Rubric for Ph.D. Oral Exam, Columbia E3B department.

	Knowledge	**Critical thinking and skills** Ability to …
Excellent (on par with practicing scientists in the student's field)	• Content knowledge • Procedural knowledge • Epistemological knowledge • Literature knowledge	• … apply knowledge • … synthesize knowledge • … process and assimilate new information • … interpret information • … evaluate information • … reason through evidence • … convey degree of certainty
Adequate (less than a practicing scientist in the student's field, but sufficient)	• Content knowledge • Procedural knowledge • Epistemological knowledge • Literature knowledge	• … apply knowledge • … synthesize knowledge • … process and assimilate new information • … interpret information • … evaluate information • … reason through evidence • … convey degree of certainty
Inadequate (lacking in a variety of important areas)	• Content knowledge • Procedural knowledge • Epistemological knowledge • Literature knowledge	• … apply knowledge • … synthesize knowledge • … process and assimilate new information • … interpret information • … evaluate information • … reason through evidence • … convey degree of certainty
Poor (lacking in most or all important areas)	• Content knowledge • Procedural knowledge • Epistemological knowledge • Literature knowledge	• … apply knowledge • … synthesize knowledge • … process and assimilate new information • … interpret information • … evaluate information • … reason through evidence • … convey degree of certainty

Student:____ Date:_____________________

Committee chair:____

Committee member:_______________________________________

Committee member:_______________________________________

Feedback:

Notes and explanations

Purposes of the oral exam:
There are many purposes of the oral exam. As a summative assessment of knowledge and skills, it is a check on the student's progress through the Ph.D. program. As a formative assessment, it provides feedback to the student and the student's adviser on the student's knowledge and skills. The hope is that this feedback will be useful to hone the student's knowledge and skills as the student moves forward in the Ph.D. program and career.

The oral exam is also meant to prepare students for the myriad situations in which knowledge and critical thinking will be assessed in real-world contexts. Two examples are at scientific meetings and job interviews, where both one-on-one meetings and Q&A sessions following talks require this sort of interaction. The faculty hope that the preparation for and participation in the oral exam will help students' performance and confidence in these situations.

Categories (columns):

Knowledge refers to breadth of knowledge within ecology, evolution, and environmental biology, as well as the depth of knowledge in the student's area(s) of specialty. The specific area(s) that students will be expected to know will differ from student to student and committee to committee, so students should meet with each committee member individually before the exam to discuss specific topics and readings. Reading lists from each committee member should not exceed ~10 papers (or equivalent for textbooks), though faculty are free to ask anything they deem relevant during the exam.

The knowledge types (bullet points) are:

- **Content knowledge** ("know that …") includes concepts, facts, and theory.
    - E.g., explaining or applying the principle of competitive exclusion.
- **Procedural knowledge** ("know how to …") includes experimental and study design, gathering data, and analyzing data.
    - E.g., how to design an experiment to evaluate competitive exclusion.
- **Epistemological knowledge** ("how we know what we know") includes the relative roles of theoretical, observational, and experimental work.
    - E.g., explaining that theory can suggest conditions under which competitive exclusion could happen.
- **Literature knowledge** ("know who/what paper/when") includes names, dates, and attribution of concepts, procedures, and epistemology.
    - E.g., knowing that Gause studied competitive exclusion of *Paramecium* in a lab in the 1930s.

Critical thinking and skills include just about any cognitive demand other than recall, along with some other skills the faculty have identified as important. The sub-categories are:

- **Applying knowledge** includes using information in context.
    - E.g., applying the principle of competitive exclusion to a question about invasive species.
- **Synthesizing knowledge** includes combining disparate pieces of information.
    - E.g., using the principle of competitive exclusion along with the relationship between biodiversity and productivity to address how the loss of niches might influence carbon cycling.
- **Processing and assimilating new information** includes thinking on one's feet.
    - E.g., learning about mugwump biology in the exam and making an informed prediction about which mugwumps will be competitively excluded.
- **Interpreting information** includes reading figures and tables.
    - E.g., translating a line from a log-log graph of two species' abundance to the equation $y = ax^z$.

- **Evaluating information** includes assessing the validity of evidence and making sense of conflicting information.
    - E.g., identifying that an experiment on competitive exclusion without a control is less powerful than one with a control.
- **Reasoning through evidence** includes using logic, inference, inductive, and deductive reasoning.
    - E.g., identifying the logical fallacy in the statement: "Competitive exclusion drives species to extinction. Moas went extinct. Therefore, moas were competitively excluded."
- **Conveying certainty** includes clarifying whether a student's response is fact vs. inference vs. speculation; also includes making sense of different ways scientific uncertainty is expressed.
    - E.g., stating that there is definitely a logical fallacy in the statement about moas and competitive exclusion, but that the actual reasons for extinction are somewhat uncertain (and why).

Proficiency levels (rows):

These define the levels of proficiency for each category and subcategory. The terminology used for the proficiency levels is necessarily vague due to the nature of the oral exam. More concrete terminology, such as cutoffs based on % of answers that are correct, would not work for a variety of reasons. Examiners ask different questions to different students and typically adapt their follow-up questions as the conversation proceeds. Examiners are often trying to find the limits of the student's knowledge, which means that it would be possible to miss a lot of questions and still achieve "excellent" in both categories. That said, the proficiency levels are meant to provide students with an idea of what the faculty expect, and to provide faculty with a common language with which to discuss students' performance on the exam.

The terminology of the proficiency levels is meant to convey that students are not expected to know everything or be able to do everything. The gold standard at this stage ("Excellent") is to have the knowledge breadth, knowledge depth, and skills of practicing scientists (e.g., faculty) within the student's field (e.g., the student's adviser(s)). Faculty, of course, do not know everything either. "Adequate" levels of proficiency indicate a trajectory toward the knowledge breadth, knowledge depth, and skills of a practicing scientist in the student's field by the time the student graduates. "Inadequate" levels of proficiency indicate that the student is below the level they should be for their stage. "Poor" levels of proficiency indicate that the student is far below the level they should be for their stage.

Students will be expected to have greater depth of knowledge within their own subfield, but also breadth of knowledge across the fields that the committee deems relevant. Therefore, a student who studies competitive interactions between *Paramecium* species in a lab would be expected to know much more about the principles of community ecology and the techniques of lab microbiology than the procedures for how to derive novel insights from a differential equation model, but might still (at the discretion of the committee) be expected to know how to read and interpret the Lotka-Volterra competition equations.

Passing the oral exam will require students to achieve proficiency levels of "Adequate" or higher in each of the two categories on the rubric.

Proficiency levels are assessed at the category level, not the sub-category level, as some sub-categories might not be covered on any given exam.