4.Firstly, H2O2 assists in breaking the outer"protective shell" of the bacteria––the phospholipid bilayer of the cell membrane, which en- ters the interior of the bacteria and reacts with the internal biomolecules such as lipid bilayer, proteins and nucleic acids, destroying the structure of the bacteria and thus leading to their death. It is encouraging to note that the modi ed ZnO composites could generate ROS under the exci- tation of visible light that was not signi cantly harmful to humans. (ii) Release of Zn2th. As a cofactor for nearly 300 enzymes in living organisms [135], Zn2th has a speci c af nity for sulfur groups and inhibit glycolytic enzymes by oxidizing their thiol groups [136]. However, as the glycolytic reactions occur in the cytoplasm, the ROS produced at this time will open channels for Zn2th to cross the cell membrane of the bacteria, and could denature their internal proteins and disrupt proliferation. Zn2th also breaks electron transport, allowing disruption of cellular respiration. It should not be overlooked that the release of Zn2th, despite being syner- gistically bactericidal, can also lead to increased toxicity to normal cells. (iii) Endocytosis. Bacterial cell walls are negatively charged, and ZnO NPs can attach to the outer surface of bacteria by the electrostatic effect of Zn2th on negatively charged membranes. This phenomenon can change the resting potential of the cell membrane and induce depolarization of the cell membrane by blocking the Kth channels [137] presented in the cell membrane, which leads to loss of phospholipid bilayer integrity and leakage of intracellular components such as lipopolysaccharides and ATP from the cell, ultimately leading to cell death (Fig. 13). Interestingly, the researchers found that the loss of cell membrane integrity was the main reason for the antibactericidal effect of ZnO NP on E. coli [138]. Pad- mavathy et al. [139] discovered that the larger the surface area of ZnO, the higher the concentrations of surface oxygen species, and the smaller the particles, the greater the antibacterial activity, thus opening the door to"non-drug" therapy.In addition, Gupta et al. [152] prepared Fe3O4@ZnO core–shell nano- particles (Fe3O4@ZnO CSNPs) using a hydrothermal method that com- bined magnetothermal and bioimaging, and the photoluminescence spectrum showed a UV emission peak at 383 nm. To investigate the imaging properties, green and red uorescence of human cervical cancer cells (HeLa) were observed by confocal microscopy.Valenzuela et al. [141] reported that the ZnO–rGO photocatalytic coating showed excellent bactericidal ability against Gram-positive bacteria Staphylococcus aureus by the reduction of e-/hth pairs recombi- nation and the enhancement of?OH production by ZnO, which showed excellent bactericidal properties and high stability in preventing bacte- rial adhesion and transmission, making it a great prospect for surface antimicrobial functionalization.In this regard, Mahmood et al. [158] successfully prepared ZnO/Cu2O composite lms by electrodeposition and constructed composite electrodes, and EIS and IV measurements showed the lowest electron mobility at the electrode/electrolyte inter- face, high current density of ZC2, and good stability of hydrolysis reac- tion.Raghupathi and colleagues [134] found that ZnO NPs produced more ROS and exhibited more antimicrobial activity under UV illumi- nation, the reason of which was mainly attributed to that the electron leaps inside the ZnO nanoparticles could generate photogenerated e- and hth, further generating ROS through in redox reactions.Biomedical field Zinc is an essential trace metal for normal growth, development and physiological functions of organisms. 12).4.1.4.1.1.4.1.2.4.1.3.4.3.

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