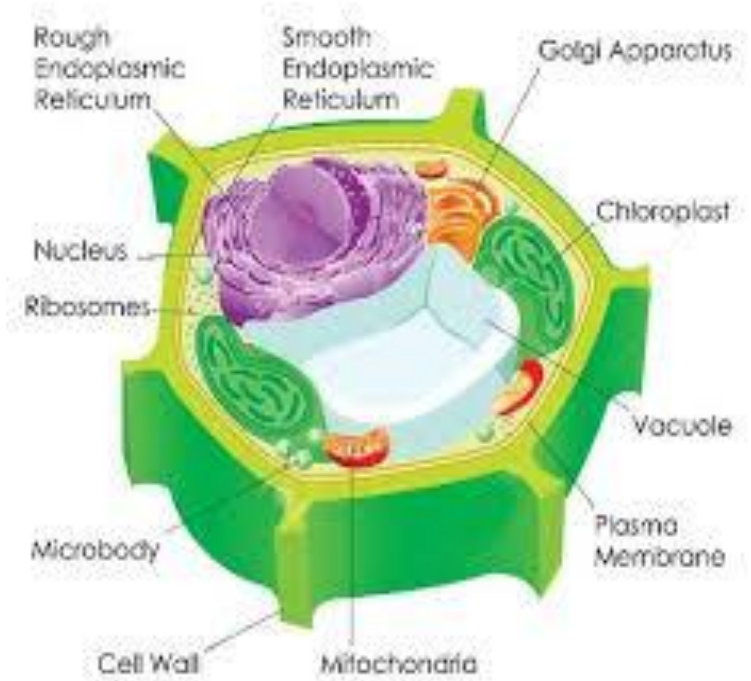
↑
Greek (khloros)

+

plast - living substance in the cell

+

↑
Greek (Plastos)



- Chloroplasts are organelles that contain a **green pigment called chlorophyll**.
- Chlorophyll allows plants to make their own food.
- It is like a **kitchen** it prepares its own food when water, sunlight and oxygen are present
- Are commonly found in the **leaves of plants**.
- Chloroplast are necessary for photosynthesis, allowing plants to make their own food.

Definitions of Parts of a Compound Microscope

You are going on an *adventure* into the scientific community to learn how science words (**parts of a compound microscope**) were created and developed.

- ↳ You will learn how **root words, prefixes, and suffixes** were used to create science words.



- When learning new science words it is important to pay attention to the parts of science words.
 - The **parts** of science terms **give you clues** to the **meaning** of the science word you are about to learn.

What is the **ocular lens** on a microscope?

Ocular lens

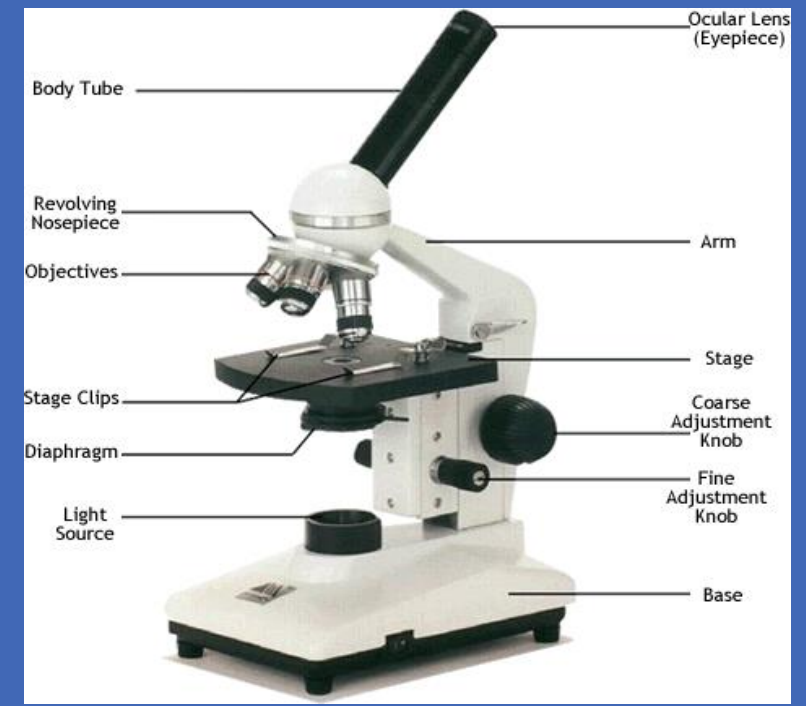
Ocular

+

Lens

Latin (oculus) : meaning an eye

Latin (lens) - meaning glass to regulate light.



Definition: The part of the microscope that you look through to view the specimen.

- It is also known as the eye piece.
- Has a magnification of either 10x or 15x power lens
- The lens the viewer looks through to see the specimen.



Quantitative Results

Cell Unit Mean Scores Pre/Post Intervention

			Instructional Method		
	<u>Traditional</u>			<u>Integrated</u>	
	Pre-Test	Post-Test*		Pre-Test	Post-Test*
Test score	8.64 (4.02)	48.23 (17.41)		8.61 (3.80)	44.57 (18.29)

***Significant increase from Pre-Post Intervention and no differences across Instructional Methods**

Microscope Unit Mean Scores Pre/Post Intervention

	Instructional Method			
	<u>Traditional</u>		<u>Integrated</u>	
	Pre-Test	Post-Test**	Pre-Test	Post-Test*
Test score	8.14 (10.82)	55.40 (11.73)	8.61 (7.35)	46.25(16.36)

***Significant increase from Pre-Post Intervention for Instructional Methods**

***Improvement was stronger for Traditional Method**



Qualitative Results

Theme 1: Increased Student Engagement

- ▶ Sense of play with pronunciations
- ▶ Reduced intimidation when learning long words
- ▶ Learned to identify patterns in words

Theme 2: Interdisciplinary learning

- ▶ Learned the history behind the words
- ▶ Learned how scientists use language

Theme 3: Culture of learning

- ▶ Learned the importance of describing words to communicate scientific discoveries
- ▶ Articulating, defining, and understanding became a shared challenge



Discussion

Discussion

- ▶ Test scores improved across both instructional methods
- ▶ All discipline specific vocab instruction improves conceptual understanding (Venida, 2021)

Discussion

- ▶ No increased benefit of integrated approach over traditional approach on test scores
 - ▶ And traditional approach led to even greater gains for microscope unit

Discussion

- ▶ Microscope versus Cell Content
 - ▶ Microscope: more tangible terms
 - ▶ Microscope: fewer morphologically complex words
- ▶ Microscope content may favour rote memorization
- ▶ Rote memorization leads to greater short-term gains (Yang & Dai, 2011).

Discussion

- ▶ Longer term gains?
- ▶ Oral tests?
- ▶ More inquiry-based learning
- ▶ Increase sample sizes across groups
- ▶ Include new units when comparing approaches

Discussion

- ▶ Despite having no quantitative benefit over the traditional approach
- ▶ Integrated approach showed stronger qualitative improvements

Discussion

- ▶ Integrated approach
 - ▶ Increased engagement, created sense of play, reduced intimidation
 - ▶ Historical and linguistic knowledge
 - ▶ Culture of learning

Conclusion

- ▶ Integrated method adopted for teaching subsequent iterations of the science units after the study ended.



Thank you

▶ Questions and comments?