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UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
Developing a Thesis Statement

It takes a fair amount of mental effort to come up with a useful thesis statement. While taking notes, continually ask yourself:

- Why am I writing this down?
- What is especially interesting about this particular information?
- What puzzles me about what I have read?
- Can I see any relationship between this information and anything else that I have read, written, or learned previously?
- What assumptions do the authors make, and does each assumption seem reasonable and well supported?

Look also for apparent contradictions in the results of different studies, and in the interpretations of different authors. Look for patterns, and for exceptions to those patterns.

As you finish each paper, jot down some ideas for topics you would like to know more about. As you start developing opinions about what you have read, jot those thoughts down, too, and ask yourself what those opinions are based on. Writing down such thoughts will help self-provoke intellectual engagement with the material, which is an essential ingredient in the recipe for success.

Eventually, you will begin coming up with original ideas, interesting things you hadn't thought about before, and then you will be ready to draft a thesis statement that both you and your readers will find interesting.

A thesis statement needs support to be convincing. You might, for example, suggest that although many authors assume that all snail species serve as intermediate hosts for parasitic flatworms, there are good reasons to question this assumption. Or you might suggest that the remarkable diversity of reproductive patterns among marine animals is made possible by the chemical and physical properties of seawater. Or you might argue that frog tadpoles rely more on chemical cues than on visual cues to distinguish relatives from nonrelatives. Or you may not reach any definitive conclusion at all, and your argument might be just that we don't seem to understand as much about some particular topic as some people think we do, and that there are specific, important issues that need to be studied further.

Refine your draft thesis statement as you keep reading, and as you keep writing, until you have a statement that you find interesting, that is not self-evident, and that requires support. This statement will fuel the entire project. You will present this statement near the beginning of your paper and then devote the rest of the paper to supporting it.

There's something magical about thesis statements and where they come from. As you continue to read and think and write, they just mysteriously appear. If you start your assignment well in advance of when it is due and spend several hours a week reading and thinking about your topic—follow the methods advocated in Chapter 3—I can almost guarantee that it will happen for you. If you wait to begin reading and thinking until a week or less before your report is due, I can almost guarantee that it will not.

Writing the Paper

Getting Underway: Taking and Organizing Your Notes

Some instructors add considerable work to their lives by monitoring your progress, such as asking to see your notes, lists of papers read, summaries or critiques of those papers (pp. 121–128), and partial drafts. This is splendid for you because it puts you on a schedule; otherwise, you must schedule yourself. Start on the project as soon as possible, and allocate at least a few hours a week to it, every week, until it's done.

Once you have at least a draft of a thesis statement, begin the formal writing process by reading all of your notes, preferably with hands off the keyboard and without pen or pencil in hand. Having read your notes to get an overview of what you have accomplished, reread them, this time with the intention of sorting your ideas into categories. Notes taken on index cards are particularly easy to sort, provided that you have not written many ideas on a single card; one idea per card is a good rule to follow. To arrange notes written on full-sized sheets of paper, some people suggest annotating the notes with pens of different colors or using a variety of symbols, with each color or symbol representing a particular aspect of the topic. Still other people simply use scissors to snip out sections of the notes and then group the resulting scraps of paper into piles of related ideas. And, of course, if you have entered notes directly into a computer, you can cut and paste the notes to group together those on related issues. Experiment until you find a system that works well for you.

At this point, you must eliminate any notes that are irrelevant to the specific topic you have decided to write about. No matter how interesting a fact or idea is, it has no place in your paper unless it helps you develop your argument. Some of the notes you took early on in your exploration of the literature are especially likely to be irrelevant to your essay, because you took those notes before you had developed a firm focus. Put these irrelevant notes in a safe place for possible later use; don't let them coax their way into your paper.

You must next arrange your categorized notes so that your essay or term paper progresses toward some conclusion. Again, ask yourself whether a particular section of your notes seems especially interesting to you, and why it does, and look for connections among the various items as you sort. Idea mapping (Chapter 6, pp. 79–83) can be a great help in organizing your material.
The Crucial First Paragraph

The direction your paper will take must be clearly and specifically indicated in the opening paragraph, as in the following example written by student A:

Most bivalve mollusks are sedentary, living either in soft-substrate burrows (e.g., soft-shell clams, Mya arenaria) or attached to hard substrates (e.g., the blue mussel, Mytilus edulis) (Barnes, 1980). However, individuals of a few bivalve species live on the surface of substrates, unattached, and are capable of locomoting through the water. One such species is the scallop Pecten maximus (Thomas and Gruffydd, 1971). In this essay, I will argue that swimming is made possible in P. maximus by a combination of unique morphological and physiological adaptations, and I will then consider some of the evolutionary pressures that may have selected for these adaptations.

In this first paragraph, student A defines the topic, states the specific problem to be addressed, and tells us clearly why the problem is of interest: (1) the typical bivalve doesn't move and certainly doesn't swim, (2) a few bivalves can swim, (3) so what is there about these exceptional species that enables them to do what other species can't and (4) what forces may have selected for such swimming ability? Note that use of the pronoun I is now perfectly acceptable in scientific writing.

In contrast to the previous example, consider the following weaker (although not totally unacceptable) first paragraph written by student B on the same subject:

Most bivalved mollusks either burrow into, or attach themselves to, a substrate. In a few species, however, the individuals lie on the substrate unattached and are able to swim by expelling water from their mantle cavities. One such lamellibranch is the scallop Pecten maximus. The feature that allows bivalves like P. maximus to swim is a special formation of the shell valves on their dorsal sides. This formation and its function will be described.

In this example, the second sentence weakens the opening paragraph considerably by prematurely referring to the mechanism of swimming. The main function of the sentence should be to emphasize that some species are not sedentary, the reader, not yet in a position to understand the mechanism of swimming, becomes a bit baffled. The next-to-last sentence of the paragraph ("The feature that allows...") also hinders the flow of the argument. Indeed, there doesn't seem to be any argument. This sentence summarizes the essay before it has even been launched, and again, the reader is not yet in a position to appreciate the information presented: What is this "special formation," and how does it have anything to do with swimming? The first paragraph of a paper should be an introduction, not a summary. It must set the stage for all that follows.

The last sentence of student B's paragraph does clearly state the objective of the paper, but the reader must ask, "Toward what end?" The author has set the reader up for a book report, not for a critical evaluation or a persuasive argument. Reread the paragraph written by student A, and notice how the same information has been used much more effectively, introducing a thoughtful essay rather than a tedious recitation of facts. Student A's first paragraph was written with a clear sense of purpose; each sentence carries the reader forward to the final statement of intent, the argument on which the rest of the paper will be based. You might guess (correctly, as it turns out) from reading student B's first paragraph that the rest of the paper was somewhat unfocused and rambling. In contrast, student A's first paragraph clearly signals that what follows will be well focused and tightly organized. It might take 3 or 4 revisions, but be sure to get your papers off to an equally strong start.

The first paragraph of your paper must state clearly what you are setting out to accomplish, and why, and should make the issue seem worth reading about. The remaining paragraphs should advance your argument, clearly and logically, toward the stated goal.

Supporting Your Argument

State your case, and build it carefully. Use your information and ideas to build an argument, to develop a point, to synthesize. Sketching an idea map (Chapter 6, pp. 79–83) is an excellent way to organize your thoughts into a powerful and logical progression of ideas. If you are writing an extensive term paper, you can (and should) use many of your idea map topics as headings or subheadings to help guide readers through the issues covered. The Quarterly Review of Biology and Biological Reviews provide particularly good examples of the effective use of headings and subheadings in structuring lengthy literature reviews.

Avoid the tendency to simply summarize papers one by one: The authors did this, then they did that, and then they suggested the following explanation. Instead, set out to compare, to contrast, to illustrate, to discuss. As described more fully in Chapter 5, you must back up all statements of fact or opinion with supporting documentation; this documentation may be an example drawn from the literature you have read or a reference (author and date of publication) to a paper or group of papers that support your statement, as in the following example:

The ability of an organism to recognize "self" from "non-self" is found in both vertebrates and invertebrates (Kuby, 1997). Even the most primitive invertebrates show some form of this immune response. For example, Wilson (1907) found that cells disassociated from 2 different sponge species would regroup according to species; cells of one species never reaggregated with those of the second species.
Similarly, the opening sentences in the student examples on pp. 131 and 135 are supported by references. In contrast, the statements by student B on p. 132 have no such support, weakening considerably the writer's authority.

In referring to experiments, don't simply state that a particular experiment supports some particular hypothesis, or that a researcher reached a particular conclusion; describe the relevant parts of the experiment and explain how the results relate to the hypothesis in question. For example, how potent are the following sentences?

Dudash and Carr (1998) presented evidence that deleterious recessive alleles were responsible for inbreeding depression in 2 closely related plants in the genus Mimulus. In contrast, Karkkainen (1999) showed that deleterious recessive alleles could not account for inbreeding depression in the self-incompatible herb Arabis petraea.

There is nothing in these sentences to convince readers of anything—not even that their author has read more than the title and abstract of the papers cited. In contrast, look at how much more convincing the following paragraph is:

Foreign organisms or particles that are too large to be ingested by a single leukocyte are often isolated by encapsulation, with the encapsulation response demonstrating clear species-specificity. For example, Cheng and Galloway (1970) inserted pieces of tissue taken from several gastropod species into an incision made in the body wall of the terrestrial gastropod Helisoma duryi. Tissue transplanted from other species was completely encapsulated within 48 hours of the transplant. Tissue obtained from individuals of the same species as the host was also encapsulated, but encapsulation was not completed for at least 192 hours.

In all of your writing, avoid quotations unless they are absolutely necessary; rely on your own words and your own understanding of what you have read.

The Closing Paragraph
At the end of your essay, summarize the problem addressed and the major points you have made, as in the following example:

Clearly, the basic molluscan plan for respiration that had been successfully adapted to terrestrial life in one group of gastropods, the terrestrial pulmonates, has been successfully readapted for life in water by the freshwater pulmonates. Having lost the typical molluscan gills during the evolutionary transition from salt water to land, the freshwater pulmonates have evolved new respiratory mechanisms involving either the storage of an air supply (using the mantle cavity) or a means of extracting oxygen while under water, using a gas bubble or direct cutaneous respiration. Further studies are required to fully understand how the gas bubble functions in pulmonate respiration.

Never introduce any new information in your summary paragraph.

Citing Sources
Cite only sources that you have actually read and would feel confident discussing with your instructor. Unless told otherwise, cite sources directly in the text by author and date of publication rather than by using footnotes. For example

Kim (1976) demonstrated that magnetic fields established by direct current can alter the rates of enzyme-mediated reactions in cell-free systems. Similarly, magnetic fields established by alternating current can affect the activity of certain liver enzymes (Yashina, 1974) and mitochondrial enzymes (Kholodau, 1973).

More detailed information about citing sources is given in Chapter 5 (pp. 66–70).

At the end of your paper, include a Literature Cited section listing all the publications referred to in your paper. Your instructor may specify a particular format for preparing this section of your paper. For specific information about preparing the Literature Cited section, see pp. 70–76.

Creating a Title
By the time you have finished writing, you should be ready to title your creation. Give the essay or term paper a title that conveys significant information about the specific topic of your paper (see also pp. 201–202):

No: Factors controlling sex determination in turtles
Yes: The roles of nest site selection and temperature in determining sex ratio in loggerhead sea turtles

No: Biochemical changes during hibernation
Yes: Adaptations to environmental stress: The biochemical basis for depressed metabolic rate in hibernating mammals

No: The control of organ development in fish
Yes: The novel gene "exdpl" regulates pancreas development in zebrafish
In your enthusiasm to make your title specific and informative, don't also make it unnecessarily wordy. How would you improve the following title?

Does adaptation to copper result in a decrease in glutathione S-transferase activity over time in the marine mussel *Mytilus galloprovincialis*?

Following the Second Commandment of Concise Writing (Chapter 6, pp. 95-96), let's strengthen the verb by replacing "result in a decrease" with simply "decrease." Also, doesn't "decrease" already imply the passage of time? By eliminating the redundancy, the title then becomes:

Does adaptation to copper decrease glutathione S-transferase activity in the marine mussel *Mytilus galloprovincialis*?

### Revising

Once you have a working draft of your paper, you must revise it, clarifying your presentation, removing ambiguity, eliminating excess words, and improving the logic and flow of ideas. Revising is discussed in Chapter 6. If you are having difficulty organizing your ideas, I urge you to try idea mapping (pp. 79-83). You may also have to edit for grammar and spelling. Always leave time for at least 1 or 2 revisions of your work.

### CHECKLIST FOR ESSAYS AND REVIEW PAPERS

- The title is informative.
- The opening paragraph indicates the specific direction that the paper will take and leads to a clear thesis statement that will drive the rest of the paper.
- All statements of fact and opinion are supported by references or examples.
- Research papers and other references are discussed in relation to one another, rather than in isolation.
- How particular results support particular hypotheses or lead to specific questions is indicated.
- No new information is presented in the final paragraph.

### BASIC PRINCIPLES

Answering essay questions on examinations is somewhat like writing summaries, except that you have only a short time to complete your work, usually from 15 to 50 minutes, and you have no choice in the subject of the essay. As with writing summaries, critiques, or review papers, you want your opening sentences to set the stage for all that follows, and as in writing a review paper, you should discuss the components of your answer in relationship to one another. Here's an example of how this is done:

Animals that live at freezing temperatures and those that live at very hot temperatures protect themselves by synthesizing different types of molecules. Cold-adapted organisms employ molecules that either lower the temperature at which water freezes within the organism or protect against the harmful effects of ice formation by causing water to freeze outside the tissues. In contrast, organisms adapted to living at hot temperatures prevent important cellular processes from failing by increasing the production of certain enzymes that stop, or reverse, protein denaturation.

The author then goes on to expand these ideas. Note how he has very nicely set the stage for what is to come.

A winning answer to an essay question will also follow all the guidelines outlined in Chapter 1. In particular, make your statements specific, and support them with examples or diagrams. Your performance on essay questions can be strengthened by keeping in mind a few additional points:

1. **Read the question carefully before writing anything.** You must answer the question posed, not the question you would have preferred to see on the examination. In particular, note whether the question asks you to list, discuss, or compare. A list will not satisfy the requirements of a discussion or comparison. A request for a list tests whether

*Based on an essay by Casey Diederich, 2011.*