APBI 401/ SOIL 501 / LWS 501 - SOIL PROCESSES

TERM 1 – Sept – Dec 2022

ACKNOWLEDGEMENT

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xwməθkwəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

Acknowledgments are nothing without action

COURSE INFORMATION

Course Title	Course Code Number	Credit Value
Soil Processes	APBI 401/SOIL 501/LWS 501	3

PREREQUISITES

APBI 200 Introduction to Soil Science or equivalent

CONTACTS

Instructional Team		Contact Details	Office Location	Office Hours
Instructor	Jean-Thomas Cornelis	jt.cornelis@ubc.ca	McMl 225	Fridays, 1.00-2.00pm McMl 225
Academic contributors	Sue Grayston Cindy Prescott	sue.grayston@ubc.ca cindy.prescot@ubc.ca	FSC 3006 FSC 2005	
TA	Harini Aiyer	harini15@mail.ubc.ca	McMl124	Fridays, 1.00-2.00pm McMl 124

COURSE INSTRUCTOR BIOGRAPHICAL STATEMENT

I am an Assistant Professor of Soil Science in Applied Biology in the Faculty of Land and Food Systems at UBC Vancouver campus. I am a pedologist by training, with expertise in soil processes and terrestrial biogeochemistry, and a specific focus on studying soil-forming factors and processes, as well as their controls on ecological functions. My research interests are rooted in investigating the interactions between physicochemical and biological processes to better understand soil-plant interactions and feedbacks and their benefits for terrestrial ecosystem functioning. I am the PI of the SoilRes^3 Lab at UBC (https://soilprocesses.landfood.ubc.ca), you can also find out more at https://www.landfood.ubc.ca/jean-thomas-cornelis or follow me on twitter @jtcornelis

ACADEMIC CONTRIBUTORS

Two academic contributors provide content for this course:

- Sue Grayston – microbial diversity and function
- Cindy Prescott – litter decomposition

COURSE RATIONALE - WHY STUDY SOIL PROCESSES?

Soil systems integrate by nature multiple scales and multiple disciplines. The soil-related challenges to pass on a living planet to future generations are enormous and pressing. A key ingredient is embracing the full complexity of soil-plant feedback interactions in natural systems and translating their benefits to contribute to building up sustainability and resilience in terrestrial ecosystems. To achieve this goal, understanding soil (physicochemical and biological) processes is key given their controls on ecosystem functions such as soil C storage, water purification, nutrient cycling and biodiversity. Soil properties and processes regulate water and solute transport, the carbon cycle, nutrient and water cycles, energy fluxes, microbial diversity/functions and biomass productivity. An integrative approach covering the biological, chemical and physical properties and processes of soils is required to understand the functioning of natural and human-modified ecosystems. Studying microscale soil processes (mineral weathering, organic matter decomposition, organo-mineral associations, soil aggregation) and their evolution depending on environmental factors is central for understanding biogeochemical cycles of elements and how soil-plant feedbacks respond to changes in environmental drivers. Agriculture has a bright, biodiverse and climate-smart future, and understanding the diversity of soil processes and properties in the landscape is a natural ally for building more resilient terrestrial ecosystems.

Understanding soil processes help us determine why soils at a particular location have the characteristics that they do, what soil properties are inherent, and how human activities may modify soil characteristics. Knowledge of soil processes is fundamental to the management of land resources, from both practical and policy perspectives. For students interested in gaining more depth in understanding soil processes, APBI 401 is a foundational course.

COURSE STRUCTURE AND DELIVERY

Year/Term: Winter 2022-2023, Term 1
Course Schedule: **Monday, Wednesday, Friday 11:00 a.m.- 12:00 p.m.** in-person class

Class location: ORCH 1001
Tutorial location: MCLD 3014 (Tuesdays 3.30 – 4.30 p.m.)

The soil, as a bio-physico-chemical reactor at the interface between lithosphere, biosphere, hydrosphere and atmosphere evolves at the expense of parental material as a result of specific combinations of soil-forming factors (climate, vegetation, time and topography). The impact of soil-forming factors on soil development (pedogenesis) will be addressed using a modular format:
This course will be taught using a modular format. We will study soil processes at two scales (pedon and landscape scales) and through the prism of six interrelated chapters, which will allow you to get an integrated view of microscale soil processes controls on soil formation and functions at the landscape:

A. Soil-forming processes at the pedon scale
    1. Weathering and formation of mineral phases: thermodynamic and kinetic principles
    2. Soil organic matter dynamics
    3. Soil colloids, surface chemistry and organo-mineral associations
B. Controls of environmental factors on soil genesis
    4. Soil-forming factors and processes
    5. Soil evolution cycles
    6. Soil sequences and ecological functions

Monday & Wednesday class time – this will be our in-person classes; and will include a mix of **lectures**, and discussion sessions covering core theory and its application. If theoretical materials (readings, online resources) are needed to be reviewed prior to class it will be provided in Canvas.

Friday class time– will largely function through break-out groups with the purpose to get a deep dive into specific soil mechanisms taught on Monday and Wednesday. Through the **group-brainstorm** approach, it will be the opportunity to get clarification on course content or assignments. This implies you will need to undertake some self-directed learning. Midterm exams will also occur on Fridays.

Readings will be assigned prior to the start of each module, and will include class handouts, journal articles, and soil textbook chapters

A tutorial session (required for MLWS students and optional for APBI401/SOIL501 students) will be held Tuesdays 3.30-4.30 pm in MCLD 3014 room. During this time students can bring questions for clarification or review on course material or assignments.

A field trip to explore soils of the UBC campus will be organized in October during class time.

Schedule 2022

Any changes to the schedule will be announced on Canvas. Please be sure you are receiving Canvas announcements for this course.

Date	Day		Topic	Instructor
Sep 7	Wed	Lecture 1	Introduction: course outline, overview – soils as a system	Cornelis
			MODULE A- Soil-forming processes at the pedon scale	
Sep 9	Fri	Lecture 2	Class brainstorm A.0. Why studying soil processes? future key environmental challenges Break-out groups (30') and panel discussion (30')	Cornelis
Sep 12	Mon	Lecture 3	A.1. Rocks, minerals and weathering processes: overview of theoretical concepts	Cornelis
Sep 14	Wed	Lecture 4	A.1. Weathering and formation of mineral phases: thermodynamics and kinetics	Cornelis
Sep 16	Fri	~~Lecture 5~~	~~Class brainstorm A.1. Primary and secondary minerals: soil genesis and functions~~ ~~Break-out groups (30') and panel discussion (30')~~ – ASSIGNMENT 1	Cornelis
Sep 19	Mon	Lecture 6	A.1. Weathering and formation of mineral phases: thermodynamics and kinetics	Cornelis
Sep 21	Wed	Lecture 7	A.1. Weathering and formation of mineral phases: thermodynamics and kinetics	Cornelis
Sep 23	Fri	Lecture 8	Class brainstorm A.1. Primary and secondary minerals: soil genesis and functions Break-out groups (30') and panel discussion (30')	Cornelis
Sep 26	Mon	Lecture 9	A.1. Weathering and formation of mineral phases: thermodynamics and kinetics	Cornelis
Sep 28	Wed	Lecture 10	A.2. Soil organic matter dynamics: balance between decomposition and stabilization processes	Cornelis
Sep 30	Fri	Lecture 11	National Truth & Reconciliation Day – no classes	Cornelis

Oct 3	Mon	Lecture 12	A.2. Soil organic matter dynamics: balance between decomposition and stabilization processes	Cornelis
Oct 5	Wed	Lecture 13	A.2. Field investigation at UBC – soil pit observation	Cornelis
Oct 7	Fri		**Midterm1** (related to A.1.): mineral weathering and soil formation	Cornelis
Oct 10	Mon		Thanksgiving – no classes	Cornelis
Oct 12	Wed			Cornelis
Oct 14	Fri			Cornelis
Oct 17	Mon	Lecture 12	A.2. Soil organic matter dynamics: balance between decomposition and stabilization processes	
Oct 19	Wed	Lecture 14	A.2. Soil organic matter dynamics: balance between decomposition and stabilization processes	Cornelis
Oct 21	Fri		Class brainstorm A.2,3. Soil organic matter paradox and new paradigm Break-out groups (30') and panel discussion (30') – ASSIGNMENT 2	Cornelis
Oct 24	Mon	Lecture 16	A.3. Soil colloids, surface chemistry and organo-mineral associations	Cornelis
Oct 26	Wed	Lecture 17	A.3. Soil colloids, surface chemistry and organo-mineral associations	Cornelis
Oct 28	Fri		Class brainstorm A.2,3. Microbial and organic matter co-interactions Break-out groups (30') and panel discussion (30') – ASSIGNMENT 3	Cornelis
			MODULE B - Controls of environmental factors on soil genesis	
Oct 31	Mon	Lecture 22	B.1. Soil forming factors and processes – landscape scale	Cornelis
Nov 2	Wed	Lecture 23	B.1. Soil forming factors and processes – landscape scale	Cornelis
Nov 4	Fri		**Midterm 2 (related to A2&3):** integrated view of mineral weathering, organic matter dynamics and organo-mineral formation	Cornelis
Nov 7	Mon	Lecture 24	B.1. Soil forming factors and processes: land use effects on soil microbial processes	Aiyer
Nov 9	Wed		Reading week – no classes	

Nov 11	Fri		Remembrance Day university closed – no classes	
Nov 14	Mon	Reading	B.2. Soil acidification and alkalinization: Van Breemen et al., 1983 (p293-295) & Binkley and Richter, 1987	
Nov 16	Wed	Reading	B.2. Soil acidification and alkalinization: Van Breemen et al., 1983 (p293-295) & Binkley and Richter, 1987	
Nov 18	Fri	Lecture 25	Class brainstorm B.1. effects of land use changes on soil formation and functions Break-out groups (30') and panel discussion (30') – ASSIGNMENT 4	Cornelis
Nov 21	Mon	Lecture 26	B.2. Soil acidification and alkalinization	Cornelis
Nov 23	Wed	Lecture 27	B.3. Soil processes of the world	Cornelis
Nov 25	Fri	Lecture 28	Class brainstorm B.2. soil-microbiome-root-plant interactions are key for agriculture adaptation and mitigation to climate change – ASSIGNMENT 5	Cornelis
Nov 28	Mon	Lecture 29	B.3. Soil sequences and ecological functions	Cornelis
Nov 30	Wed	Lecture 30	B.3. Soil sequences and ecological functions	Cornelis
Dec 2	Fri		Graduate student's poster presentation (specifically for SOIL 501)	Cornelis
Dec 13-18			Final exam TBA	

LEARNING OUTCOMES

Upon completion of APBI 401 / SOIL 501 / LWS 501 successful students will be able to:

1. Integrate the fundamental disciplines to **assess** and **compare** pedogenic processes and their roles in contributing to build sustainable ecosystems
2. **Categorize** and **diagnose** the laws governing soil development by articulating key soil physical, chemical and biological processes
3. **Formulate** and **predict** soil processes controlling soil evolution according to changes/variation in environmental factors
4. Integrate fundamental soil processes and **apply** concepts to assess soil characteristics, their influence on soil formation, properties and related ecological functions

5. Critically **evaluate** and **formulate** practices that contribute in developing resiliency and sustainability in terrestrial ecosystems by **applying** the understanding of soil processes.

LEARNING MATERIALS

Teaching Technology:

The UBC *Canvas* learning management system will be used throughout the course for course communication, assignment submission, grading etc. Course notes and pre-recorded videos are available in Canvas. Please see here for a student guide to using Canvas and for Canvas related technical support.

Zoom will be used for virtual tutorials and office hours, when specifically stated. A link to UBC Zoom can be found within the course Canvas site.

Please do not email the instructor or the TA for technical support issues. We cannot solve these issues and this will only further delay your efforts. Please DO let us know if something is missing or not working properly on the Canvas/iPeer course sites – this may be something we can fix and will help us resolve the issue for all class members.

Readings:

Readings are organized by module and listed in canvas. Required readings will be available via Canvas or links to the UBC Library. The following books can be proposed as additional readings for complementing your learning, though they are not required to meet the learning outcomes:

- *Digging into Canadian soils* "https://openpress.usask.ca/soilscience/"
- *The Nature and Property of Soils* by Brady and Weil,
- *The Chemistry of Soils* by Sposito,
- *Soil Formation* by van Breemen and Buurman
- *Pedology* by Duchauffour.
- *Virtual Soil Tour:* https://processes.soilweb.ca/

Given the relatively high cost of these books, if you wish to consult them I am willing to share with you my personal copies.

LEARNING ACTIVITIES & ASSESSMENT OF LEARNING

The Environmental consulting sector (as one of the main employers of those with soil science knowledge) has identified the need for excellent technical communication skills based on the 5 Cs of communication - correct, clear, concise, consistent, and complete. We will use the 5 Cs approach to report writing in this course (assignments and exams).

Overview:

Activity		401 Weighting	501 Weighting	Due date
Assignments	Individual (n=4)	30%	30%	The following Friday
Midterm exams	Open book (n=2)	30%	25%	Oct 7 & Nov 4, 2022
Final exam	Seen question[1]	40%	35%	Dec TBA
Poster / Presentation		/	10%	Dec TBA

[1] In seen question exams students are given questions ahead of time (see details below)

Assignments:

***Individual written reports*:** there are 5 assignments that follow the modular nature of the course: 1) mineral weathering and formation, 2) organic matter dynamics, 3) organo-mineral associations, 4) Soil-forming factors and processes, 5) Soil evolution/sequences. Recognizing how flexible schedules might be beneficial for student's well-being, which when improved significantly increase cognitive abilities, students are asked to choose 3 assignments among the 5 proposed. For each assignment, students will integrate concepts covered in class via calculations, data interpretation and the application of concepts for soils, plants and/or the environment. Specific details for each assignment will be posted in Canvas.

***Submission of assignments*:** all assignments are to be submitted online in Canvas in Word (doc or docx), pdf, or pptx and xls formats only. If your file does not open, I will consider the assignment as not submitted.

Late assignments: assignments must be uploaded to Canvas by the due date. Individual assignments submitted beyond the due date will be subject to a -10% per day (including weekend days) late penalty, maximum 4 days. Recognizing life is not always a bed of roses, I remain open to discussion of well-justified specific cases. If you are having trouble meeting an assignment deadline, please let me know so that I can work with you and your advising office to come up with a plan to fulfill course requirements should you have documented medical or other extenuating circumstances.

The assignments will be assessed on the basis of content (i.e., scientific rigor and accuracy), organization, application potential, and originality/creativity, as follows:

20% - Clear structure and organization of your rationale

30% - Scientific rigor of your statements and accurate interpretation

10% - potential application and importance of your statement for Environmental consulting sector

30% - originality and creativity of your statements. How your interpretations and ideas can move the field forward, and towards new research avenues.

Midterm exams: will be open book (online), and consist of 2 short answer questions, duration 45 minutes. All answers must be written in your own words. An example of questions will be posted in Canvas. No make-up exams will be offered.

Final exam: will be scheduled by classroom services during the exam schedule in December, 2022. The final exam will be cumulative. Questions will be posted 3 days prior to the exam (i.e., a seen question exam), however, not all of the posted questions will be on the exam, and you will not know the exact format of individual questions until the exam (e.g., 150 word synopsis, 500 word mini-essay, a drawn schematic or combination…). All answers must be prepared by individual students and written in your own words.

Retention of assignments: Students should retain a copy of all submitted assignments (in case of loss). Students have the right to view their marked examinations with their instructor, providing they apply to do so within a month of receiving their final grades. The examination remains the property of the university.

Grading guidelines: see http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,42,96,0

Percentage (%)	Letter Grade	Percentage (%)	Letter Grade
90-100	A+	85-89	A
80-84	A-	76-79	B+
72-75	B	68-71	B-
64-67	C+	60-63	C
55-59	C-	50-54	D
0-49	F (Fail)		

HOW TO GET HELP

There are two main platforms for you to get help with course content. 1) Tuesday's tutorials 3.30-4.30pm, and 2) Post your questions to a Canvas discussion forum. I will not answer content related questions via email, as other students benefit from clarification – please use the discussion forum in Canvas.

For non-content related questions, please email me via Canvas mail or use the "Office hour Sign Up" tool on Canvas. In-person Office hours can be arranged by appointment.

UNIVERSITY POLICIES

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access, including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions.

Details of the policies and how to access support are available on the UBC Senate website.

OTHER COURSE POLICIES

Academic Integrity:

Academic honesty is a core value of scholarship; all students are expected to know, understand and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you, and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not copy, present the work of others as your own, or self-plagiarize. Violations of academic integrity (i.e., misconduct) are taken very seriously at UBC, and harsh sanctions are imposed. Incidences of plagiarism or cheating may result in a mark of zero on an assignment or exam, and more serious consequences may apply when the matter is referred to the Office of the Dean. Careful records are kept in order to monitor and prevent recurrences. A more detailed description of academic integrity, including the University's policies and procedures, may be found in the UBC Calendar: Student Conduct and Discipline. Please contact me if you are unsure about these policies so that I can clarify them for you.

Early Alert:

During the term, I will do my best to reach out and offer support if I am concerned about your academic performance or wellbeing. I also encourage you to come and speak with me, or with student services, if you need assistance. In addition, I may identify my concerns using Early Alert. The program is confidential and provides you with connection to resources such as academic advising, financial advising, counseling, or other resources and support to help you get back on track. For more information, please visit earlyalert.ubc.ca.

Academic Concession:

For the first occurrence of an acute illness (cold, flu or other) or compassionate grounds, a *self-declaration* will suffice. To request academic concession, please email me prior to the due date. A doctor's note is NOT required for this request. If you have an ongoing issue including: conflicting responsibilities, medical circumstance, or compassionate ground (e.g. death in the family) please contact your Faculty's advising office for guidance.

Once academic concession is granted, the weight of the missed assignment or midterm will be redistributed to the other course items of the same type. If you miss the final examination for reasons such as illness or family crisis, you must inform your Faculty's advising office of the reason for the absence in a timely manner (within a few days). Note that if you are ill for an exam and choose to write it, then the grade obtained on the examination will stand. There are no rewrites or make-ups of midterm or final examinations.

Assignment or exam regrades:

If you notice a potential grading error on an assignment or exam, please notify me (email or Canvas mail) as soon as possible.

To request a regrade of your final examination you must apply for a Review of Assigned Standing. Information on this process is found in the UBC calendar.

LEARNING ANALYTICS

Learning analytics includes the collection and analysis of data about learners to improve teaching and learning. This course will be using the Canvas learning technologies. Many of these tools capture data about your activity and provide information that can be used to improve the quality of teaching and learning. In this course, I plan to use analytics data to:

- View overall class progress
- Track your progress in order to provide you with personalized feedback
- Review statistics on course content being accessed to support improvements in the course
- Assess your participation in the course

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Generic Grading Rubric for Assignments

	Excellent	Good	Satisfactory	Unsatisfactory
Calculations (20-50%)	90-100% of steps and solutions are completed with no errors (mathematical or in formulas)	Almost all (80-89%) of steps and solutions completed without errors	Most (70-79%) steps and solutions completed without errors	Less than 70% of steps and solutions attempted or have errors
Interpretation (20-50%)	Interpretation of data detailed and clear; includes all key components and concepts	Interpretation of data clear and includes key components and concepts; lacks some detail	Data interpretation difficult to understand but includes key components and concepts	Data interpretation difficult to understand and is missing several key components; or interpretation lacking
Application / importance (20-40%)	Clear focus on relevant soil characteristics; detailed assessment of the importance of soil processes for plants and/or for the environment	Focus on major soil characteristics; demonstrates the importance of soil processes for plants and/or for the environment; lacks some detail	Not all relevant soil characteristics or processes considered; lacks depth	Fails to demonstrate an understanding of key soil processes and their importance for plants and/or the environment

Structure, organization, grammar, references (5-10%)	Report is presented in a well-organized, logical order; diagrams or sketches provide additional clarity; easy to read, few grammatical errors; sources referenced	Report is presented in a well-organized manner; diagrams or sketches used where appropriate; easy to read, few grammatical errors; sources referenced	Report lacks logical organization; diagrams or sketches not clear; some grammatical errors; not all sources referenced	Report unorganized, difficult to read; diagrams or sketches not used; many grammatical / spelling errors; sources not referenced

Note: specific rubrics for individual assignments will be posted in Canvas.