Role of ferroptosis and ferroptosis-related non-coding RNAs in the occurrence and development of gastric cancer

Ling Lu1†, Bei Chen2,3†, Yumeng Xu2, Xinyi Zhang2, Longtao Jin1, Hui Qian2, Yi Wang4* and Zhao Feng Liang2*

1Child Healthcare Department, The Fourth Affiliated Hospital of Jiangsu University, Zhenjiang, JS, China, 2Jiangsu Key Laboratory of Medical Science and Laboratory Medicine, School of Medicine, Jiangsu University, Zhenjiang, JS, China, 3Suzhou Science and Technology Town Hospital, Suzhou, JS, China, 4Department of Urology, the Second Hospital of Anhui Medical University, Hefei, China

Gastric cancer (GC) is a malignant cancer of the digestive tract and is a life-threatening disease worldwide. Ferroptosis is a newly discovered form of regulated cell death, which involves the accumulation of iron-dependent lipid peroxides. It has been found that ferroptosis plays an important regulatory role in the occurrence, development, drug resistance, and prognosis of GC. Non-coding RNAs (ncRNAs) play a critical role in the occurrence and progression of a variety of diseases including GC. In recent years, the role of ferroptosis and ferroptosis-related ncRNAs (miRNA, lncRNA, and circRNA) in the occurrence, development, drug resistance, and prognosis of GC has attracted more and more attention. Herein, we briefly summarize the roles and functions of ferroptosis and ferroptosis-related ncRNAs in GC tumorigenesis, development, and prognosis. We also prospect the future research direction and challenges of ferroptosis and ferroptosis-related ncRNAs in GC.

KEYWORDS

gastric cancer, ferroptosis, noncoding RNA, mechanisms, function

Introduction

Cell death is strictly regulated by complex intracellular and extracellular signals, and is very important for various physiological and pathological processes, including growth, development, and tumorigenesis. The imbalance between abnormal proliferation and cell death of cancer cells is an important basis for the biological characteristics of malignancy. Ferroptosis is a newly discovered form of regulated cell death, which involves the accumulation of iron-dependent lipid peroxides and leads to fatal cell damage (Zhang et al., 2020). Ferroptosis, a unique form of nonapoptotic-regulated cell death caused by overwhelming iron-dependent lipid peroxides, is considered an emerging cancer suppression mechanism for gastric cancer (GC) (Ma et al., 2022). GC is one of the most common malignant cancers that seriously affect human health in the world. Although great progress has been made in the diagnosis and treatment of GC.
in recent years, there is still lack of effective diagnostic markers, and the prognosis of advanced GC is not optimistic. Studies have started to reveal the essential role of ferroptosis in GC (Lee et al., 2020; Zhang et al., 2020; Guan et al., 2022; Ma et al., 2022). Ferroptosis plays an important regulatory role in the occurrence, development, invasion, migration, diagnosis, drug resistance, and prognosis of GC (Gomaa et al., 2019; Zhang et al., 2020; Liu Y. et al., 2021; Guan et al., 2022). Increasing evidence has shown that non-coding RNA (ncRNAs) play a crucial role in the occurrence and development of GC. NcRNAs are important regulators of gene expression and contribute to the promotion of a large number of human diseases. In general, miRNAs negatively regulate gene expression by binding to the 3′ untranslated region of the target messenger RNAs (mRNAs), resulting in mRNA silencing or degradation (Luo et al., 2019; Yan and Bu, 2021). Long noncoding RNAs (lncRNAs) are a class of potentially-coding RNA transcripts, which have the functions of regulating gene expression by inhibiting the mRNA translation, modulating the mRNA stability, or as competing endogenous RNAs (ceRNAs) by acting as miRNA sponges (Li et al., 2020a; Yan and Bu, 2021). Circular RNAs (circRNAs) are mainly produced by the reverse splicing of exons of precursor mRNAs. The functions of circRNAs are mainly ceRNA or miRNA sponging, binding with proteins, regulation of precursor mRNAs (pre-mRNA) splicing, regulation of parental gene expression, and potential translation templates for proteins or peptides (Yan and Bu, 2021; Zhang Y. et al., 2022). MiRNAs, lncRNAs, and circRNAs may have other ways to regulate the expression of mRNAs or proteins jointly or competitively. NcRNAs play a key role in GC occurrence and development with disruption of their function including gene splicing and transcription as well as biological processes related to ferroptosis, cell differentiation, migration, apoptosis, and immune response (Wei et al., 2020; Tang et al., 2021; Ye et al., 2021).

However, the role of ncRNAs associated with ferroptosis in GC has not been systematically discussed. Herein, we analyzed and discussed the relationship between ferroptosis, ferroptosis-related ncRNAs, and GC. This review summarized the role of ferroptosis and ferroptosis-related ncRNAs in the occurrence, development, drug resistance, and prognosis of GC, which may provide a new basis for the early diagnosis and treatment of GC.

**Ferroptosis and gastric cancer**

Ferroptosis is a newly defined form of programmed cell death characterized by iron-dependent peroxide lipid accumulation (Shao et al., 2021). Fe^{2+} enters cells and is reduced to Fe^{3+} through STEAP3. Then, the divalent metal transporter 1 (DMT1) leads to the release of Fe^{3+} from endosomes, leading to the accumulation of ROS, which induce lipid peroxidation and ferroptosis (Jiang N. et al., 2021; Zhang C. et al., 2022).

Glutathione peroxidase 4 (GPX4)-mediated lipid peroxidation pathway plays an important role in inhibiting ferroptosis. GPX4 converts glutathione (GSH) into oxidized glutathione (GSSG) and reduces lipid peroxidation (Jiang N. et al., 2021; Zhang C. et al., 2022).

GC is a malignant tumor that causes a great burden globally, and its molecular mechanism is not very clear. Dysregulation of the balance between cell proliferation and death is a central feature of GC. Studies have found that ferroptosis plays a critical role in the carcinogenesis and progression of GC (Gomaa et al., 2019; Liu Y. et al., 2021). The levels of ferroptosis were related to a variety of prognosis and cancer immune characteristics, which might be conducing to the individualized treatment of GC (Ma et al., 2021).

Ferroptosis played a regulatory role in GC by affecting the biological characteristics of GC cells, such as proliferation, migration, and apoptosis. Ferritinophagy-induced ferroptosis and the KEAP1/NRF2/HO-1 pathway was involved in the epithelial-to-mesenchymal transition (EMT) process of GC cells (Guan et al., 2022). Lee et al. demonstrated that the biosynthetic pathway of polyunsaturated fatty acids determines the sensitivity of GC to ferroptosis (Lee et al., 2020). The data of Sun et al. expounded that perilipin-2 promotes the proliferation or apoptosis of GC cells by modifying the ferroptosis pathway (Sun et al., 2020). It was reported that cytoplasmic polyadenylation element binding protein 1 (CPEB1) enhanced erastatin-induced ferroptosis in GC cells by inhibiting TWIST1, and then promotes GC cells metastasis and angiogenesis (Wang J. et al., 2021). The above studies showed that ferroptosis plays an important role in the occurrence and development of GC, and its specific role and mechanism need to be further explored.

The drug resistance of patients with advanced GC seriously affects the effect of chemotherapy. Many studies suggested that ferroptosis could enhance the sensitivity of GC cells to chemotherapeutic drugs. Zhang et al. demonstrated that miR-522 secreted by cancer-associated fibroblasts (CAFs) suppressed ferroptosis and promoted chemoresistance in GC (Zhang et al., 2020). The results revealed that apatinib could induce lipid peroxidation through SREBP-1a-mediated GPX4, and regulate multidrug resistance and ferroptosis of GC cells (Zhao et al., 2021). Activating transcription factor 3 (ATF3) made GC cells sensitive to cisplatin by blocking NRF2/KEAP1/XCT pathway transduction and inducing ferroptosis, which provides a promising treatment for overcoming the chemoresistance of GC (Fu et al., 2021). The silent information regulator 6 (SIRT6) silencing overcomes resistance to sorafenib via promoting ferroptosis in GC (Cai et al., 2021).

Ferroptosis was expected to be used in the treatment and prognosis of GC (Liu S. J. et al., 2021; Huo et al., 2021). Shao et al. screened 10 ferroptosis-related markers (SP1, MYB, ALDH3A2, KEAP1, AIFM2, ITGB4, TGFBR1, MAP1LC3B, NOX4, and ZFP36), which could well predict the prognosis and immunotherapy of GC (Shao et al., 2021). Studies have shown
that by changing the activation degree of ferroptosis, GC cells and the microenvironment can be formed (Xiao et al., 2021a). Ferroptosis-related genes NOX4, CHAC1, and HIF1A were the prognostic biomarkers of gastric adenocarcinoma (Xiao et al., 2022). In addition, it was also found that the ferroptosis pattern in GC is related to the characteristics of immune microenvironment (Jiang X. et al., 2021; Liu S. J. et al., 2021; Wang F. et al., 2021). The establishment of markers associated with ferroptosis will help to predict the biological characteristics of GC and select the appropriate treatment for GC patients. However, there are still many problems to be solved in the application of ferroptosis to the clinical diagnosis and treatment of GC.

Ferroptosis was the major mechanism mediating antitumor activity, which was expected to become a promising compound for the treatment of GC (Liu Y. et al., 2021; Zhang L. et al., 2022; Ye et al., 2022). Jiyuan oridonin A, a naturally occurring ent-kaurane diterpenoid, induced ferroptosis through the autophagy pathway, suggesting that the induction of ferroptosis may be the main mechanism mediating the antitumor activity of Jiyuan oridonin A and its derivatives (Liu Y. et al., 2021). The results showed that Yang Huayu Decoction (a Chinese herbal medicine formula) could induce GC ferroptosis through the JAK2-STAT3 pathway and ACSH4 (Song et al., 2022). The data of Zhang et al. suggested that 6-Thioguanine (6-TG) performed as a potential novel compound for GC treatment via inducing ferroptosis (Zhang J. et al., 2022). Tanshinone IIA, a pharmacologically active component isolated from Chinese herb, induced ferroptosis in GC cells by affecting the expression of p53-mediated SLC7A11 (Guan et al., 2020). The data of Zhang et al. identified a new mechanism mediating miR-4715-3p silencing and AURKA induction in upper gastrointestinal adenocarcinoma. The inhibition of AURKA or reconstitution of miR-4715-3p inhibited GPX4 and induced cell death, suggesting a link between AURKA and ferroptosis (Gomaa et al., 2019).

Ferroptosis has been proved to play an important role in the pathogenesis of GC. MiRNAs have regulatory function in GC cells and have potential diagnostic and prognostic value in the occurrence and development of GC. Ferroptosis-related miRNAs have potential clinical application prospect in the diagnosis, personalized treatment, and prognosis of GC (Table 1).

Ferroptosis-related IncRNA and gastric cancer

LncRNAs and ferroptosis play a crucial role in the occurrence and development of GC (Jiang N. et al., 2021). In this part, we focus on the role and mechanism of ferroptosis-related LncRNAs in the occurrence and development of GC.

It is reported that the IncBDNF-AS/WDR5/FBXW7 axis regulated ferroptosis and mediated peritoneal metastasis of GC through VDAC3 ubiquitination (Huang et al., 2022). The experiment of Wang et al. confirmed that IncLASTR mediated the proliferation and migration of GC cells through the regulation of ferroptosis (Wang G. et al., 2022). GC stem cells
(GCSC) are the main cause of the occurrence and prognosis of GC. Zhang et al. suggested that GC cell-derived exosomal lncFERO controls the tumorigenicity of GCSC by inhibiting ferroptosis, suggesting that the targeted exosomal lncFERO/hnRNPA1/SCD1 combined chemotherapy may be a promising GCSC based therapeutic strategy (Zhang et al., 2021). Yao et al. found that lncRNAs (A2M-AS1, C2orf27A, and ZNF667-AS1) targeted ferroptosis-related genes and impaired the activation of CD4+ T cells in GC, which provides a new strategy of GC immunotherapy (Yao et al., 2021). Pan et al. prognostic model based on the 17 ferroptosis-related lncRNAs may improve the overall survival prediction of GC (Pan et al., 2021). These ferroptosis-related lncRNAs may play an important role in the immune infiltration of GC, which may help to determine the personalized prognosis and treatment of GC patients (Chen W. et al., 2021). Zhang et al. also established a ferroptosis-related lncRNA model that could predict the prognosis of stomach adenocarcinoma patients (Zhang S. et al., 2022). There are other prediction models showing ferroptosis-related lncRNAs associated with drug resistance, immunity, and tumor microenvironment changes in GC (Chen X. et al., 2021; Lai et al., 2021; Xiao et al., 2021b; Wei et al., 2021; Zhang S. et al., 2022).

Ferroptosis-related lncRNAs are differentially expressed in different stages of GC, which can provide a basis for ferroptosis-related lncRNAs clinical application in the diagnosis, treatment, and prognosis of GC. These studies suggest that ferroptosis-related lncRNAs can be used as potential markers for the progression, prognosis, personalized treatment, and drug resistance of GC (Table 2).

### TABLE 1 Overview of the role of ferroptosis-related miRNAs in GC.

| MiRNA     | Expression status | Relationship with autophagy | Target       | Type of biomarker        | References          |
|-----------|-------------------|------------------------------|--------------|--------------------------|---------------------|
| miR-522   | Upregulated       | Inhibited ferroptosis        | ALOX15       | Chemo-resistance         | Zhang et al. (2020) |
| miR-375   | Upregulated       | Triggered ferroptosis        | SLC7A1       | Stemness of GC           | Ni et al. (2021)    |
| miR-103a-3p | Downregulated    | Promoted ferroptosis         | GLS2         | Development and prognosis | Ni et al. (2019)   |
| miR-489-3p | Upregulated       | Enhanced ferroptosis         | SLC7A1       | Development and treatment | Mao et al. (2021)  |
| miR-125b-5p | Upregulated       | Enhanced ferroptosis         | STAT3        | Development               | Liu Y. P. et al. (2021) |
| miR-4715-3p | Downregulated    | Enhanced ferroptosis         | AURKA/GPX4   | Development and prognosis | Gomaa et al. (2019) |

### TABLE 2 Overview of the role of ferroptosis-related lncRNAs in GC.

| LncRNA          | Expression status | Relationship with autophagy | Target          | Type of biomarker | References          |
|-----------------|-------------------|------------------------------|-----------------|-------------------|---------------------|
| lncBDNF-AS      | Upregulated       | Inhibited ferroptosis        | WDR5/FBXW7      | Development       | Huang et al. (2022) |
| lncLASTR        | Upregulated       | Inhibited ferroptosis        | GPX4            | Occurrence, development, and prognostic | Wang G. et al. (2022) |
| lncFERO         | Upregulated       | Inhibited ferroptosis        | hnRNPA1/SCD1    | Development, resistance, and treatment | Zhang et al. (2021) |
| lncA2M-AS1, C2orf27A, and ZNF667-AS1 | Upregulated | Inhibited ferroptosis        | hub FRGs (MYB, PSAT1, TP53, and LONP1) | Treatment and prognostic | Yao et al. (2021) |
| 17 ferroptosis-related lncRNAs | Differential expression |                          |                 | Treatment and prognostic | Pan et al. (2021) |
| 20 ferroptosis-related lncRNAs | Differential expression |                          |                 | Diagnostic and prognostic | Chen W. et al. (2021) |
| AP000695.2, AL365181.3, and LINC01615 | Upregulated |                          |                 | Treatment and prognostic | Zhang S. et al. (2022) |
| AP003392.1, AC245041.2, AP001271.1, and BOLA3-AS1 | Upregulated |                          |                 | Treatment and prognostic | Wei et al. (2021) |
| 17 ferroptosis-related lncRNAs | Differential expression |                          | cytoskeleton, WNT and PI3K/mTOR | Development, treatment, and prognostic | Xiao et al. (2021b) |
| 10 ferroptosis-related lncRNAs | Differential expression |                          |                 | Prognostic and resistance | Lai et al. (2021) |
| TMEM105, PVT1, LOC646588, FLJ22447, and DLEU1 | Differential expression |                          |                 | Treatment and prognostic | Chen X. et al. (2021) |
Ferroptosis-related circRNAs and gastric cancer

Multiple circRNAs have been verified to act as essential regulators in the occurrence and progression of GC. As new prognostic biomarkers, ferroptosis-related circRNAs will be a broad application prospect in GC diagnosis, individualized treatment, microenvironment, drug resistance, and immunotherapy in the future. Herein, we summarized the role of ferroptosis-related circRNAs in GC.

The expression level of circ0008035 was upregulated in GC tissues and cells. Li et al. reported that circ0008035 repressed ferroptosis and affected the proliferation and apoptosis of GC cells by up-regulating EIF4A1 via sponging miR-599 (Li C. et al., 2020). Circ0000190 was down regulated in GC tissues and cell lines, indicating a poor prognosis of GC patients. Circ0000190 overexpression suppressed GC cell proliferation and migration by inducing ferroptosis (Jiang et al., 2022).

Summary and the challenges

Ferroptosis plays an important role in the pathogenesis of GC. NcRNAs play a crucial role in the occurrence, development, treatment, and drug resistance of GC. However, the relationship between ferroptosis, ferroptosis-related ncRNAs, and GC has not been well summarized and clarified. In recent years, the understanding of the relationship between ferroptosis, ferroptosis-related ncRNAs, and GC has advanced rapidly. Based on the abovementioned overview, we conclude that ferroptosis and ferroptosis-related ncRNAs play essential roles in the occurrence and prognosis of GC (Figure 1). Ferroptosis-related ncRNAs are expected to be used as potential clinical markers of GC.

However, to achieve clinical application, there are still many aspects to be improved and many challenges to be solved in the future research. First, the regulatory mechanism between ferroptosis and ferroptosis-related ncRNAs are not very clear. In the future, we believe that the role and mechanism of ferroptosis-related ncRNAs in GC may become one of the research focuses. Second, the mechanisms of generation and selection of ferroptosis-related ncRNAs are still unclear. Clarifying the mechanism of ferroptosis ncRNA generation, selection and degradation may be an important link in promoting its clinical application. Third, at present, there are only a few studies on ferroptosis-related ncRNAs in the occurrence and prognosis of GC. It is necessary to further explore the role of more ncRNAs in GC. Furthermore, the research and verification of large-scale population tissue samples need to be carried out before clinical application. The reproducibility, specificity, and sensitivity of ferroptosis-related ncRNA detection and application need to be further evaluated. In addition, exosomes can carry mRNAs, ncRNAs, proteins, and other components to participate in the cell-cell communication. Whether ferroptosis related ncRNAs can affect the microenvironment of GC through exosomes, and then play in the occurrence, prognosis, and drug resistance of GC needs to be explored.

Based on the abovementioned studies, we also speculated the potential future development direction of ferroptosis and ferroptosis-related ncRNAs in GC. First, developing experimental methods or detection techniques of ferroptosis and ferroptosis-related ncRNAs, so that they can be better used in the early diagnosis of GC, monitoring progress, drug resistance, and prognosis. Second, liquid biopsy is more and more widely used in GC and other cancers. It is particularly important to detect ferroptosis-related ncRNAs in blood or exosomes, and analyze the relationship between these abnormally expressed ncRNAs and the occurrence, development, drug resistance, and prognosis of GC. Last, as a potential therapeutic target for GC, giving better use of ferroptosis-related ncRNAs in diagnosis and treatment may
help to prolong the survival time and improve the quality of life of GC patients.

Author contributions

LL, BC, and ZL designed research and wrote the manuscript. YX, XZ, and LJ participated in data collection and analysis. HQ, YW and ZL contributed to the writing and revisions.

Funding

This work was supported by the National Natural Science Foundation of China (no. 81602883), project of social development in Zhenjiang (no. SH2021045), "Tsinghan Doctor" medical field talent training plan of Zhenjiang, Foundation for Excellent Young Teachers of Jiangsu University, Clinical Medical Science and Technology Development Foundation of Jiangsu University (No. JLY2021013), Medical Research Collaborative Innovation Joint Fund of The Second Affiliated Hospital of Anhui Medical University and Center for Medical Physics, Chinese Academy of Sciences (LHJ2020003), and Suzhou Science and Technology Town Hospital Pre-Research Fund (No. szkjcy2022002).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors, and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Cai, S., Fu, S., Zhang, W., Yuan, X., Cheng, Y., Fang, J., et al. (2021). SIRT6 silencing overcomes resistance to sorafenib by promoting ferroptosis in gastric cancer. Biochem. Biophys. Res. Commun. 577, 158–164. doi:10.1016/j.bbrc.2021.08.080

Chen, W., Feng, Z., Huang, J., Fu, P., Xiong, J., Cao, Y., et al. (2021). Identification of ferroptosis-related long noncoding RNA and construction of a novel prognostic signature for gastric cancer. Dis. Markers 2021, 7724997. doi:10.1155/2021/7724997

Chen, X., Zhu, Z., Li, X., Yao, X., and Luo, L. (2021). The ferroptosis-related noncoding RNA signature as a novel prognostic biomarker in the tumor microenvironment, immunotherapy, and drug screening of gastric adenocarcinoma. Front. Oncol. 11, 778557. doi:10.3389/fonc.2021.778557

Fu, D., Wang, C., Yu, L., and Yu, R. (2021). Induction of ferroptosis by ATF3 elevation alleviates epilumina resistance in gastric cancer by restraining Nrf2/Keap1/CCT signaling. G6P Med. Biol. Lett. 26 (12), 26. doi:10.1186/s11658-021-00271-y

Gomaa, A., Peng, D., Chen, Z., Soutto, M., Abouelezz, K., Corvalan, A., et al. (2019). Epigenetic regulation of AURKA by miR-4715-3p in upper gastrointestinal cancers. Sci. Rep. 9 (1), 16970. doi:10.1038/s41598-019-53174-6

Guo, Z., Chen, J., Li, X., and Dong, N. (2020). Tanshinone IIA induces ferroptosis in gastric cancer cells through p53-mediated SLC7A11 down-regulation. Biosci. Rep. 40 (8), BSR20210807. doi:10.1042/BSR20210807

Guo, D., Zhou, W., Wei, H., Wang, T., Zheng, K., Yang, C., et al. (2022). Ferritinophagy-mediated ferroptosis and activation of keap1/Nrf2/HO-1 pathway were conducive to EMT inhibition of gastric cancer cells in action of 2,3'-Di-pyridineketo-hydrazone dithio-carbamate butyric acid ester. Oxid. Med. Cell. Longev. 2022, 3920664. doi:10.1155/2022/3920664

Huang, G., Xiang, Z., Wu, H., He, Q., Dou, R., Lin, Z., et al. (2022). The IncRNA BDNF-AS/WDR5/FBXW7 axis mediates ferroptosis in gastric cancer peritoneal metastasis by regulating VDAC3 ubiquitination. Int. J. Biol. Sci. 18 (4), 1415–1433. doi:10.7150/ijbs.69434

Huo, J., Wu, L., and Zang, Y. (2021). Eight-gene prognostic signature associated with hypoxia and ferroptosis for gastric cancer with general applicability. Epigenomics 13 (11), 875–890. doi:10.2217/epi-2020-0411

Jiang, M., Mo, R., Liu, C., and Wu, H. (2022). Circ_0000190 sponges miR-382-5p to suppress cell proliferation and motility and promote cell death by targeting ZNF3 in gastric cancer. J. Biochem. mva003. doi:10.1093/jb/mva003

Jiang, N., Zhang, X., Gu, X., Li, X., and Shang, L. (2021). Progress in understanding the role of IncRNA in programmed cell death. Cell Death Discov. 7 (1), 30. doi:10.33328/cdd.021-00407-1

Jiang, X., Liu, F., Liu, P., Yan, Y., Lan, S., Zhuang, K., et al. (2021). Ferroptosis patterns correlate with immune microenvironment characterization in gastric cancer. Int. J. Gen. Med. 14, 6575–6586. doi:10.2147/IGJ.GM.353129

Lai, D., Tan, L., Zuo, X., Liu, D., Jiao, D., Wan, G., et al. (2021). Prognostic ferroptosis-related IncRNA signatures associated with immunotherapy and chemotherapy responses in patients with stomach cancer. Front. Genet. 12, 796612. doi:10.3389/fgene.2021.796612

Lee, J. Y., Nam, M., Son, H. Y., Hyun, K., Jang, S. Y., Kim, J. W., et al. (2020). Polysaturated fatty acid biosynthesis pathway determines ferroptosis sensitivity in gastric cancer. Proc. Natl. Acad. Sci. U. S. A. 117 (51), 32433–32442. doi:10.1073/pnas.2006828117

Li, C., Tian, Y., Liang, Y., and Li, Q. (2020). Circ_0080835 contributes to cell proliferation and inhibits apoptosis and ferroptosis in gastric cancer via miR-599/EIF4A1 axis. Cancer Cell Int. 20 (1), 84. doi:10.1186/s12943-020-01168-0

Li, Y., Li, G., Guo, X., Yao, H., Wang, G., Li, C., et al. (2020). Non-coding RNA in bladder cancer. Cancer Lett. 485, 38–44. doi:10.1016/j.canlet.2020.04.023

Li, Y., Tian, Z., Tan, Y., Lian, G., Chen, S., Chen, S., et al. (2020). Bmi-1-induced miR-27a and miR-155 promote tumor metastasis and chemoresistance by targeting BIK in gastric tumor. Mol. Cancer 19 (1), 109. doi:10.1186/s12943-020-01229-y

Liu, S. J., Yang, Y. B., Zhou, J. X., Lin, Y. J., Pan, Y. L., Pan, J. H., et al. (2021). A novel ferroptosis-related gene risk signature for predicting prognosis and immunotherapy response in gastric cancer. Dis. Markers 2021, 2385406. doi:10.1155/2021/2385406

Liu, Y., Song, Z., Liu, Y., Ma, X., Wang, W., Ke, Y., et al. (2021). Identification of ferroptosis as a novel mechanism for antitumor activity of natural product derivative a2 in gastric cancer. Acta Pharm. Sin. B 11 (6), 1513–1525. doi:10.1016/j.apsb.2021.05.006

Liu, Y. P., Qiu, Z. Z., Li, X. H., and Li, E. Y. (2021). Propofol induces ferroptosis and inhibits malignant phenotypes of gastric cancer cells by regulating miR-125b-5p/STAT3 axis. World J. Gastrointest. Oncol. 13 (12), 2114–2128. doi:10.4251/wjgo.v13.i12.2114

Luo, Y. J., Huang, Q. M., Ren, Y., Liu, Z. L., Xu, C. F., Wang, H., et al. (2019). Non-coding RNA in drug resistance of gastric cancer. World J. Gastrointest. Oncol. 11 (11), 957–970. doi:10.4251/wjgo.v11.i11.957

Ma, J., Hu, X., Yao, Y., Wu, L., Sheng, C., Chen, K., et al. (2021). Characterization of two ferroptosis subtypes with distinct immune

Lu et al.
