Pharmacopoeia 2014 (*IP-2014*) version (additional entries done in subsequent editions). Incidentally, the corresponding author[1] (R.K.S.) was the Chair of the IPC Expert Committee tasked with the first-time entry of monographs of radiopharmaceuticals in the *IP*.

The above-mentioned points should serve to clarify the internal regulatory approval process of DAE units for production and supply of radiopharmaceuticals in India, as well as will respond to the authors' generic contention in the abstract ('and particularly India, which does not have guidelines for their approval, and intensifies the concern for a harmonized regulatory platform of global acceptance.').

1. Sharma, S. *et al.*, *Curr. Sci.*, 2019, **116**(1), 47–55.

SHARMILA BANERJEE

Radiation Medicine Centre,
Bhabha Atomic Research Centre, Parel,
Mumbai 400 012, India
e-mail: sharmila@barc.gov.in

Teaching English for science students

The 2005 editorial by Balaram[1] throws much light on the poor English language ability of students of science. Although it is more than a decade now, there has not been any improvement and the situation seems to be as grave as before. Raman[2] has expounded his experience on the dire need of sparing more than four hours of teaching basic English to students who registered for research under him. Most students of science and technology are under the misconception that English language learning is trivial and something that is unnecessary. It is considered petty, little forgetting that English is an international language which is widely spoken across the globe and used in all sectors. It is time pupils realize and understand the absolute significance of English in their lives and careers. Subbarao[3] opined that students of science, even at the postdoctoral level, are unable to appreciate, let alone practice, the importance of correct English.

Working as English professors in a university, we find it unpalatable to read the atrocious English in the scripts of our science students. At graduate and post-graduate levels, we do find it tricky to explain to them, the appalling errors in their scripts. English is not a language that is as simple as it seems; it has extensive vocabulary, intricate grammar and broad lexicology. In most cases, teachers of English in higher educational institutions are trapped in following a conservative and outdated system of teaching and not wary of the demands of the industry and research institutions. They are acutely bothered about completing the syllabus on time and hence the teaching is painfully robotic and monochromatic. 'Teaching' most of the time is rushed through without giving consideration to the student's ability to comprehend what is being taught. English for specific needs is the order of the day. It is vital to provide an opportunity to the students to bask on the myriad facets of language – exposing them to vocabulary-building, newspaper reading, writing of articles, scientific writing, story-telling, paraphrasing, précis writing, comprehensive listening, impromptu speaking, debating, role-playing, language-gaming, mock-interviewing, book reviewing, etc. can come a long way in developing proficient English language skills. Teaching or learning English is a never-ending process. The task of the teacher is only to give the student a blissful taste of what English language is. The unquenchable thirst by itself will awaken the student's voracity to learn and yearn for more. For 'A little learning is a dang'rous thing;/Drink deep, or taste not the Pierian spring', so quoted Alexander Pope in his poem.

1. Balaram, P., *Curr. Sci.*, 2005, **88**, 205–206.
2. Raman, A., *Curr. Sci.*, 2015, **109**, 398.
3. Subbarao, C., *Curr. Sci.*, 2005, **88**, 847.

S. SUSHMA RAJ*
C. V. PADMAJA

Department of English,
GITAM Institute of Science,
GITAM University,
Visakhapatnam 530 045, India
**e-mail: s.sushmaraj@gmail.com*

Can peptide nucleic acid be the future substitute for antibiotics?

With the emergence of growing antibiotic resistance among microbes because of habitual use of antibiotics, there is an urgent need to develop appropriate and economical substitutes for antibiotics. Antimicrobial resistance (AMR) threatens the conventional method of treatment and prevention of a wide range of multidrug-resistant (MDR) microbes which include bacteria, parasites, fungi, etc. AMR is gradually establishing itself as a serious threat to global public health which requires immediate attention from the scientific community across the globe. According to a report of the World Health Organization (WHO), in 2016 alone, approximately 500,000 people developed MDR tuberculosis worldwide and it also expected that such growing antibiotic resistance will make the fight against HIV and malaria more complicated soon[1].

In recent times, peptide nucleic acid (PNA)-based antimicrobial products are

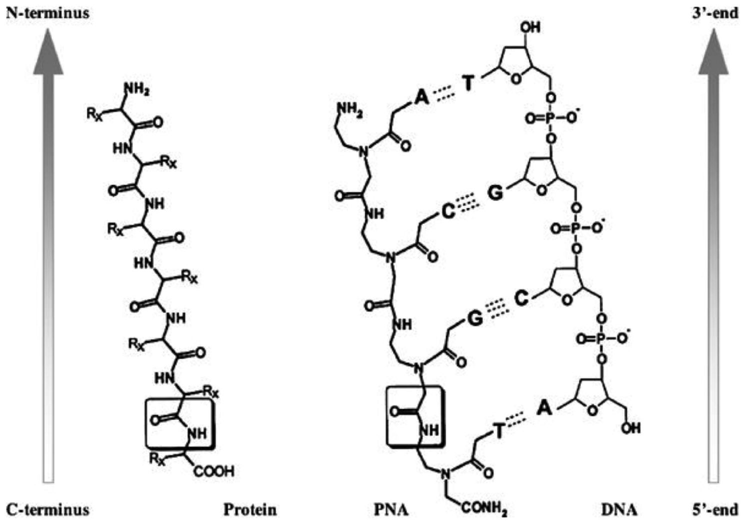

Figure 1. Comparison of the structure of a protein, PNA and DNA[8].

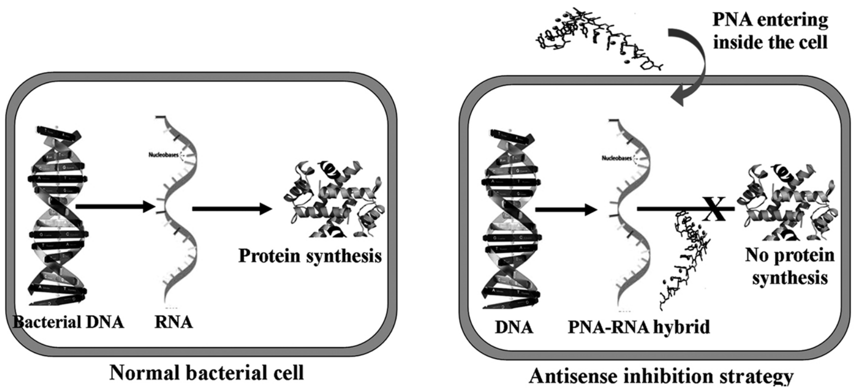

Figure 2. Schematic diagram showing PNA-based antisense strategy to act as an antimicrobial agent.

gaining attention among researchers with their promising anti-bactericidal activities against some of the MDR microbes. PNAs were first synthesized in 1991 by Nielsen and co-workers with a repeating N-(2-aminoethyl)-glycine peptide backbone connected to nucleotide base pairs via a linker as an analogue of DNA (Figure 1)[2]. Since PNAs are resistant against enzymatic digestion with higher biostability, they are exploited for various chemical and biological assays and in recent times in antimicrobial studies to fight against MDR microbes. The key mode of action of PNA includes lysis of bacterial cell wall and working as antisense antimicrobial agents which targets essential bacterial genes by lowering corresponding mRNA level leading to cell death. In addition, it has the advantage of its resistant property against nucleases and proteases during its entry into the cells (Figure 2)[3,4]. Design and evaluation of species-specific PNA antibacterials may be another aspect of antimicrobial PNA research. Scientists have now successfully developed PNA-based antimicrobial agents against multidrug-resistant *Haemophilus influenza*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pnuemoniae*, *Salmonella enterica* serovar *Typhimurium*, etc. in their planktonic form and also their respective biofilms[5,6].

Despite the promising beneficial properties of PNA such as its simplicity in synthesis, higher biological stability which makes it a potential antimicrobial candidate, there are some challenges which need to be addressed before its clinical exploitation. One such problem is its less solubility in water due to its neutrality which leads to poor intracellular uptake of PNA-based drugs and also its tendency to form a globular structure[2]. Hence, further research is on-going to improve its water solubility by modifying its oligomers by adding positively charged residues on the terminals and further conjugation with negatively charged DNA[7]. Another significant challenge while implementing it for clinical trials is that PNA alone cannot interact with the target sequence without passing through the cell membrane[2,7]. In conclusion, the future scope of PNA-based drugs to fight against MDR microbes as a suitable substitute for conventional antibiotics cannot be ignored.

1. https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance (accessed on 26 September 2019).
2. Montazersaheb, S., Hejazi, M. S. and Charoudeh, H. N., *Adv. Pharm. Bull.*, 2018, **8**(4), 551–563.
3. Hansen, A. M., Bonke, G., Larsen, C. J., Yavari, N., Nielsen, P. E. and Franzyk, H., *Bioconjugate Chem.*, 2016, **274**, 863–867.
4. Lee, H. T., Kim, S. K. and Yoon, J. W., *J. Microbiol.*, 2019, **57**(6), 423–430.
5. Otsuka, T. *et al.*, *J. Antimicrob. Chemother.*, 2017, **72**, 137–144.
6. Ghosal, A. and Nielsen, P. E., *Nucleic Acid Ther.*, 2012, **22**(5), 323–334.
7. Quijano, E., Bahal, R., Ricciardi, A., Saltzman, W. M. and Glazer, P. M., *Yale J. Biol. Med.*, 2017, **90**, 583–598.
8. Pellestor, F. and Paulasova, P., *Eur. J. Human Genet.*, 2004, **12**, 694–700.

RUPESH KUMAR
BHASKARJYOTI GOGOI
DEBAJIT BORAH*

Department of Biotechnology,
Royal Global University,
Guwahati 781 035, India
**e-mail: dborah89@gmail.com*