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Educational Qualification:

- B.Sc. (1994) R K M Vidyamandir, Belur
- M.Sc. (1996) IIT Kanpur
- PhD (2002) Carnegie Mellon University, USA

Professional Experience:

- Research Associate (2002-2005), The Scrips Research Institute (With Prof. M G Finn)
- Alexander Von Humboldt Fellow (2005-2006), Technical University of Munich, Germany (With Prof. Thomas Schiebel)
- Scientist, CSIR-National Chemical Laboratory, Pune (2006-2016)
- Associate Professor, Indian Institute of Science Education and Research, Kolkata (2016-2021)
- Professor, Indian Institute of Science Education and Research, Kolkata (2021-Present)

Group Webpage: https://bicamlab.wixsite.com/ssg-lab

TEACHING ASSISTANTSHIP:

- Teaching Assistant for **"CH2101-Elements of Chemistry II"**- 2nd Year UG Students
- Teaching Assistant for **"CH4201-Bioinorganic Chemistry"**- 4th Year UG Students
- Teaching Assistant for **"CH5106-Sustainability and Chemistry"**- 5th Year UG Students
- Online Teaching at **Jawahar Navodaya Vidyalaya, Kalyani**, Nadia- XIth and XIIth Students
- Teaching Assistant for **"CH1101-Elements of Chemistry"**- 1st Year UG Students
- Teaching Assistant for **"CH1102-Chemistry Lab I"**- 1st Year UG Students
- Online Teaching at NPTEL for the course **"Chemical Process Intensification"**
- Practical demonstration of cool scientific experiments at **"Garden High School"**
- Practical demonstration of scientific experiments in a school outreach program at **"IISER Kolkata"**
- Online Teaching at **Sashi Bhusan Rath Government Autonomous Women's College, Berhampur**- B.Sc. 1st year students

RESEARCH INTEREST:

Organic Synthesis, Polymer Synthesis, Polypeptide synthesis, Bio-inspired Materials, Drug Delivery, Anti-cancer agents, Bio-medical Applications, Bio-conjugation, Protein Delivery.

EDUCATIONAL BACKGROUND:

S. N	DEGREE	BOARD/UNIVERSITY	NAME OF INSTITUTION	YEAR	PERCENTAGE/ CGPA
1	10th	BOARD OF SECONDARY EDUCATION	UNVERSITY HIGHER SECONDARY SCHOOL, BHANJABIHAR	2011	92.5 %
2	12th	COUNSIL OF HIGHER SECONDARY EDUCATION	KHALLIKOTE JUNIOR COLLEGE, BERHAMPUR	2013	85.83 %
3	B.Sc.	KHALLIKOTE UNIVERSITY	KHALLIKOTE AUTONOMOUS COLLEGE, BERHAMPUR	2018	9.24 CGPA
4	Int. PhD	I.I.S.E.R. KOLKATA	I.I.S.E.R. KOLKATA	2018-PRESENT	1st SEM 9.17 2nd SEM 9.33 3rd SEM 10 4th SEM 9.5 5th SEM 10 6th SEM 10 TOTAL 9.7CGPA

AWARDS & ACHIEVEMENTS:

- Junior Merit Scholarship from 2011-2013
- Kishore Vaigyanik Protshahan Yojana (KVPY) from Aug 2016-July 2018
- JAM Qualified- AIR 670 in 2018 (Joint Admission Test for M.Sc)
- Joint CSIR-UGC NET JRF Qualified- AIR 32 in June 2019
- 1st Rank Holder in the University during B.Sc
- GATE 2020 and 2021 Qualified AIR 505
- Prime Minister's Research Fellow (May 2020)
- Chemical Science Best Poster Prize at **ChemSci2020**
- ACS Best Poster Award at International conference **SPSI-MACRO-2023**

EXPERIMENTAL and TECHNICAL SKILLS:

- Spectrophotometry (UV-Vis, Fluorescence), Spectroscopy (FTIR, NMR), Spectrometry (Mass), Electron Microscopy (SEM, TEM, AFM), Rota Vapor, Schlenck Line, Glove Box etc.

- Softwares of ChemDraw, Origin, ACD NMR, MesterNova, Adobe Illustrator
- Chromatographic Techniques (TLC and Column), Solvent Distillation
- N-carboxyanhydride (NCA) synthesis and their Polymerization
- Gel electrophoresis such as SDS-PAGE and Agarose
- Mammalian cell culture techniques
- In vitro experiments such as cytotoxicity assay, cellular uptake, gene transfection etc.
- Protein labelling, bioconjugation, purification techniques

PUBLICATION:

- Mondal, B.; Pandey, B.; Parekh, N.; Panda, S.; Dutta, T.; **Padhy, A.**; Sen Gupta, S[*]. **Amphiphilic mannose-6-phosphate glycopolypeptide-based bioactive and responsive self-assembled nanostructure for controlled and targeted lysosomal cargo delivery**. *Biomater. Sci.* **2020**, *8*, 6322-6336.
- B. Mondal, T. Dutta, **A. Padhy**, S. Das, S. Sen Gupta[*], **Lysosome Targeting Strategy using Polypeptides and Chimeric Molecules,** *ACS Omega* **2022**, *7*, 1, 5–16.
- B. Mondal[#], **A. Padhy[#]**, S. Maji[#], A. Gupta[*], S. Sen Gupta[*], **Dual Stimuli Responsive Photo Cross-linked Nanogel from Amphiphilic M6P Functionalized ABC tri-Block Copolymer for Lysosomal Cell Death**, *Biomater. Sci.* **2023**, *11*, 1810-1827. (# equal contribution)
- **A. Padhy**, P. Das, N. S. Mahadik, S. Panda, M. Anas, S. Das, R. K. Banerjee[*], S. Sen Gupta[*], **Design and Synthesis of Shikimoyl-functionalized Cationic Di-block copolypeptide for Cancer Cell Specific Gene Transfection.** (*Manuscript submitted for publication*)
- **A. Padhy**, M. Gupta, I. Farooq, A. Das, R. Dutta, S. Dutta[*], S. Sen Gupta[*], **Lysosome specific Delivery of β-glucosidase Enzyme using Protein-glycopolypeptide Conjugate via Protein Engineering and Bioconjugation.** *(Manuscript to be submitted)*
- D. Chatterjee, **A. Padhy**, A. Gangopadhyay, S. Sivaram[*], S. Sen Gupta[*], **Solvent-free Oxidation of Cellulose and Lignocellulose by Fe Complex.** *(manuscript under preparation)*

PICTURES ABOUT RESEARCH:

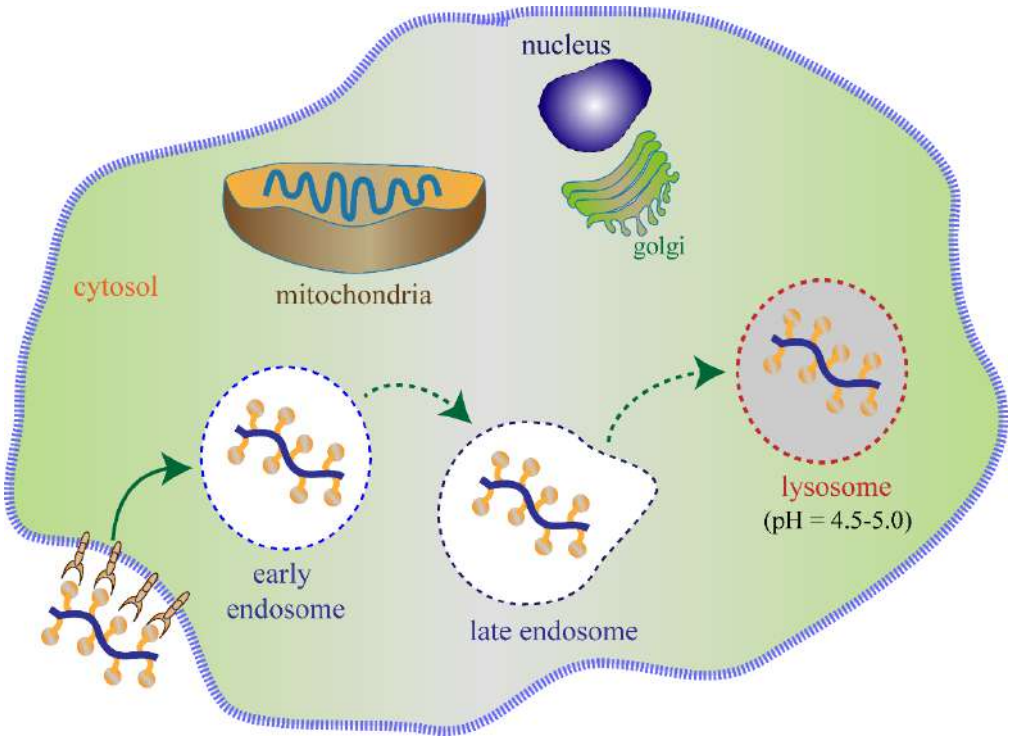

Fig: Schematic representation of Lysosome Targeting using specific Ligands

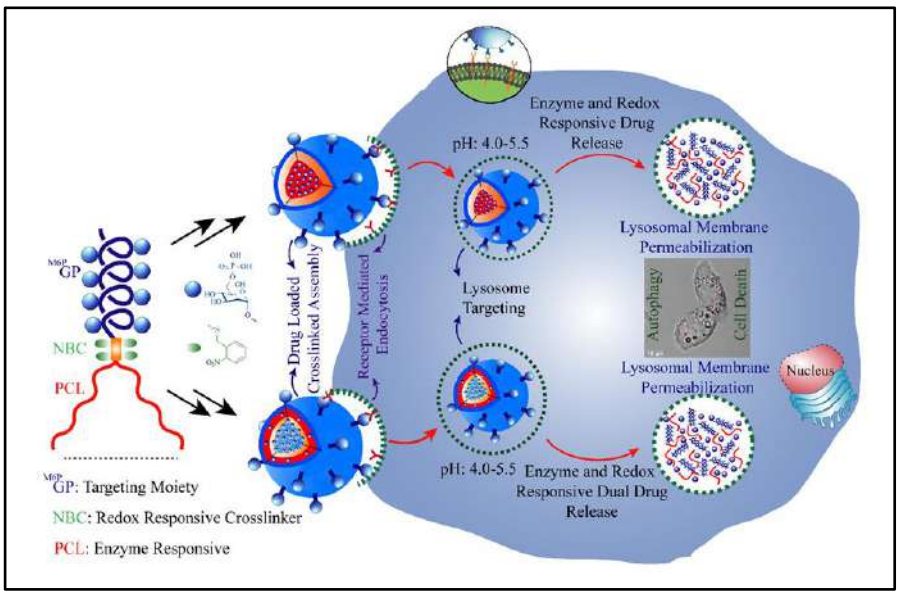

Fig: Lysosomal Membrane Permeabilization by delivering Lysosomotropic agents using cross-linked drug delivery vehicles fabricated from Amphiphilic block-copolymers

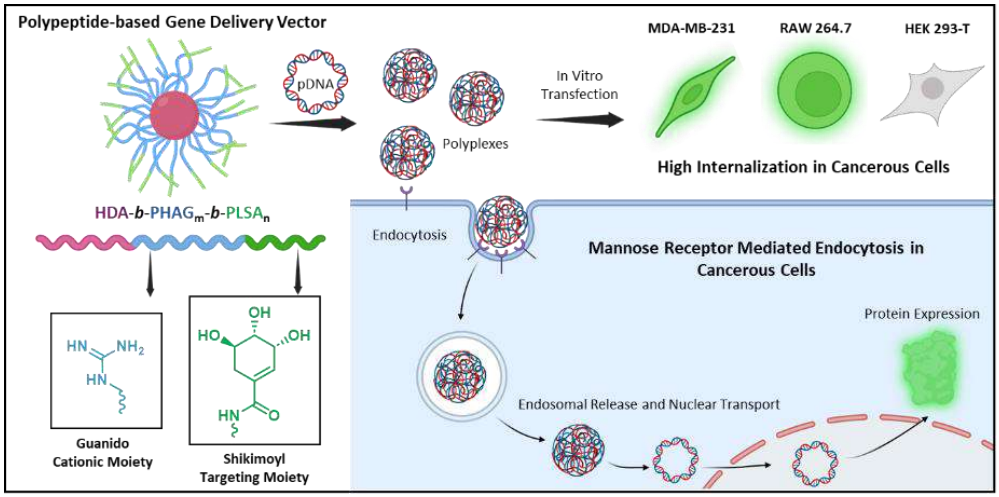

Fig: Cancer Cell Specific Gene Transfection using Polypeptide-based Gene Delivery Vector from Shikimoyl-functionalized Cationic di-block copolypeptide

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d uv uwyo m r-P- u umr tyo y r vpr-nmrp nv mo v r m p r vr rys-m r nyrp m o r s o yyrp m p mtr rpy myomt prywr †

Basudeb Mondal, ‡[a] Bhawana Pandey, §‡[b,c] Nimisha Parekh, ‡[b,c] Sidharth Panda, [a] Tahiti Dutta, [a] Abinash Padhy [a] and Sayam Sen Gupta *[a]

Receptors of carbohydrate mannose-6-phosphate (M6P) are overexpressed in specific cancer cells (such as breast cancer) and are also involved in the trafficking of mannose-6-phosphate labeled proteins exclusively onto lysosomes *via* cell surface M6P receptor (CI-MPR) mediated endocytosis. Herein, for the first time, mannose-6-phosphate glycopolypeptide (^{M6P}GP)-based bioactive and stimuli-responsive nanocarriers are reported. They are selectively taken up *via* receptor-mediated endocytosis, and trafficked to lysosomes where they are subsequently degraded by pH or enzymes, leading to the release of the cargo inside the lysosomes. Two different amphiphilic M6P block copolymers $^{M6P}GP_{15}$-$^{A}PPO_{44}$ and $^{M6P}GP_{15}$-$(PCL_{25})_2$ were synthesized by click reaction of the alkyne end-functionalized $^{M6P}GP_{15}$ with pH-responsive biocompatible azide end-functionalized acetal PPO and azide end-functionalized branched PCL, respectively. In water, the amphiphilic M6P-glycopolypeptide block copolymers self-assembled into micellar nanostructures, as was evidenced by DLS, TEM, AFM, and fluorescence spectroscopy techniques. These micellar systems were competent to encapsulate the hydrophobic dye rhodamine-B-octadecyl ester, which was used as the model drug. They were stable at physiological pH but were found to disassemble at acidic pH (for $^{M6P}GP_{15}$-$^{A}PPO_{44}$) or in the presence of esterase (for $^{M6P}GP_{15}$-$(PCL_{25})_2$). These ^{M6P}GP based micellar nanoparticles can selectively target lysosomes in cancerous cells such as MCF-7 and MDA-MB-231. Finally, we demonstrate the clathrin-mediated endocytic pathway of the native FL-^{M6P}GP polymer and RBOE loaded ^{M6P}GP micellar-nanocarriers, and selective trafficking of MCF-7 and MDA-MB-231 breast cancer cell lysosomes, demonstrating their potential applicability toward receptor-mediated lysosomal cargo delivery.

Received 1st September 2020,
Accepted 14th September 2020

DOI: 10.1039/d0bm01469a

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Perspective

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Basudeb Mondal, Tahiti Dutta, Abinash Padhy, Sabyasachi Das, and Sayam Sen Gupta*

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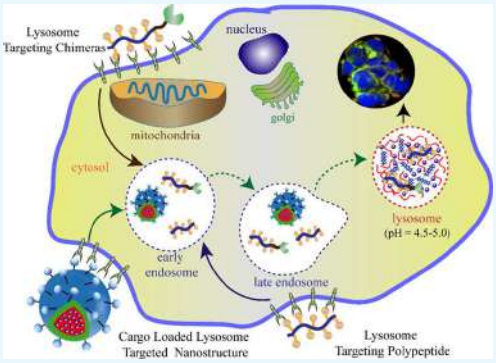

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https://doi.org/10.1021/acsomega.1c04771
ACS Omega 2022, 7, 5−16

Biomaterials Science

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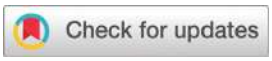

Cite this: *Biomater. Sci.*, 2023, **11**, 1810

Dual stimuli-responsive cross-linked nanoassemblies from an amphiphilic mannose-6-phosphate based tri-block copolymer for lysosomal membrane permeabilization†

Basudeb Mondal, ‡§[a] Abinash Padhy, §[a] Saptarshi Maji, §[b] Arnab Gupta *[b] and Sayam Sen Gupta *[a]

Stimuli-responsive cross-linked nanocarriers that can induce lysosomal cell death (LCD) *via* lysosomal membrane permeabilization (LMP) represent a new class of delivery platforms and have attracted the attention of researchers in the biomedical field. The advantages of such cross-linked nanocarriers are as follows (i) they remain intact during blood circulation; and (ii) they reach the target site *via* specific receptor-mediated endocytosis leading to the enhancement of therapeutic efficacy and reduction of side effects. Herein, we have synthesized a mannose-6-phosphate (M6P) based amphiphilic ABC type tri-block copolymer having two chains of FDA-approved poly(ε-caprolactone) (PCL) as the hydrophobic block, and poly(*S*-(*o*-nitrobenzyl)-L-cysteine) (NBC) acts as the photoresponsive crosslinker block. Two different tri-block copolymers, $[(PCL_{35})_2$-*b*-NBC_{20}-*b*-$^{M6P}GP_{20}]$ and $[(PCL_{35})_2$-*b*-NBC_{15}-*b*-$^{M6P}GP_{20}]$, were synthesized which upon successful self-assembly initially formed spherical uncross-linked "micellar-type" aggregates (UCL-M) and vesicles (UCL-V), respectively. The uncross-linked nanocarriers upon UV treatment for thirty minutes were covalently crosslinked in the middle PNBC block giving rise to the di-sulfide bonds and forming interface cross-linked "micellar-type" aggregates (ICL-M) and vesicles (ICL-V). DLS, TEM, and AFM techniques were used to successfully characterize the morphology of these nanocarriers. The dual stimuli (redox and enzyme) responsiveness of the cross-linked nanocarriers and their trafficking to the lysosome in mammalian cells *via* receptor-mediated endocytosis was probed using confocal microscopy images. Furthermore, the addition of a chloroquine (CQ, a known lysosomotropic agent) encapsulated cross-linked nanocarrier (CQ@ICL-V) to non-cancerous (HEK-293T) cells and liver (HepG2), and breast cancer cells (MDA-MB-231) was found to initiate lysosomal membrane permeabilization (LMP) followed by lysosomal destabilization which eventually led to lysosomal cell death (LCD). Due to the targeted delivery of CQ to the lysosomes of cancerous cells, almost a 90% smaller amount of CQ was able to achieve similar cell death to CQ alone.

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Introduction

Lysosomal cell death (LCD) *via* lysosomal membrane permeabilization (LMP) triggers a cascade of events that culminate in cell death.[1–3] LMP is induced by lysosomal destabilization followed by translocation of cathepsins from the lysosomal lumen to the cytoplasm. Although occurring less frequently, several small molecule drugs and antibodies can destabilize the lysosomes to permeabilize the lysosomal membrane, which destroys the cancer cells *via* LCD.[4–6] The critical factor of LCD is the release of proteases through the lysosomal membrane, resulting in lysosomal membrane permeabilization (LMP) and subsequent cell death.[6–15] LCD may be convenient for cancer treatment, provided that small molecule drugs or antibodies that function as lysosomotropic reagents can be delivered into cancer cell lysosomes specifically and destabilize the lysosomal membrane to initiate LMP. In this context, mannose-6-phosphate is being explored as a targeting ligand to deliver therapeutics specifically inside the lysosomes. Mannose-6-phosphate receptors (MPR) are insulin-like growth

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†Electronic supplementary information (ESI) available. See DOI: https://doi.org/10.1039/d2bm02110b

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§These authors contributed equally to this work.

Registered charity number: 207890

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Chemical Science

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