Hello, everyone. Everyone......, and most especially the graduating seniors of the class of 2013.

It is a great honor to be here.

As I cast about originally for a theme for this talk, a chance occurrence sent me in the direction I would ultimately follow. Having been asked to recite one poem by Charles Baudelaire, the 19th symbolist, I was reminded of another, Correspondances, in which the poet imagines our physical world as representative of another world, a world of wonders that lies just beyond our normal perception. All we have to do to gaze into this world of wonders is pierce the veil of obscurity that hides it. Baudelaire, of course, imagined poetry as the engine of discovery.

Well, I am not much of a poet, but I have spent the better part of my life exploring a world of unseen wonders, the sub-microscopic world of biological molecules. Over the years, I’ve developed a sense that there is a correspondence between levels of order, a kind of resonance, such that the essence of one level seeps up to color the levels above it.

Now, as a scientist, I hasten to add that there is no strong evidence for this idea, but I rather like it, so......
In any event, the real point here is that I was primed; the memory of Baudelaire’s poem struck a chord, so what follows are some musings on that theme.

The world of macromolecules is one of exquisite relationships between structure and function, and the true champions of structural diversity are the proteins. Some of you have surely heard me say, “If you want a job done ask a protein”.

➢ By the way, those of you who managed to avoid my classes for your four years here, you didn’t really think that you were going to get out of here without a biology lesson, did you?

So, let’s think together for a while about proteins. They have an astounding range of structural diversity, and it does not come by chance.

Each protein, coded in the DNA, is the product of complex molecular origami programmed to yield a unique shape tailored to the assigned task. The protein fits perfectly into the order of its world.

How does that apply to you? Look around you. Everywhere you look, you see structure tailored to function. Consider the cables and poles that hold up this tent, for example. Ours is a world of pattern and form. This is as true in the sphere of our social and professional interactions as it is in our material existence.
• OK. If we apply the simple lesson from our proteins to our everyday lives, we would conclude that your surest path to success lies in shaping yourself precisely to your future job, to become the best tool for the task you will do.

A closer look at proteins shows us that the lesson is not quite so simple. It never is. A protein functions in a world not of static shapes, but of constant motion, in which it is pulled this way and that by the changing demands of multiple dynamic equilibria.

➤ That term will be on the next test, by the way. Just so you know.

Static shape, however well designed, will not suffice in such a world. The protein must adapt to the ambient conditions in order to do its job. And so it does, by subtle conformational shifts, shape changes that fit it better to its task.

• Thus, the recipe for success from the molecular world has another layer. To thorough preparation must be added subtle adaptability.

The story is still not done. A step back from the microenvironment of our protein affords us a little broader perspective.
While it is true that some proteins function as solitary machines they are the rare exceptions. The important tasks in the living environment are typically far too complex for individual molecules, however well designed and adaptable, to carry out alone.

The real work of the cell is done by shifting arrays of multi-molecular complexes, teams, committees of molecules, if you will. Those teams must form at the right places in a timely fashion; they must perform flawlessly for the required time; and then they must disassemble equally rapidly, the respective components going off to do the next task, typically in a new team.

- Thus we have yet another layer to our lesson from the molecular world. To preparation and flexibility we must add cooperation.

The laundry list for success is already pretty long. Are you getting nervous?

But wait. It's even worse than that.

As busy and as boisterous as it is, the world of our protein is one of homeostasis, constancy. For all the chaotic molecular movement of that world, the general conditions under which a protein functions remain, on average, essentially unchanging. Life fights to maintain internal stability. How do we know this? Well, proteins that do similar tasks in organisms all up and down the evolutionary tree are amazingly similar.
Constancy. Homeostasis. Perfect conditions for long-term job security. Each protein identical to its predecessors, stamped from the same DNA mold, because the job remains the same.

Metaphors are lovely, but each has its limits, and we’ve just run smack in to the limits of this one.

Nothing could be further from the reality of this world, the world in which you will make your lives, than the idea of constancy.

At no time in human history has the aggregate rate of change been greater than it is today, and it’s getting faster every day. Think of the changes that you have seen already during your lives, and just imagine what the world will be like tomorrow, or next week or next year. You live in unprecedented times. The world of tomorrow may be unrecognizably different from the world of today, the rules of success completely different from those of the present.

It will not be enough to be perfectly adapted to the task at hand; that task may become irrelevant. It will not be enough train yourself for a career. That career may disappear.
You will have to be ready to tackle a new and different challenge every day, and since many of those challenges will be beyond the reach of any one individual, you will have to work cooperatively and productively with new people in new settings all the time.

Our poor protein, perfect for its one task of the ages, would be lost in such a world, obsolete. Fortunately, you are not that protein. You are not at all like that protein. You have something that protein can never have. You have a liberal arts education.

We make much of our genetic heritage, and rightly so. It provides us the basic blueprint for our very being. Consider again the protein, and how it is structurally programmed through the DNA for its appointed task. Structure-function, the perfect link.

Even so, across the biological kingdoms, we see another gift of at least equal importance: the gift of education - one generation passing on its collected knowledge and wisdom to ensure the success of the next.

This is widespread in the biological world, because it works. Now, not all species do it equally well or to the same extent. Of all the organisms that train their young, none invest as much as *homo sapiens* in the education of their youth, and of all the human cultures on the planet, no other trains its youth quite as we do.

You are the lucky beneficiaries of a liberal arts education, one of the great achievements of human cultural evolution. Its roots in ancient Greece, codified by Rome, resurrected
by Charlemagne, re-imagined during the renaissance, and refined through recent centuries of progressively modern life, it comes to you as a gem of intellectual achievement.

Think about it. Your education has not been simply about filling your head with information, although you have done that. Computers can now bring you just about any fact, anywhere, any time, with the stroke of a finger. Your education has not been about acquiring job skills, although you have done that, too. Specific skills will become outmoded as technology evolves.

No, your education has been about something richer and deeper.

It has been about asking the right questions, making new connections, recognizing the patterns in the chaos, the music in the din. …and most of all, most fundamentally, it has been about learning to learn. Learning for a lifetime, a lifetime of unprecedented change, and it has only begun.

You are now the best learning machines we know how to produce. You are prepared to take on any task, any challenge, and trust me; there are plenty of them out there.

The real question is what will you do with that education, the gift of generations past. How will you tackle the very real challenges of the future?
The answer lies in you.

Each of you is unique, with a unique combination of skills, perceptions, knowledge, imagination......

No one else is exactly like you. No one else will do exactly what you will do. You have great, unique potential. What will you do with it?

No pressure here, but we will all be waiting to know.

Now, my most compelling muse is reminding me that there is beauty in brevity, but I beg your indulgence for a couple moments for a more personal reflection.

Sitting amongst you, the graduating seniors, are a few who went with me to Strasbourg, France, for the first semester of their freshman year...the original Global Beginners, the intrepid few. What a magical, luminous time we had. The liberal arts experience simply does not get any better, I think, and I feel privileged to have shared that with you. I met most of you before your college career officially began, I've watched you grow and mature through the years here, and it seems uncannily appropriate that I be here, today, to see you off to the next stage of your journey.

Bon courage and bonne chance.
Now to the rest of the senior class, I thank you for your patience, and I’d like to close with a few words, a benediction of sorts, from two kindred spirits who have brightened my path through the years and given me a special perspective on the future:

Live long and prosper; .......make it so.

Thank you all.