

Advice to Young Mathematical Biologists

by Kenneth Lange

The following practical recommendations for graduate student survival are taken from my own observations and several written sources. Foremost among the outside sources is the provocative book *Indiscrete Thoughts* by the late mathematician Gian-Carlo Rota [3], who served as my doctoral thesis advisor. Rota devotes chapters 18 and 19 of his book to giving career advice to mathematicians. I have also included some of the wonderfully dictatorial rules of composition of Strunk and White [4] and Gopen and Swan [2] and the grandmotherly advice of Suzette Elgin [1]. Laboratory scientists should ignore a few of my recommendations specifically intended for mathematical biologists.

1. Taking charge of your education

- (a) Get a broad undergraduate education in the sciences, emphasizing biology, chemistry, classical physics, applied mathematics, computer science, and statistics.
- (b) Don't be inhibited about taking courses outside your major graduate department. Ignore the self-serving admonitions of most departments to the contrary.
- (c) Take the minimum number of laboratory courses. You need to understand techniques, not master them.
- (d) Enroll in medical school if strongly motivated. You'll get a good general education in human biology that will inform your judgment about worthy research problems.
- (e) Skip the prolonged residency programs after medical school. Do you want to reach middle age before you embark on research?
- (f) Attend seminars and scientific conferences. Some talks are incomprehensible, some trivial, and some platforms for boasting. However, other talks will suggest avenues of research that would never have occurred to you.

2. Finding and relating to a Mentor

- (a) Choose someone who is interesting, has influence, and will devote time to you. A good mentor will be your guardian angel.
- (b) Follow his or her thesis advice unless you have a brilliant idea of your own.
- (c) Be prepared for withering criticism and a total rewrite of the first drafts of your papers.
- (d) Don't give up because your first thesis attempt doesn't pan out. If your mentor has handed you a sure-fire project, then it probably is dull.

- (e) Rely on his or her advice about jobs, both at the start and midway through your career.
- (f) Don't continue to work solely with your advisor once you have graduated. Review committees will comment on your lack of independence.

3. Writing style

- (a) Write with your readers in mind. Pity them in their confusion.
- (b) Write informative introductions. (Rota)
- (c) Give lavish acknowledgments. (Rota)
- (d) Choose a suitable design and hold to it. (Strunk and White)
- (e) Use the active voice. (Strunk and White)
- (f) Put statements in positive form. (Strunk and White)
- (g) Use definite, specific, concrete language. (Strunk and White)
- (h) Omit needless words. (Strunk and White)
- (i) Express parallel ideas in parallel form. (Strunk and White)
- (j) Follow the subject of a sentence as soon as possible with its verb. (Gopen and Swan)
- (k) Make certain that the antecedent of every pronoun is clear.
- (l) The end of a sentence is the "stress position." Place new information there. (Gopen and Swan)
- (m) The beginning of a sentence is the "topic position." Place old information and connections to previous material there. (Gopen and Swan)
- (n) Avoid jargon and the introduction of unnecessary mathematical symbols.
- (o) Don't copy Faulkner (long Germanic sentences) or Hemingway (a succession of short, choppy sentences). Strive for variety in vocabulary and sentence structure.
- (p) Favor a plain style over a formal, stilted style. Scientific findings are best expressed in ordinary language.
- (q) Read your prose out loud to test its cadence.
- (r) Take the advice of colleagues, editors, and reviewers in revising your work.

4. Giving seminars

- (a) Never underestimate the importance of a seminar to your career. A good seminar presentation is almost as important as a good paper.
- (b) Every lecture should make only one main point. (Rota)
- (c) Never run overtime. (Rota)
- (d) Prepare more than enough material and decide beforehand on a few conveniently placed stopping points.
- (e) Relate to your audience. (Rota)
- (f) Give them something to take home. (Rota)

- (g) Make sure the blackboard is (initially) spotless. (Rota)
- (h) Start writing on the top left corner. (Rota)
- (i) Use transparencies or slides, but don't make them too busy. Use large print.
- (j) Label the axes of graphs.
- (k) Don't embarrass yourself by carrying out impromptu arithmetic calculations.

5. Publishing

- (a) Publish the same result several times. (Rota)
- (b) You are more likely to be remembered by your expository work. (Rota) (Reserve authoring books for later in life.)
- (c) In submitting a paper, match the journal to the content of your paper.
- (d) Avoid journals with especially long times to publication unless their prestige merits an extra wait.
- (e) If you are convinced that you have received an unfair review, be willing to fight for the acceptance of your paper. Reply to criticisms logically, not angrily.
- (f) If your paper is finally rejected, don't be discouraged. Use the comments of the reviewers as a basis for revision before you submit elsewhere.
- (g) Hold to a "three strikes policy." If your paper has been rejected three times, drop it and go on to something else.

6. Getting and keeping a job

- (a) Never ask someone to write a letter of recommendation whose support you are unsure of.
- (b) Supply recommenders with your resume and statement of purpose.
- (c) Never make enemies unnecessarily. Enemies wind up reviewing your papers, grant proposals, promotion to tenure, and applications for outside jobs.
- (d) Never make nonnegotiable demands unless you are prepared to live with the consequences of being turned down.
- (e) Don't reject a job offer because you were the second or third choice of the institution.
- (f) Never trust a department chair or, particularly, a dean you don't already know. Get every deal in writing.
- (g) All else being nearly equal, always choose the job at the more prestigious institution.
- (h) If you are inclined to boast, don't; if you are shy and not inclined to boast, do.

7. Scientific collaborators

- (a) Do not show your questioners the door. (Rota)
- (b) Seek out laboratory biologists with a strong theoretical bent. They are the ones who can define problems for you.
- (c) Respect the contributions of your collaborators. Every scientist thinks his or her contribution is the crucial one.
- (d) When getting someone else to do a task is more work than just doing it yourself, do it yourself. (Elgin)
- (e) Organize joint seminars to find a common ground for collaboration.
- (f) Ask friendly laboratory scientists to verify your theoretical predictions.
- (g) Remember, if grant money is involved, the principal investigator of a grant has ultimate control of how the money is spent.
- (h) Don't allow your name to be added to an inferior paper as a goodwill gesture.

8. Work habits

- (a) Every mathematician and every scientist has only a few tricks. (Rota)
- (b) Don't worry about your mistakes. (Rota) (Perfection is impossible, and you will be remembered more for your successes than your failures.)
- (c) Use the Feynman method (of keeping a dozen problems constantly in mind and testing every new technique you learn against these problems.) (Rota)
- (d) Regularly read demanding scientific books outside your area of expertise.
- (e) Other things being equal, finish the job that is nearest done. (Fred Mosteller)
- (f) Be prepared to exit a field that is in decline.
- (g) Develop a thick skin, but learn from your mistakes.

9. Scientific ethics

- (a) Never stoop to dishonesty. It destroys careers, corrupts the scientific process, and erodes public support for science.
- (b) Never engage in sexual harassment or ethnic denigration. These are certain routes to disgrace.
- (c) Most arguments are about who is in charge. (Elgin)
- (d) Don't alienate collaborators with fights about order of authorship. Publish enough solo authored papers so that your reputation doesn't hinge entirely on one collaboration.
- (e) Don't call a press conference without good reason. Let the review process work before you inject the media.
- (f) Don't look down on good teachers. (Rota)
- (g) Never lose your objectivity. Abandon your favorite hypothesis when enough evidence accumulates against it.

10. Traits of Successful Scientists

- (a) Intelligence
- (b) Mastery of subject matter
- (c) Curiosity
- (d) Delight in problem solving
- (e) Balance of objectivity and overestimation of the importance of one's research
- (f) Flexibility
- (g) Perseverance
- (h) Stamina
- (i) Organization – Mosteller quote
- (j) Writing ability
- (k) Risk taking
- (l) Toughness in dealing with criticism
- (m) Confidence and willingness to deliver the imperfect
- (n) Rejection of the romantic ideal of the lonely creative genius
- (o) Teamwork
- (p) Willingness to settle for second or third best
- (q) Ambition
- (r) Mental stability – depression saps creativity
- (s) Supportive mate
- (t) Publicity consciousness – cultivate your web page
- (u) Lack of enemies
- (v) Recall of the other virtues — kindness, fairness, honesty

References

- [1] Elgin SH (1998) *The Grandmother Principles*. Abbeville Press, New York
- [2] Gopen GD, Swan JA (1990) The science of scientific writing. *American Scientist* 78:550–558
- [3] Rota G-C (1997) *Indiscrete Thoughts*. Birkhäuser, Boston
- [4] Strunk W Jr, White EB (1959) *The Elements of Style*. Macmillan, New York

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