

## **Life of Govindjee, known as Mister Photosynthesis\*<sup>#</sup>**

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*\*Based on an interview of Govindjee (of the University of Illinois at Urbana- Champaign), available at the University Archives and Records Management Services, Madison, Wisconsin; OH #2103; Govindjee, 2016). The honorific in this title was given to Govindjee in the UIUC School of Integrative Biology's 2012 News Report.*

*#The honorable late C.P. Malik, former editor-in-chief of the Journal of Plant Science Research, invited Prof. Govindjee and sent e-mail reminders to publish an autobiography (or biography) of this nature, covering both his personal and social experiences from his journey from Allahabad (UP, India) to Urbana (IL, USA).*

**This article presents autobiographical memories of Govindjee Govindjee, from his life in Allahabad (India) to Urbana, Illinois (USA). It includes his life in India, especially sections on his family and upbringing; his experiences in his adopted country, the USA; and a bit on his research life. For further information on Govindjee's academic life, see, e.g., Govindjee (2019a) and Stirbet et al. (2020); also see messages on his 88<sup>th</sup> birthday and 20-years of his retired life in Eaton-Rye et al. (2020). This article begins with my prologue; the rest of it is an edited text based on Govindjee's responses in a 2016 interview.\***

**Keywords: University of Allahabad, University of Illinois at Urbana-Champaign, Robert Emerson, Eugene Rabinowitch, Rajni Govindjee**

### **Prologue**

In 1956, a young man named Govindjee traveled from India to the United States to enter graduate school at the University of Illinois in Urbana-Champaign (UIUC). He was not alone in making such a trip. A growing number of Indian students were studying abroad in the United States, and Govindjee joined over 1,800 Indian students in the U.S. that year, most of whom traveled for graduate studies (Institute for International Education, *Open Doors*, 1956). Few remained in the U.S. after acquiring degrees, given America's restrictive immigration laws at the time (Hong, 2019). Nevertheless, Govindjee and his wife Rajni received a rare opportunity to settle in Illinois, establishing research careers at the UIUC and training several generations of scientists in the fields of Plant Biology, Biophysics, and Biochemistry. In so doing, the Govindjees joined the vanguard of the post-1965 boom of Indian immigration to the United States.

Settling in their new country was hardly easy, as they developed new cultural skills, pushed beyond the expectations of others, and navigated an American society that did not embrace multi-culturalism nor racial equality at the time. International events of the Cold War also threatened their attempts to straddle two cultures; nevertheless, Govindjee maintained family, research, and teaching ties across country lines. Changes reshaped India as well, with cities renamed, provinces redistributed, and the nation developing. In the midst of these tensions and changes, Govindjee built his life and career in the United States, using the strengths he had learned in India as a foundation for understanding and flourishing in his new country.

The following personal narrative is edited from Govindjee's responses to an interview I did with him in the fall of 2016 as part of my doctoral research in the History Department at the University of

Wisconsin–Madison. In 2019, Govindjee began to turn this interview transcript into a personal memoir. Then in 2020, I organized and edited Govindjee’s comments, with his permission and advice, into the narrative you see here. Beginning with his birth, Govindjee’s oral history traces his life from Allahabad to Urbana, discussing family upbringing, academic trajectory, and experiences in the United States, with special focus on experiencing America in the 1950s and 1960s. We celebrate Govindjee’s 90<sup>th</sup> birthday this year (2022) by sharing his personal memories based on his own voice.

## INTRODUCTION

### The early life

Govindjee was born on October 24, 1932, in Allahabad, UP, India, although it was erroneously recorded as 1933. (Typographical errors such as this were not uncommon at the time, although the birthdates of all his siblings were correctly recorded.) At the time, UP stood for the United Provinces (of Agra and Oudh), but now it is known as Uttar Pradesh (the Northern Province). Allahabad was also known as *Ilahabad* to the Mughals, meaning “the city set up by God.” Even earlier, it was a Hindu city called “*Prayag*,” a name that recently has been restored. Govindjee grew up there, and his father, Vishveshwar Prasad (Asthana), worked as a sales representative for the Oxford University Press (OUP) after teaching in a local college.

Govindjee’s childhood was steeped in learning and academic life. His father was interested in several languages: English, Hindi, Urdu and Persian. Govindjee’s father had a lot of books – mostly published by OUP – in the office, which also served as their living room. His father’s job led him to meet the many vice chancellors of major north Indian universities. Govindjee remembers that his father knew quite well the Vice-chancellor of Allahabad University. Unfortunately, Mr. Prasad died of a fatal heart attack in 1943. Govindjee was very young then, only an 11 year-old boy. Nevertheless, he grew up in an environment where there were always books in English at home. It was a positive thing for him, although he was never really interested in languages himself. Govindjee also grew up with the city itself as his home.

His family never owned a house. They always lived in rented homes. Thus, Govindjee got to see the whole city of Allahabad since they moved from one neighborhood to another. Finally, according to Govindjee, they ended up in the university housing on what was then 14 B Bank Road (now Lala Ram Narain Road). (For Allahabad, see Gour, 2010; Gour, 2015.)

Govindjee’s family represented a hybrid of religious life that gave him a strong sense of Hindu identity as well as an open-minded approach to faith. His mother, Savitri Devi, was a very kind and gentle person [see Govindjee (ed.), 2007]. He called her “*Amma*” and his father “*Babuji*.” Savitri Devi was quite religious and a follower of rituals, but Govindjee’s father was a follower of a social-religious movement called “*Arya Samaj*.” (see: <https://www.britannica.com/topic/Arya-Samaj>). Vishveshwar Prasad believed in “Oneness,” in *Vedas* and *Upanishads*, but not in deities or idol worship; for him, idols had no meaning, and he did not believe in the rituals, only in a higher power. That is what Govindjee learned from him. On the other hand, his mother valued rituals; she always had the “*Puja*” (prayer service) and “*Kathas*,” (narration of religious stories), especially the “*Satyanarayan Katha*” - Hindi for the “Story of the God of Truth.” This was a regular feature in their house. Govindjee’s mother went regularly to a temple called *Alopi Mandir* to worship a goddess who cannot be seen. Govindjee remembered going with her to this temple because it was “kind of fun for a child.” Even as an adult, he recalled a swing that they would put flowers in and push and remembered how he had enjoyed pushing it. He also recalled a big platform with water. It is the only temple he remembers, since his father did not go to temples. Still, although his father was an *Arya Samajist*, he was always receptive to the desires of the family. Govindjee grew up in this way, calling it “a wonderful environment.”

Since Govindjee was the youngest of four siblings, his entire family helped shape him as he grew. Krishnaji, ten years older than him, took care of him after the death of their father; Govindjee called him “*Dada*” (meaning the eldest brother). After Krishnaji obtained his MSc, at Allahabad University, he was

appointed a lecturer of physics there. Although he did not have a PhD, many students did doctoral work under him (see Govindjee and Srivastava (eds.), 2010, for details). Krishnaji was a physicist, an expert on microwaves and wireless technology, and quite important for the Defense of India, as recognized by the Prime Minister of India, Jawaharlal Nehru (see **Figure 1**). Govindjee's other brother, Gopalji (whom he called *Bhaiya*), was six years older than Govindjee and also began in the field of physics. Later, he moved

to science administration in a business concern, finally retiring from Engineering Projects (EPI) Ltd. (Government of India). As Govindjee recalled, "My sister, Malati, was three years older than me; she had studied and later taught Hindi literature; she married her class-fellow, Radha Krishna Sahay, an author of many books in Hindi literature. While Krishnaji (Dada) brought me up and taught me many things, my mother's care was pivotal, as she accepted all my idiosyncrasies!"



**Fig.1. Krishnaji (left), Govindjee's eldest brother, with Pandit Jawaharlal Nehru (right), the first Prime Minister of India. Nehru was very much interested in Krishnaji's research that dealt with Radar technology for the Defense of India. Nehru had come to inaugurate his first laboratory of "Experimental Microwave Spectroscopy." Photo, 1956; source: Govindjee's archives.**

Govindjee's family followed a rather unique practice when it came to last names. His father's name was Vishveshwar Prasad, as mentioned above. "Prasad" was used as his last name but was really his middle name. The family name "Asthana" was not used because it implied a caste, and Govindjee's father was against the Caste system (see: <https://en.wikipedia.org/wiki/Kayastha> as well as discussion below). Instead of using their father's last name, the sons just used their given names, thus, one name only! So Govindjee grew up with one name – "Govindji" (with

the spelling later changed). You can imagine the bureaucratic headaches the sons encountered when only using one name. In view of the troubles involved in filling out forms and travelling around the World, eventually in 2019, Govindjee legally changed his name to "Govindjee Govindjee," a compromise between not using a family name and avoiding explanations at every turn.

Now, what is the real story behind using one name only? As mentioned above, Govindjee's father was an *Arya Samajist*, and against the "ills" of the

caste system. Govindjee told me that his family belonged to the “Kayastha” caste, and they were “Asthana” Kayastha – one of the twelve sub castes. Since the family name usually designated a family’s caste and resulted in certain social treatment, not using it was their way of helping to undo India’s system of caste injustice.

Govindjee’s caste still played a role in the family’s culture. According to him, “Kayasthas are usually associated with Accounting and Clerical work; however, they are clearly in other fields such as Law, Teaching, and Military service. Basically, they believe in education, and nobody in this group (‘caste’) was uneducated. Everybody had to be educated, no matter how poor they were.” This tradition was, perhaps, one of the reasons his family prioritized learning. Likewise, caste practices influenced things like their diets. Growing up, many of Govindjee’s caste ate meat, even though many traditional Hindus and even non-believers never eat meat. Govindjee’s family never ate beef, but lamb and goat meat were quite popular with them. They also ate chicken. Most often their mothers did not eat meat, although their fathers and brothers did. Govindjee mused, “Perhaps the women were more religious, or perhaps the men ate meat to be strong to fight the enemy! Who knows? Today, many of us realize some of the ills from red meat, and the lifestyle of the whole world is changing.” As far as alcohol was concerned, people in Govindjee’s community drank alcohol as well. However, there was no alcohol in their family at all. This is the kind of community in which Govindjee was raised.

## **The 1940s – SCHOOL YEARS, UPHEAVAL, & INDEPENDENCE**

### **Initial Reluctance to Learn**

The high value that his family placed on education did not mean that Govindjee initially embraced learning. Before going to school in 1943, he had a tutor who came to teach him at home because of his poor health as a child. Govindjee told me that at the time he did not want to study. When the tutor would say, “What are you doing? Why not come and sit down?” He remembered saying, “Oh, I am busy – I have to do work.” When the tutor would ask, “What kind of

work?...Are you washing dishes? Are you making beds? Are you sweeping the floor?” Govindjee would say, “No, no, no.” Still, he would claim, “I am busy.” Obviously, Govindjee was not very keen to learn from this tutor, but then he went directly into the 4th grade (class) when he started school in 1943. Govindjee said, “I suppose that even after all those initial attempts to avoid being taught, I must have learned something from this tutor. Or maybe I learned by myself, through my books and by my father.” Either way, he went into the 4th grade instead of going through the earlier levels.

### **Schools Attended**

Govindjee studied in three schools in Allahabad. From 1943–1948, he was a student at the Colonelganj High School – from 4th grade through 10th grade (class). Then from 1948 till 1950, he studied at the Kayastha Pathshala (K.P.) Intermediate (Inter) College for his 11th and 12th grade (class). According to Govindjee, he studied all the subjects in High School, but Science rather than Arts was his focus. In the K.P. College, he opted for Biology, Chemistry, Physics, and Math. In both High School Diploma (1948) and Inter Certificate (1950), he received first class (division), with distinction in Physics in the Inter Exam. What a change from his earlier resistance to education! Govindjee was motivated and helped by many wonderful teachers along the way. Using only the last names and adding “Ji” for respect (or “Saheb” or “Babu,” as he called them), they were, as he remembered, chronologically: Mehrotra Saheb (Nature Study), Sharma Ji (History), Ghosh Babu (Science), Gaur Saheb (Biology), and Jalpa Prasad Ji (Chemistry). He gives credit to these teachers and others who helped and motivated him to excel in his studies.

### **Independence Movement**

The following story is long, but important to present here and is retold basically in his words. Govindjee’s school years were ones of national and family upheaval, so his memories of school are woven with those of Indian independence. After many earlier attempts for independence from the British, the first attempt at freedom in his lifetime was the 1942 independence movement that started in July. He was

10 years old at the time. According to Govindjee, it was called “Gandhiji’s Andolan” (revolution or protest) because Mohandas Karamchand (M.K.) Gandhi led Indians in civil disobedience, attempting to force the British to “Quit India.” Govindjee remembered very vaguely a kind of fear because he remembered many mobs and police. He told me that he really did not understand well at that time what was going on; he remembered once running back home when he saw police marching towards them, the students, and the teachers. He himself was not in school at that time, since he started schooling only in July of 1943. His father died in the winter of 1943, making the year one of tragedy and upheaval for the young boy.

Govindjee certainly remembered 1947, when India became an independent country. He was 15 years old at the time and received his high school certificate (10th grade; equivalent to junior High School in the USA) in 1948. Govindjee mentioned that although some areas of India experienced great violence and migration after Independence, most of Allahabad did not, except in certain sections. According to Govindjee, he had many Muslim friends, and so did Rajni, whom he later met in 1951. The parents of both Rajni and Govindjee were interested in education, and they even had learned Persian. In fact, many of the people from their community were accountants and clerks, as stated above. During the Mughal as well as the British times, there was a long history of their friendly association with both Muslims and Christians.

Furthermore, there was much happening on the streets leading to independence. Govindjee told me that when he was in the 9th grade, he heard shooting of folks by the police. He also remembered being very scared at that time because one of the students at Allahabad University was shot. The Vice-Chancellor of the University of Allahabad ordered the gates of the University to be closed to the police following the shooting, so that they would not come in! Govindjee said, “It was a very sad day for the students, and all the schools participated in mourning for the deceased student. It was indeed a complicated time. The police were all Indians, but they were doing their duty, i.e., following the orders of the British. If ordered, they

would shoot.”

Govindjee also remembered clearly that the student leaders were very fearless. “They would stand up,” he said. Govindjee recalled that Rajni’s older sister, whom she called “Kamla Jijji,” put the Indian flag on her school (Balika Vidyalaya, Kanpur). When she was caught by the police, she went to jail, and her father (Avadh Narain, “Engineer Saheb” as he was called) got her out by paying her bail. In Govindjee’s family, his sister Malati was very much influenced by Mahatma Gandhi. She was much affected by Gandhiji’s idea that the British should “Quit India.” When Gandhi’s followers made the decision not to wear clothes that were fabricated in the West and England, his sister Malati took it upon herself to make her own yarn, called “khadi.” She bought a “charakha” (a spinning wheel) to spin her yarn, and she always wore khadi fabric. Still, she was the only one in the family who did that. According to Govindjee, both he and his brothers were too much into science, and they did not actively participate in the social protest.

Of course, Jawaharlal Nehru lived in his hometown (Allahabad, now Prayag). Govindjee told me that he remembered walking to his school (Colonelganj High School) past Nehru’s big bungalow (*‘Anand Bhavan’*; see <[https://en.wikipedia.org/wiki/Anand\\_Bhavan](https://en.wikipedia.org/wiki/Anand_Bhavan)>), and he still remembered the house compound. He told me that he once heard a lecture by Mrs. Vijaya Lakshmi Pandit (Jawaharlal Nehru’s sister), who stood above the boundary wall, perhaps on a platform. There she gave her talk, and the gathered crowd listened; he also remembered her talk at Allahabad University. At other times, Govindjee would go to a park in the town called Purushottam Das Tandon Park, where he listened as Gandhiji and Nehruji came to give speeches. He told me, “They were powerful and touched deeply my thoughts.” Talk of independence was all around him.

Some of Govindjee’s relatives were actually in the Congress Party, which was fighting the British. During our interview, he remembered his distant relative. A sister of his brother’s (Krishnaji’s) wife (Bhabhi) was married to Laxmi Kant, who was in the Congress Party. Govindjee remembered a park in Allahabad, known as Company Bagh (formerly Alfred

Park), where there was a statue of Queen Victoria, and of King George the 5<sup>th</sup>. Although these reflected the British rule, he still remembered vividly those marvelous white marble statues. Laxmi Kant Ji (Govindjee called him “Chaukan Dada”) would hide in that park in order not to be caught by the Police, and the family would bring food in the dead of night to leave there for him, as Govindjee recalled. Then, Laxmi Kant would come out when the police were not looking and eat his food. All in the non-violent movement had to hide lest the police catch them. Govindjee told me that many of these nationalists later served the Indian government after independence. In this way, Govindjee was connected to India’s independence movement even though, as he said, “My family was more into science, so we served education.” No one in India could really be removed from the events leading up to 1947, however, and so Govindjee’s school years coincided with his home country’s fight for independence.

#### **ACADEMIC INTERESTS AND WHAT LED GOVINDJEE TO THE USA**

Govindjee’s life in science also began during these early school years. Govindjee recalled, “When I was growing up, there was always the question of what one should become. It was very common to believe that a medical career was the way to go; then, you could be free from many things and serve the society. So, the idea was that I would become a medical doctor (i.e., Doctor of Medicine). In India, we call it MBBS (Bachelor of Medicine and Bachelor of Surgery). At Inter College, I had studied Biology, but I was not good at animal dissection. I liked plants better because my fourth-grade teacher, Mehrotra Saheb, had been a nature lover and used to teach me nature study.” Basically, he did not want to be a doctor, but there was a kind of unsaid pressure because of the money and social importance attached to medical work. In the end, Govindjee simply did not appear for the premed exam. He recalled, “I was told to take the entrance exam to be selected for medical school, but I just refused to take it. Instead, I went into basic biology: botany (plant biology), zoology (animal biology), and chemistry. Finally, I decided to specialize in botany, taking it as the subject for my master’s degree with

specialization in *Plant Physiology*.” He has been working with plants since 1954; algae, and cyanobacteria were added by him in 1959. It is interesting to note that one of his very first papers was published in *Nature* on the effect of virus infection on the amino-acids in tobacco (Laloraya and Govindjee, 1955; see <https://www.life.illinois.edu/govindjee/pubschron.html>). Manmohan Laloraya had been his classmate since school days, and they continue to remain in contact by phone).

Sri Ranjan was the name of the most senior Plant Physiology professor at the University of Allahabad. According to Govindjee, “Ranjan came from a very famous family in Banaras (now Varanasi). His ancestors were bankers for the East India Company. His uncle was the famous Bharat Ratna Bhagwan Das, and his cousin was Shri Shri Prakash, Governor of Madras (now Tamil Nadu). Beyond his family connections, I respected the work of Sri Ranjan. He had gone to England and had studied under a very famous plant physiologist, Felix Frost Blackman, who, in 1905, had proposed the theory of law of limiting reactions in photosynthesis. Sri Ranjan had done his master’s degree with him in Cambridge. Later, Ranjan had a Doctor of Science from France, but I was more impressed with his British degree because it was in an area that I liked very much.”

During his time at Allahabad University, Govindjee opted to take a “Special paper in Plant Physiology.” Unlike other classes, Ranjan ran it like a seminar, meaning that the students read the literature and gave talks, just like it is done in some seminar courses in the USA. This was in 1953, when such teaching practices were unusual in India. Govindjee did not remember whether it was Ranjan’s idea, or if he was following the system in Cambridge. Regardless, it was transformative for Govindjee. He went to the library, read a lot of original papers, and took notes. Then he wrote about the discoveries in Germany on chlorophyll (the green pigment) from the work of Nobel laureates Richard Willstätter (<https://www.nobelprize.org/prizes/chemistry/1915/willstatter/biographical/>) and Hans Fischer ([https://en.wikipedia.org/wiki/Hans\\_Fischer](https://en.wikipedia.org/wiki/Hans_Fischer)), and then on the problem with

the role of chlorophyll *a* in photosynthesis by Robert Emerson (who was a grandnephew of Ralph Waldo Emerson; [https://en.wikipedia.org/wiki/Ralph\\_Waldo\\_Emerson](https://en.wikipedia.org/wiki/Ralph_Waldo_Emerson)). Robert Emerson's article had been published in 1943 in the *American Journal of Botany* (Emerson and Lewis, 1943). According to Govindjee, "It posed the unexplained phenomenon: 'When chlorophyll *a* is the only pigment that is absorbing light, why is photosynthesis low?' This was a total surprise in the field; it was called the 'Red drop'!"

The above conundrum drove Govindjee to continue reading papers on the topic. He even decided to write a letter to Robert Emerson who was a research professor of botany at the University of Illinois at Urbana Champaign. Govindjee hand-wrote a couple of letters to him. One said: "Dear Professor Emerson, I have read your 1943 paper. And, I do not understand it, and I wonder if you now have an understanding of what was discovered then." He received a letter back that said, "Dear Mr. Govindjee. It is exactly the problem I'm working on right now, and if you are interested in it, I encourage you to apply to the University of Illinois Admission and Fellowship Program. And I suggest that you try to get funding for travel from your country." Govindjee then applied to the Fulbright Foundation to get a travel grant, and he was selected. That was in 1956, and when Govindjee arrived at UIUC, Emerson still was doing that very experiment. Govindjee told me, "Of course, I did not really understand what precisely he was doing, as I was taking basic courses in Chemistry, Physics and Math. In 1957, just a year after my arrival at UIUC, Emerson published his famous paper in the *Proceedings of National Academy of Science USA*, showing that there is what we called, 'the two light effect,' meaning that when two light beams are given together, the rate of photosynthesis is higher than the sum of the rates of photosynthesis when they are given separately (also known as the 'Emerson enhancement effect'; see Emerson et al., 1957). Over the years, I have worked on this concept myself and have discovered many new nuances. I continue to write about this topic even today. So, that's how I came to the USA."

## **FROM DOCTORAL STUDENT TO UIUC FACULTY**

### **Student Days**

When Govindjee arrived at the University of Illinois at Urbana Champaign (UIUC) in September of 1956, he entered into a lineage of researchers to whom he always felt a great debt. His advisor, Robert Emerson, had received his PhD in 1928 under Otto Warburg of Germany, the 1931 Nobel laureate in Physiology or Medicine. Govindjee recalled, "While researching at the Carnegie Institute of Washington at Stanford in 1943, Emerson found that in photosynthesis, the minimum quantum requirement per molecule of oxygen evolved was 8–12, in total disagreement with his old advisor's value of 3–4. Because Warburg's lab had been destroyed by the German Army during World War II, Emerson invited Warburg to research with him at UIUC. There in room 155–157 of the Natural History Building (NHB) on Matthews Avenue – where Govindjee would later do his own PhD research – the two scientists tried to solve their controversy (see a photograph of NHB in Fig.3 in Govindjee, 2020). However, Warburg and Emerson never came to an agreement about the minimum number of quanta per oxygen evolved in photosynthesis. As Govindjee told it, Warburg left Urbana "in a huff and puff," saying to the effect that his former advisee, Emerson, did not know how to do experiments nor, "How to count quanta."

Govindjee benefitted from the scholarly heritage of not only Emerson, but also another UIUC professor Eugene I. Rabinowitch, whose post-doc professor, James Franck, was a Nobel laureate (1926) in Experimental Physics ([https://en.wikipedia.org/wiki/James\\_Franck](https://en.wikipedia.org/wiki/James_Franck)). Like Franck, Rabinowitch also had left Germany to continue his career in the United States. Being Jewish, Rabinowitch struggled under Hitler's rule, so he came to USA through the Niels Bohr Lab in Copenhagen. Rabinowitch initially worked as a research scientist at MIT (Massachusetts Institute of Technology). Then he made his way to Illinois, first to the University of Chicago to work on the Manhattan Project and then to UIUC in 1947 as Co-Director (with Emerson) of the "Photosynthesis Project," administered by the Graduate College of

UIUC. This was the scientific heritage to which Govindjee and his wife Rajni laid claim when they came to the United States for their doctoral studies. (See their articles on these two giants of Photosynthesis: Govindjee (2004); Govindjee and R. Govindjee (2021); Govindjee et al., (2019).)

A few years into his graduate studies, a catastrophe threatened to overturn all Govindjee's research ambitions. On February 4, 1959, Robert Emerson was killed in a plane crash in the East River on the way to La Guardia Airport. Govindjee did not remember the specific plane, although he said it was some kind of *Electra Turbojet*. The plane went down, and almost everybody died. By then, Govindjee had not published anything with Emerson. Govindjee recalled, "I was simply working on a project that Emerson had suggested. He wanted me to explore how the yellow pigments (carotenoids) function: Which ones? And how? (see Govindjee, 1999). I was just struggling like hell working on it, finding nothing new. And suddenly, my advisor died. Now we did not know what would happen to us."

No longer was Govindjee a solitary graduate student studying abroad; Rajni had come to study under Emerson as well. Govindjee knew Rajni back in Allahabad and wanted to marry her. During his first semester (in 1956) at UIUC, he had told Emerson about his possible future wife and asked, "She also wants to work for PhD; what can be done?" Emerson suggested that she should apply to work at UIUC, so she applied for admission and a fellowship for the fall of 1957. The two were both first class students in Allahabad – "toppers" in their class – which meant that they had high grades. Thus, Rajni was admitted with a UIUC fellowship in September of 1957, just as Govindjee had received one in September of 1956. Rajni started to work with Emerson, but was given what seemed a strange project, since she had wanted to work on biology not chemistry. The project given to her dealt with the photochemistry of chlorophyllide in solution. According to Govindjee, Rajni saw no hope in that project. Regardless, Rajni and Govindjee were married on October 24, 1957, at the YMCA Chapel by Mr. John Price, a function attended by not only Emerson but also Eugene I. Rabinowitch. For the next

year and a half, both Rajni and Govindjee worked on their assigned projects with Emerson as their graduate advisor. Emerson's death was thus a blow to both. In Govindjee's words, "It left us sort of homeless, fatherless, or advisor-less. What to do?"

The other professor in the "Photosynthesis Project" was Eugene Rabinowitch, but he was a top physical chemist not a plant biologist. He was also a prolific author and had captured all the basics about photosynthesis in 2000 pages. In 1945 he published his first volume (volume I); his second volume (Volume II, Part 1) came in 1951; and by 1956 he completed the third volume of *Photosynthesis and Related Processes*. These three volumes composed the "Bible of photosynthesis" at that time (see Govindjee, 2004).

After Emerson's death on February 4, 1959, Rabinowitch came to Rajni and Govindjee and put his hand on their shoulders, saying, "Would you two like to be my students?" What an unusual offer. Govindjee recalled, "We were biologists while Rabinowitch was trained as a physicist and physical chemist. I said to him, 'We will return to India to do a PhD there or somewhere else. You are a physicist, a physical chemist.' However, Rabinowitch responded, 'Govindjee, what you are doing is very important; it will carry the work of Emerson forward, so you do not have to change your PhD thesis. Keep doing what you were doing, and that will be your PhD thesis.' He offered the same for Rajni, so that neither of us were forced to cut short our studies at UIUC." And Rabinowitch proved to be correct. Both made important discoveries on projects of their own choice (see Govindjee, 1960; R.V. Govindjee, 1961. At that time, Rajni used her maiden name "Verma" as her middle name but later dropped it).

According to Govindjee, "Although Emerson had been right in his concept of two light reactions and two photosystems, he was wrong in believing that one system was run by chlorophyll *b* and the other by chlorophyll *a*. My 1960 work proved that both systems are run by different spectral forms of chlorophyll *a*. It's too bad that Emerson was not there to see this work and to coauthor my paper. It was published in *Science* (Govindjee and Rabinowitch, 1960)."



Rajni's paper was also published the same year. According to Govindjee, she proved "that Emerson's two-light effect indeed occurred in photosynthesis, not in respiration, as Lawrence Blinks had wrongly challenged it (see R. Govindjee et al., 1960; R. Govindjee et al., 1962). The confusion had come because photosynthesis and respiration are opposite processes, so to speak. We all know that respiration uses glucose and oxygen and makes ATP. On the other hand, in photosynthesis, light is absorbed and is used to make O<sub>2</sub> and food, as well as ATP." Govindjee further explained, "Emerson had used Warburg's technique of 'manometry,' which unfortunately could not distinguish between the release or the uptake of oxygen. Thus, a decrease in oxygen uptake in light (by respiration) could be misread as increase in oxygen release by light (by photosynthesis), allowing Emerson's conclusion to be challenged by Blinks. Rajni proved that Emerson's two-light effect was not in respiration by using a method that Warburg had used earlier – killing respiration by adding parabenzoquinone (see a historical account of Warburg's work in Dau et al., 2021). Rajni showed that Emerson's conclusion was correct; the two-light effect occurred in photosynthesis."

Both Rajni and Govindjee received their PhDs under Rabinowitch: Govindjee in Biophysics in September 1960, and Rajni in Botany in May 1961 (cited above). In addition to the discoveries mentioned,

both their theses clearly confirmed Emerson's values of 8–10 quanta (of light) per oxygen evolved over Warburg's 3–4. Govindjee told me about a later paper by R. Govindjee et al., (1968) showing "that 8–10 was right even under conditions (use of young cells; 10% CO<sub>2</sub>; blue catalytic light) dictated, rather vehemently, by Warburg himself." See Nickelsen and Govindjee (2011) for a complete story. (Currently, Kärin Nickelsen is Professor and Chair of History of Science at the University of Munich, Germany; see [https://www.en.kooperation-und-konkurrenz.geschichte.uni-muenchen.de/project-members/professors/prof\\_dr\\_kaerin\\_nickelsen/index.html](https://www.en.kooperation-und-konkurrenz.geschichte.uni-muenchen.de/project-members/professors/prof_dr_kaerin_nickelsen/index.html).) The two left the USA in 1961, since Govindjee's Fulbright grant required that he return to India.

In the early 1960s, most Indian graduate students returned to careers in India following graduation, but both Rajni and Govindjee went on to scientific careers in the United States. Just when they were finishing their studies, the UIUC was looking to fill Emerson's position; also, their department needed somebody to teach "*Plant Physiology*" to undergraduate students. Thus, even before Govindjee left Urbana, the UIUC Department of Botany verbally offered him an Assistant Professorship, and the official offer came as soon as he reached Allahabad, India.

**Figure 2** shows the two relaxing in 2016 in a restaurant in California- remembering those good old days!



**Fig. 2:** Rajni (left) and Govindjee (right) relaxing at a restaurant in California. Photo, 2016; source: Govindjee's archives.

## SETTLING INTO AMERICAN LIFE

Stories of the academic careers of Govindjee and Rajni have been told in other publications. For Rajni's academic life, see Ebrey (2012), who described her as "Brighter than the Sun". For Govindjee's academic life, see Eaton-Rye (2007a, 2013, 2019) and Kumar et al. (2021). However, his experiences during those early days of coming to the United States and of integrating with American society in the 1950s and '60s have not previously been shared. In our 2016 interview, he responded to my questions about the challenges he faced and needed to overcome as a new immigrant.

Govindjee told me, "My first day in USA, in September 1956, was quite memorable. When I first came as a graduate student, my original boat ride to the U.S. was on the *Queen Elizabeth* from Southampton (UK) to New York. I think I had only a total of \$42 with me. So, I went to the YMCA when I arrived in New York; that was the only place I could afford to stay. (The Fulbright Program recognized what we had, so they had arranged it for all the scholars.) Anyway, when I went to the room, I heard folks shouting, 'I like Ike! I like Ike!' And I was extremely puzzled. Why did I come? What country had I come to? Who is this, Ike? What is this going on at NIGHT? Why are they shouting, 'I like Ike?' I had no clue, and I couldn't sleep. The next morning, I asked the people, 'What was going on all night? What is this 'Ike' business?' They said it was for the presidency of Dwight D. Eisenhower (known popularly as Ike)! And they were asking people to vote for him. It was September, and there was already this fervor to elect Eisenhower in the national elections two months later!"

### On Manual Work

Many things about adjusting to American life were hard for Govindjee. Perhaps the most significant was the expectation of doing physical work for oneself. Many growing up in middle class families in India don't (or didn't) work with their hands. I am told that this was so with boys; it seems girls were taught many things including cooking, but boys were pampered to the extent that they did not learn how to do anything

by hand. When Govindjee came to Champaign-Urbana, one of the biggest problems for him was that when they rented a house, they were supposed to mow the lawn. Govindjee recalled, "My God! It was so tough! It was really tough, and I remember somebody in the Department of Botany came by, saw me mowing, and said, 'Gosh. Coach, you are able to mow the lawn!' So, basically, that was one of the hardest things - learning to work with my hands."

Most laboratory work for a PhD is not really "manual labor." However, Govindjee remembers considering one task - washing dishes and glassware - as sort of below his dignity. When Professor Emerson gave him a dishwasher's job to provide for his expenses in the summer of 1957, he had no choice but to do it! His UIUC fellowship was for only 9 months. He received only \$133.33 per month, and that amount wouldn't last to the end of the month. Govindjee had to do something more. He recalled, "Emerson said, 'Oh, we can hire you as a dishwasher.' There were no dishwashing machines, so I had to wash all the dishes by hand. It was really tough for me because, you know, I did not want to do it due to my past background. To wash dishes was considered menial work for me. Still, I did it." He further recalled, "Everyone in the lab laughed, and they had a lot of fun with me."

Menial labor took on personal significance too to him. He didn't know that he had to work at home in the family also. Govindjee recounted the event that changed this for him: "Long after this early period, one day Dr. Vijaya Ramchandran, who happens to be the daughter of the world famous G.N. Ramchandran of India, was invited to our home for dinner. I said to Rajni, 'I will wash the dishes today.' Hearing the word 'today,' Vijaya looked at me and said, 'Govindjee, what do you mean by TODAY? Don't you wash the dishes every day?' So, I said, 'Vijaya, but I work all day at the University, and I'm very tired after work.' She smiled and responded, 'Doesn't Rajni work and get tired every day?' I immediately recognized and said, 'You know, you are right.' And from that day on, I've been washing dishes at home every day. So even though this whole concept of menial work was very difficult in the beginning, it became a part of my life.

Now I like to clean. I like to wash dishes. I like to clean anything I see dirty. In fact, I will be the one to clean the place, and I feel good about it. All my American friends used to make fun of me and teach me how to do things, so I learned from them. That was for me the hard thing – to learn to do what I had called menial work. Nevertheless, in India the majority of people do menial work. It is nothing bad. It seems that avoiding menial labor was just the way children grew up in certain families then, where boys were not expected to do anything.”

### **On Accent**

Other things about adjusting to American life were difficult too. Govindjee told me about some people making fun of him for his accent, but it didn't bother him. It seems no one really complained about his accent. He said, “Yes, my English was not good, and perhaps still I have an accent of some sort. For instance, there are certain words I can't pronounce properly even now. Rajni's English is much better in that sense. She can pronounce those words, and I can't.” When he became an assistant professor (in 1961), he went to a speech clinic at the University to learn how to pronounce words properly. He liked the teaching assistant who was teaching him, and he was learning...until the real teacher came. Govindjee recalled, “She was quite tough on me, and I literally left the class! I wanted somebody more sympathetic and tolerant of me, so I decided not to bother. I tackled the issue of pronunciation in my lectures by writing on the blackboard the word I was not sure of pronouncing. I would say, ‘You know I can't pronounce this word properly. However, I will say it.’ And the students loved that! I think it had to do with my own way of life: To be with people. To be with the students. Don't think that I was not afraid or wasn't scared. I WAS. I had to teach a class, and I wasn't sure if I would be accepted as a teacher. However, the students loved my teaching and gave good comments to the University via their department heads, so my accent did not prove a difficulty.”

### **US Citizenship**

Govindjee and Rajni became US citizens in 1972. However, they had received their “green cards” for

permanent residency approximately one year after he had joined the faculty – in 1962. He did not really know why. Still, he thinks that his entry into the department was easy. Perhaps because of the good comments made by his students, his lectures were considered very good by the department heads, who were mainly from the College of Agriculture, Department of Forestry, and the Department of Horticulture at the UIUC. He told me that the comments he received directly from the students also gave him great pleasure; they really liked his lectures! Working in the Department of Botany at UIUC was good for him as well. He mentioned: “Granted, I was told by one person on the staff that some in the department thought my appointment was only temporary. Some staff still looked upon me as a foreigner, which was understandable: I was a foreigner!” Deciding to switch citizenship in the 1970s was tough for him. He said that many of his friends did not stay in USA. However, for him it was clear: “If we are going to live here, we must participate in the Electoral College; we must participate in who goes to the Congress. And this would happen only when we are allowed to vote. A good citizen, and a person who is living here, must belong to where he or she is living. Thus, it was because of our feeling of belonging to the place and wanting to be a part of the society that we became U.S. citizens.” Since then, Rajni and Govindjee have always taken part in all the elections. Govindjee emphatically stated, “*Democracy is the way!*”

### **On Challenges in American Society: Religion and Housing**

When Govindjee arrived in the United States in the mid-1950s, American society was quite different than it is today: it was less open to cultural differences, more racially segregated, and more difficult to maintain connections across the ocean. At the time, the United States was in the throes of a Civil Rights Movement that sought to expand America's “equal rights” to those from non-European ancestries; previously, Blacks and other non- “Whites” could be excluded and treated poorly with relative impunity. After decades of American policies to exclude Asians from immigration, American people also often looked on Asian people

and their culture as fundamentally foreign. Thus, I asked Govindjee about his experiences with these less ideal aspects of America in the 1950s and '60s. In short, he shared that he and Rajni needed to do a lot of explaining about themselves, try to understand others, and sometimes find ways around constricting societal requirements.

Religion was one area where the two were very different than the average American at that time. As mentioned above about his religious upbringing, he was very free with all religions and accepting of them. He told me that Hinduism believes in the oneness of the "Higher Power" (God). Many of his friends are Muslims in India; he told me that he has friends from Pakistan, some of whom he would meet at Espresso Royale on the UIUC campus. He had, and still has, a lot of good conversation with the Christians who often visit their home. Further, he and Rajni have great respect for the Sikhs and the Jains, and they both have very good friends among them. So, they like persons of all faiths, but he told me that they are unable to relate to fundamentalists, including the ultra-conservative Muslims, Hindus, and Christians. Still, they are very committed to the Hindu faith. He said: "We are Hindus; we were born Hindus. We had pujas, and I even visited a temple with my mother when I was a kid, as I mentioned earlier. We believe in Higher Power (God), and we believe in even some rituals, because they are fun." He told me that, like his father, he does not necessarily believe in the deities as incarnation of God, but he has great respect for them and those who believe in them.

When he came to the USA, Govindjee was a bit surprised when people wanted to make them Christians. He told me that even now this happens often and, "we have been badgered sometimes also." Govindjee told me one story from his early years in Champaign-Urbana. A very good ("and wonderful") person had invited them to go to the southern United States. This friend and his family drove them by car to their home in South Carolina, and then the Govindjees discovered that their main interest was to make them Christians. Govindjee remembered, "They put us up in their home and took us to their church. We were lectured and told how Christianity is the only

religion and all other folks are pagans." At least Govindjee was invited to talk about his faith as well, which helped ease the tension. He added: "Now I know better; I know a lot of Hindu philosophy. Still, we felt that the whole affair was kind of demeaning to some extent. Rajni seemed a little more bothered by those things; when she was a child, she had studied in a Missionary School in India." The Govindjees returned to Urbana, but not with a very good feeling, all due to somebody pressuring them in this manner because they were vulnerable. He said, "We didn't have much money; we were just students here at that time. So that was a negative experience. Still, it has not been something terrible in my memory. I always understand people. They were doing it because that is the way they were trained, and they meant well. And from their standpoint, they were not doing anything bad, but had good thoughts towards us." Nevertheless, from Govindjee's perspective, it was difficult to be on the receiving end of such actions.

American racial segregation also proved quite a challenge when they were trying to settle into life in the United States. He remembered one story from the mid-1960s when they wanted to rent apartments in their own town (Urbana, Illinois). Govindjee told the following story. He had telephoned somebody who had advertised a large apartment, and they had agreed to meet near the apartment. Govindjee was already on the UIUC faculty at the time. As Govindjee and Rajni were walking on the sidewalk, the owner drove up in his car. He rolled the car window down and yelled as if from a distance, "I'm sorry, sir. The apartment...house you wanted to rent is rented." As quick as that, Govindjee recalled, the man drove off. Later when they were looking to buy a home, the Govindjees had hired a real estate person to help them see available residences. The agent took the Govindjees to "run-down" houses and then chided them. "Well, you know, Mr. Govindjee, you didn't like the houses we showed you." Govindjee told me that the agent was taking them only to the houses in the "African American" neighborhoods. "They were not good houses, so we didn't want them." Then the agent said to Govindjee, "I'll show you a good house since you did not like any others. However, I doubt they will sell it to you because your wife wears a sari."

Govindjee told me: “Rajni didn’t normally wear a sari. She usually wore trousers, or pants, or *shalwar-kurta*, wearing saris only for parties.” But, it seems, the sari was the symbol of everything that was foreign and, thus, off-putting about them. The realtor did show the house, but when they wanted to buy it, she told them that the owner would not sell it to them because of the reason given above. At that time in the 1960s, the Govindjees could not break out of the rental market’s racial segregation.

In the meantime, a friend of the Govindjees, William (Bill) Payne, who was an Assistant Professor in the Department of Botany at UIUC, was having a home built for him on McHenry Street in Urbana and introduced Govindjee to his builder. The builder’s name was Mr. Tyler Allhands, a lecturer in the Department of Mathematics, UIUC. (There is now a scholarship in his memory; see <<https://arch.illinois.edu/culture/awards/scholarships-and-fellowships/>>.)

Govindjee explained, “He had a master’s degree in Math, but he was also a builder.” When asked, Mr. Allhands said, “Sure, we will build you a house.” To which, Govindjee replied, “But it will be like I want it. Build the house like you built for Mr. Payne—just with minor changes.” So, in 1965 (the year Govindjee was tenured at UIUC), Mr. Allhands built the house just as the Govindjees had asked. They loved it. Their children (Anita and Sanjay) were born there and went to Yankee Ridge school. Govindjee told me “Our neighbors were great; we lived there for 15 years until it was too small for us. And then, in 1979, when our children were older, we moved to this bigger house on Boudreau Drive with no hassle. For us, building a house gave access to the kind of housing we wanted.”

Govindjee found housing discrimination to be a problem outside of Urbana too in those days. One summer, in 1963, they were going to Baltimore, Maryland, to do research at RIAS (Research Institute of Advanced Science) with the Martin-Marietta Company. He told me, “Nobody would rent us a house. There was a big hotel in Baltimore that someone had suggested for us to go there. At the hotel, the *Receptionist* said, ‘Rented. We have no place.’ Then the man at the front desk amended, ‘Sorry, I forgot to turn the sign,’ turning it to read ‘No Vacancy.’ However,

when we left, the sign was turned to ‘Vacancy’ again. In the end, George Hoch, our host at RIAS, took us to a racially mixed neighborhood, and helped us find a decent house there to rent. Another time, we traveled in New Mexico by car. One lady offered us a place, but she had only one room, and our group had 5 people. We said, ‘No, no. We can’t live in this room; it is too small. We need at least 2 rooms.’ She said, ‘I don’t have 2 rooms, but I will keep this place for you since I’m afraid you won’t get another.’ We went looking, and once again it was the same story. When we stopped at places with vacancy signs, they would say, ‘Oh, we’re sorry. We forgot to turn the sign off!’ So, they would put the note ‘No Vacancy,’ but as soon as we left and looked back, we would see the ‘Vacancy’ sign again. Ultimately, we had to return to the first place, and we all slept in one room. In addition, we met other total strangers who invited us to stay in their homes, and this more than compensated.”

Govindjee added, “But you see, again, as far as I’m concerned, I understand it because people learn such things from their families as they grow up. Unless they recognize it, how can they change? We felt bad, but we always understood that this is a human frailty and nothing more. Even in India, there is discrimination from one to the other. Not that I say it is a good thing! Rather, it can be understood, but we need to change it. Certainly the U.S. has changed, but does it mean that people are not discriminated? We all know that humans are humans. People discriminate and are discriminated against. Still, the law of the land is so much better now. Former President Lyndon Baines Johnson (LBJ) needs to be praised for what he did in this direction.”

When Govindjee received his first verbal appointment to the UIUC faculty, it was also an issue in some quarters. Most other students in the department were Euro-Americans or “White.” The Govindjees were on their way to becoming Indo-Americans, so to say. Govindjee remembered one Euro-American student, who was senior to him was unhappy that he was not offered the position while Govindjee was. He said, “Well, I hope you are taking it just temporarily and you will be going back to your country. Won’t you?” To him, Govindjee was a

foreigner taking things away, but others recognized the benefits of incorporating international students into their departments. Soon thereafter, when Govindjee was on the faculty, he took in graduate students or postdocs from around the globe: UK, USA, Europe, India, Canada, and China. As Govindjee explained, “The diversity of my own graduate students (see: <[https://www.life.illinois.edu/govindjee/g/Graduate\\_Students.html](https://www.life.illinois.edu/govindjee/g/Graduate_Students.html)>) gives us a small glimpse of how we can push past the drive to discriminate and instead work together.”

### **Transnational Ties that Bind**

In an era with time-consuming transportation and challenging long-distance communication, maintaining ties to family and friends in India was difficult in the mid-20<sup>th</sup> century. This could mean that deciding to move across the ocean would feel like losing a family member.

Govindjee’s mother was very upset when he decided to take the UIUC job and settle in the USA. She clearly said, “Govindjee will not return ever!” When he returned home for the first time, after being in USA for some time, she did not even recognize him. As Govindjee recalled, she said to him, “You are not Govindjee.” So, she was very emotionally affected by it, but Govindjee thinks it was more than just the long distance. He thinks she was starting to get ill. As far as Govindjee’s brothers and sisters were concerned, they were not as sad. They looked upon it as an opportunity for their brother to be selected as a faculty member of another major university, so no one thought (or thinks) that there was any real issue there. Both his brothers had an international view of science and what it meant. Govindjee said to me, “Scientists belong to the World not just one country.”

### **Staying in touch with family and friends back home**

According to our interview, the Govindjees always wrote letters, sent by regular mail through the post-office. He said to me: “Thank goodness for the existence of post offices and the mailboxes! We wrote letters by hand and would wait every day to get letters in reply. When a postman came, we eagerly rushed to the mailbox. In our earlier house (on McHenry

Street, Urbana), the mailbox was attached to the house; here (on Boudreau Drive), it is outside on the other side of the street. So, the mail was the main thing. We would just run back to the mailbox every day, day after day.” Govindjee added, “Now, phones did exist. The phone calls were like this: We would call via an operator, and then wait. Maybe the other party would contact in half an hour, one hour, or even two hours later. Until then, we would wait and sit there in the evening, just sort of studying or doing something. We would be holding the phone for half an hour or even one hour before we got connected. Then we would say a few words to each other, just to remember. A time-consuming process!” Govindjee remembered those as very exciting days. How they looked forward to getting letters, even though there was a delay of 2 weeks! He told me that not only his eldest brother Krishnaji replied to all his letters, but Rajni’s eldest brother Suresh Chandra always wrote letters to her. He told me that they had constant hand-written letters back and forth, and so they kept in touch. They also looked for people who were traveling to India in person. Every time somebody was going, they would send something like chocolate for the family. In return, those coming from India would bring some great Indian sweets for them. Govindjee remarked: “All those things are now gone. Today we connect not only by phone and e-mail, but also by Skype, Facetime, and WhatsApp. Technology has indeed changed, and we love it.”

When Rajni and Govindjee were working (until 1999, when both retired), there was rarely much time to visit their families. The only time they went to India, then, was when they had a program organized. For many years, Govindjee served together with Steve Huber from the US side as a specialist on the US-India PL 480 program. However, after he retired in 1999 and closed his lab in 2002, both have been able to go to India whenever there was an opportunity, almost every year now—except in 2021 due to COVID-19. Following retirement, Govindjee began to want to give back something to India, so he looked for ways to go, lecture, and visit families as well. He gave lectures there and “mixed” with graduate students in Life Sciences. The Fulbright Program had sponsored one of his earlier visits to India. Of course,

he had come on a Fulbright from India to U.S. in 1956, as mentioned above, but after he became an American citizen, he went on a Fulbright as an American to India and taught at the University of Indore (Indore, Madhya Pradesh) about 10 years ago (see e.g., a write-up on a conference for him by Jajoo et al., 2009). Recently, in the last 6–8 years, he has been going to the Jawaharlal Nehru University in New Delhi, to be with students and their advisors (e.g., Baishnab C. Tripathy, and Ashwani Pareek). **Figure 3** shows the Govindjees with B.C. Tripathy and his students, including some with whom he has collaborated. In addition, he has

collaborated with the research group of Ashwani Pareek (see e.g., Kandoi et al., 2016; Soda et al., 2018; Wungrampha et al., 2019; and Padhi et al., 2021). In addition to India, Govindjee has been going to China and has worked with the research groups of Xin-Guang Zhu (in Shanghai) and Ya (David) Guo (in Wuxi); see e.g., Hamdani et al. (2019), Fu et al. (2020), Khan et al. (2020) and Pandhiyan et al. (2021). Both in India and China, all of their research deals with increasing food productivity in rice and other crops to alleviate food shortage for the benefit of all.



**Fig. 3.** Left to right: Kamal Ruhil, Deepika Kandoi, Rajni Govindjee, Govindjee Govindjee, Baishnab Tripathy, and Garima Chauhan, at the International Guest House, Jawaharlal Nehru University, New Delhi, India. Ruhil, Kandoi and Chauhan were graduate students of Tripathy, collaborating with Govindjee. Photo, 2016; source: Govindjee’s archives.

At UIUC, Rajni and Govindjee have established a small Award for students (<https://sib.illinois.edu/graduate/grants/Govindjee>; also see <https://www.life.illinois.edu/govindjee/photooftheyear2021.html>). Rajni and Govindjee attempt to give back in this manner, and so keep students in their hearts.

Three articles have been published on Govindjee’s teaching in India, and they demonstrate the kind of teaching he has done there. One article covered the way he taught the “Z- scheme,” of electron and proton transport in oxygenic photosynthesis at Ravenshaw University (in Cuttack,

Odisha), with students and faculty acting as molecules (Mohapatra and Singh, 2015; for evolution of this scheme, see Govindjee et al., 2017). This was one dramatic lecture – done outdoors. The second one was also on the Z-Scheme, which was done in the SLS (School of Life Science) at Jawaharlal Nehru University (JNU). This was also a drama, where students acted as molecules, but it was indoors in their auditorium (Jaiswal et al., 2017). As they did at Ravenshaw University, students chose molecules in a chloroplast and acted out their role, actively transferring electrons from water to carbon dioxide by following the precise process of photosynthesis. Govindjee described how they used tennis balls and balloons as electrons, protons, and oxygen atoms, bringing further realism to his version of the model for the “Z-scheme.” We are told that Professor Tom Sharkey of Michigan edited the article since he had liked it and thought that Govindjee’s technique of teaching photosynthesis was a great idea for education! Perhaps, other people can learn from it and see how one can work science into drama. In addition to these two events, Govindjee has been to India to teach courses on “Photosynthesis” sponsored by different agencies including a Fulbright Award from USA, as well as a 2016 GIAN (Global Initiative on Academic Network) program from India (JNU, New Delhi; host: Prof. Baishnab Tripathy), and a special program of the Department of Biotechnology, JNU. In the latter program, Govindjee again had fun teaching in the course taught by Prof. Swati Tiwari.

### **A BIT ON GOVINDJEE’S STUDENTS**

For Govindjee, the stories of those who have shaped his field of research, their interpersonal connections, and the histories behind their choices have been highly valuable (see Stirbet et al., 2020). Even as he has contributed to key research areas and with educational materials to the field of “photosynthesis” (see Govindjee, 2019a), Govindjee has prioritized his writing to remember those who have left this World. He has collaborated on over 40 biographical tributes to those who have shaped the study of photosynthesis (see [http://www.life.illinois.edu/govindjee/recent\\_papers.html](http://www.life.illinois.edu/govindjee/recent_papers.html)). His own recollections are filled with references to and stories about the students and loved ones with

whom he has interacted closely. They stand as a different sort of legacy for the future, not through publications and discoveries, but through regular mentoring, intellectual partnership, and love for his students and coworkers.

Many of Govindjee’s academic memories involve the students he advised and with whom he worked. Over the years, five of his students have passed away. One was Prasanna K. Mohanty (1934–2013; PhD, 1972). Govindjee and others have remembered Mohanty twice in publications (Tiwari et al., 2014; Naithani and Govindjee 2018), and an award has been established in his name at the ISPR (International Society for Photosynthesis Research). The second was Fred Cho (1939–2011; PhD, 1969), who was remembered in depth by Govindjee et al. (2017). The third was Thomas (Tom) Wydrzynski (1947–2018; PhD, 1977) who was commemorated by Govindjee (2008a; Govindjee et al., 2018) and Conlan et al. (2019), and an award has been established in his name at the ISPR. The fourth was Maarib Bazzaz (1940–2020; PhD, 1972) and she was remembered by Govindjee et al. (2020). The fifth was Govindjee’s very first PhD student, George Papageorgiou (1933–2020; PhD, 1968). Govindjee continued to work with him for many years, even following their retirements (see e.g., Papageorgiou and Govindjee, 2014; Govindjee et al., 2019; Stirbet et al., 2019). There was a celebration of George’s life, and Govindjee visited Greece to participate in it (Allakhvardiev et al., 2016).

For a list of all Govindjee’s graduate students, see the following web page: <<https://www.life.illinois.edu/govindjee/g/GraduateStudents.html>> (Govindjee, 2019a, 2019b). Govindjee remembered many of his students including the following: Rita Khanna (PhD, 1980), who is currently a lawyer in Washington, D.C; Julian Eaton-Rye, Professor in Biochemistry in New Zealand who wrote marvelous articles on Govindjee’s 75<sup>th</sup>, 80<sup>th</sup>, and 85<sup>th</sup> birthdays (Eaton-Rye 2007a, b; 2013, 2018, 2019). Govindjee told me that he feels very lucky to have been treated so wonderfully well. Other outstanding former graduate students who went into academia include: John C. Munday (PhD, 1969); Ted Mar (PhD, 1971); Glenn Bedell (PhD, 1972); Alan



Stemler (PhD, 1974); Barbara A. Zilinskas (PhD, 1975); Paul Jursinic (PhD, 1977; Medical Physics); Danny J. Blubaugh (PhD, 1987); and JinXiong (PhD, 1996). Others who have done research and/or administration, in industry or government, include: Louisa Yang (MS, 1965); Carl N. Cederstrand (PhD, 1965; instrumentation at Beckman Co); Anne Krey (MS, 1966; NIH); Ralph Schooley (MS, 1976); David Vander Meulen (PhD, 1977); Daniel Wong (PhD, 1979); William Coleman (PhD, 1987); Chunhe Xu (PhD, 1992); and J. Cao (PhD, 1992). The last student Paul Spilotro (MS, 1999) went to get an MD and is a practicing pediatrician. Almost all who went into industry had great success, proving that the training Govindjee gave them also prepared them for careers outside of academia.

The two children of Rajni and Govindjee have gone on to careers that fill their parents with pride. When the children were growing up, Rajni and Govindjee wanted them to do what they wanted. Their daughter Anita became a Computer Scientist for a major company in USA, and their son Sanjay became an Engineer; he is on the faculty at a major University, also in USA.

Govindjee expressed his appreciation for the kindnesses he has received from many in his field over the last few decades: “I end by first citing a remarkable presentation by Eaton-Rye et al. (2020) and by expressing my heartfelt pleasure in reading the 65+ wonderful messages there on my 20 years of retired life and on my 88<sup>th</sup> birthday. In addition, there have been a few earlier lovely things. I have been proud and thrilled to have been recognized in my country of birth several times including (1) The 8<sup>th</sup> International Conference on ‘Photosynthesis and Hydrogen Energy Research for Sustainability,’ held in November, 2017, at the University of Hyderabad, India – where I shared the platform with my friends Bill (William Cramer of Purdue University) and Ragma (A.S. Raghavendra of Hyderabad University); it was wonderfully organized by S. Rajagopal (of Hyderabad); and (2) the ‘National Conference on Photosynthesis,’ held in December, 2017, at Mohanlal Sukhadia University in Udaipur, Rajasthan; it was organized, in an extraordinary manner, by Vineet Soni.

See <https://www.life.illinois.edu/govindjee/world-historical.html> for further details on these two conferences. In addition, I cannot forget the love expressed by Virendra Kumar (2020) when he published his booklet titled ‘Wings to a Child’s Dream.’ Further, I express great pleasure in recognizing that the wonderful stuff (from the times of Robert Emerson and Eugene Rabinowitch) in my ‘old’ office, was written up by Diana Yates (of UIUC) as a follow-up of her interview (see <https://news.illinois.edu/view/6367/801235>) under the title: ‘Govindjee’s Photosynthesis Museum’.”

**Figure 4** shows Govindjee with a few others while he was sightseeing in Hyderabad, India, in 2017, during a break at the afore-mentioned 8<sup>th</sup> International Conference on “Photosynthesis and Hydrogen Energy Research for Sustainability.”

Others before me have conducted interviews of Govindjee, and interested readers should listen to these for further information on Govindjee’s research and life, particularly the interviews by Professor Don Ort (<https://www.youtube.com/watch?v=cOzuL0vxEi0>) and by the Indian (Upper House) TV Program “Eureka” (<https://www.youtube.com/watch?v=OBKusHcjMzw>). Several others, including an interview in Hindi by Kapoormal Jain (2019) and by Meher Wan (2020), are fun to read. Last, but not the least, the 2012 School of Integrative Biology (SIB) News Report, page 9, gave him the title of “Mister Photosynthesis,” which is the source of this paper’s title.

Finally, for perspectives on both Govindjee and Rajni, see (1) “Govindjee and Rajni Govindjee - Confluence of Photosynthesis and Photobiology” by Ravi Sharma: <https://www.linkedin.com/pulse/govindjee-rajni-confluence-photosynthesis-dr-ravi-sharma>, and (2) “Govindjee: The Living Legend I Met” by Ravi Sharma <https://www.linkedin.com/pulse/govindjee-living-legend-i-met-dr-ravi-sharma>

I end this Tribute with 2 photographs of Govindjee. **Figure 5** shows him holding his prestigious 2015 B.M. Johri Award from India; here, to honor his first Professor in Photosynthesis, Govindjee is wearing Emerson’s historical lab apron (which is now in the



**Fig. 4.** Left to right: N. Aparna ( a research scholar from India), G. Govindjee, an unidentified research scholar, Suleyman Allakhverdiev (a research leader from Russia), and an identified young person (selling water bottles). Place: Hyderabad, Andhra Pradesh, India. Photo, 2017; source: Rajni Govindjee (see Allakhverdiev et al., 2019 for the conference in honor of Govindjee; William Cramer; and A.S. Raghavendra).



**Fig. 5.** Govindjee with a plaque for the prestigious B.M. Johri Memorial Award of the Society of Plant Research (of India); to honor his Professor, Robert Emerson, Govindjee is wearing the Lab apron Emerson wore when he had discovered the Emerson Enhancement Effect in Photosynthesis. Photo, 2016, New Delhi, India; source: Rajni Govindjee.



**Fig. 6:** Govindjee in his office in 669 Morrill Hall (505 South Goodwin Avenue, Urbana, Illinois). It is from a 2019 article for the School of Molecular and Cell Biology at the University of Illinois at Urbana-Champaign <<https://mcb.illinois.edu/news/article/512/>> : “Govindjee: A pioneer in photosynthesis” by Ananya Sen; Photo by Serina Taluja.

Archives of the University of Illinois at Urbana-Champaign. **Figure 6** shows, Govindjee in his office in Morrill Hall (at UIUC) in 2018.

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Many thanks to Govindjee for sharing with me not only his experiences as a South Asian in the USA in the 1950s and the 1960s, which was my research interest, but also the more personal picture of his life. He has taught this history student more about photosynthesis than I had ever dreamed! His guidance in preparing this article for publication has also made this article possible. Thanks also to my PhD advisor, Cindy I-Fen Cheng, who encouraged me to include oral histories in my research methods, even when others suggested avoiding their time-intensive demands. Indeed, personal stories are what bring life and humanity to all the statistics and details we find. Finally, I thank Dr. Arthur Nonomura for his suggestions and encouragement during the publication process, and Dr. Rajni Govindjee for reading this text.

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