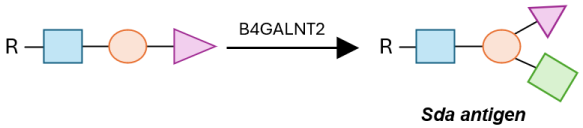
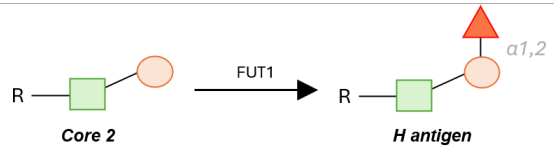
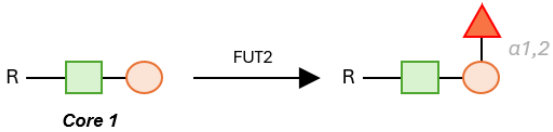
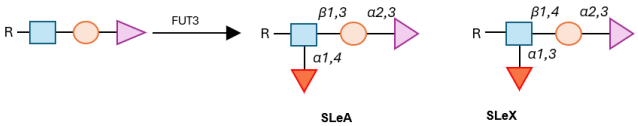
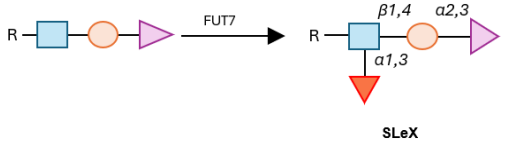
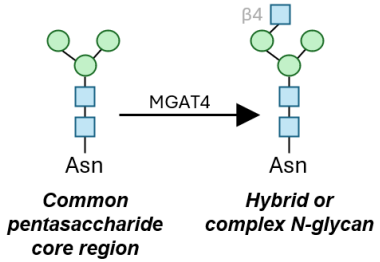
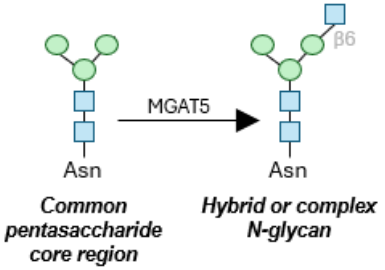
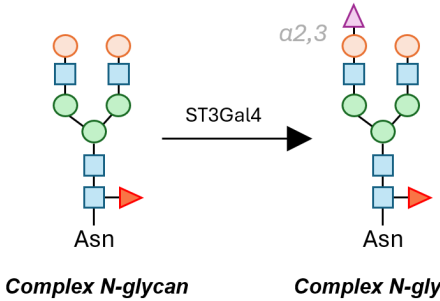
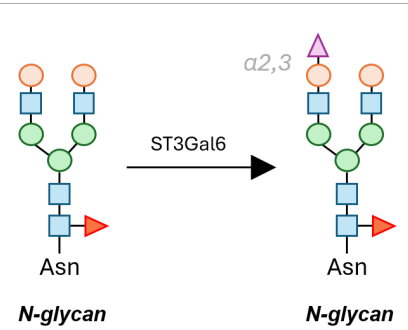
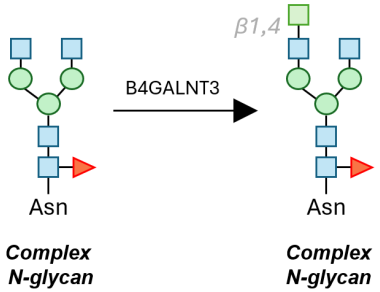
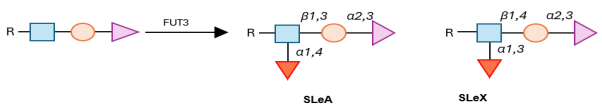
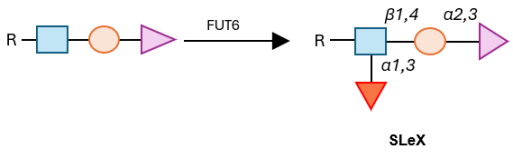
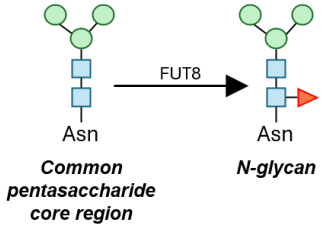
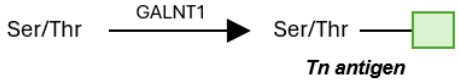
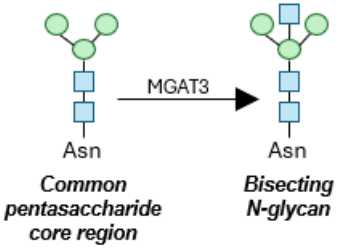
Summary of glycosyltransferases discussed in this review: Catalytic reactions, tumor types reported to date and associated biological consequences

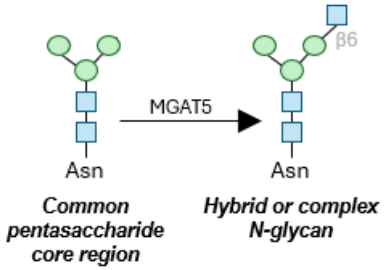
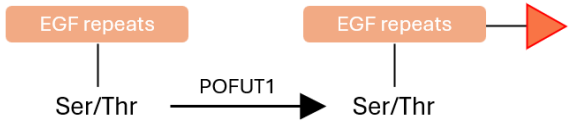
Table 1. Glycosylation alterations in cancer: Causes and consequences for inflammation and metastasis.

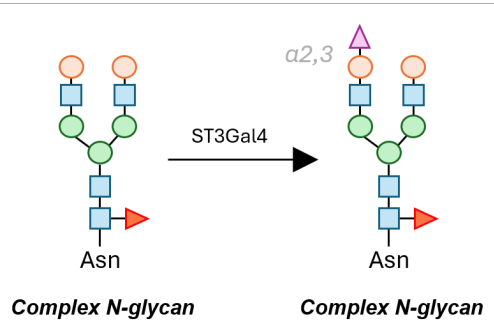
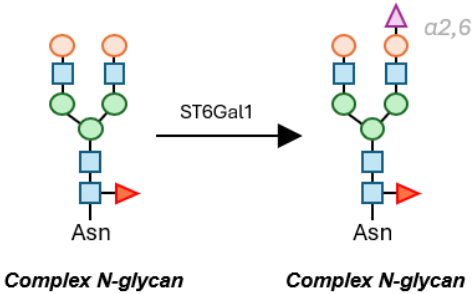
Glycosyltransferase	N- or O-glycosylation	Reaction/glycosylation catalyzed	Cancer with reported dysregulation	Biological consequences
Potential causes of glycosylation deregulation in cancer				
B4GALNT2	O – Sd^{a} antigen (mainly)		Gastric cancer, colorectal cancer	▪ In gastrointestinal cancer: Hypermethylation in gastric cancer cells → ↓Sda antigen and ↑SLe antigens → ↑ migration[49]
FUT1	O – H antigen (mainly)		Pancreatic cancer, breast cancer, gastric cancer	▪ ↓HIFα (inhibition of hypoxia) → ↑FUT1/FUT2[40]
FUT2	O (mainly)		Pancreatic cancer, colorectal cancer	
FUT3	O – SLe antigens		Pancreatic cancer, colorectal cancer	▪ 5-Aza-dC (methylation inhibitor) → ↑FUT3 → ↑SLe antigens → ↑ metastasis[48]
FUT7	O – CLA/SLe^{X} (mainly)		Colorectal cancer	▪ Hypoxia → ↑FUT7 → ↑SLe^{X}[43]

MGAT4 (GnT-IV)	N		Pancreatic cancer, leukemia, breast cancer	▪ In pancreatic cancer cells: ↓MGAT4a ↑MGAT4b → 5-Aza-dC (methylation inhibitor) + butyrate → ↑MGAT4a[47,50]
MGAT5 (GnT-V)	N		Hepatocellular carcinoma, colorectal cancer	▪ ↓GATA2/GATA3 (HIFα stabilizing transcription factors) → ↓MGAT5[42] ▪ NM23 (tumor suppressor gene) → ↓MGAT5 → ↓ chemotaxis and motility[46]
ST3GAL1	O		Colorectal cancer, breast cancer, ovarian cancer	▪ Hypoxia → ↑ST3Gal1 → ↑SLe[X43]
ST3GAL4	N (mainly)		Colorectal cancer, gastric cancer	▪ ↓GATA2/GATA3 (HIFα stabilizing transcription factors) → ↓ST3Gal4[41]

ST3GAL6	N (mainly)		Colorectal cancer, leukemia	▪ 5-Aza-dC (methylation inhibitor) → ↑ST3GAL6 → ↑SLe antigens → ↑ metastasis[48]
Glycosylation deregulation in cancer: Implications for inflammation and metastasis				
B3GNT6 (C3GnT)	O		Colorectal cancer, gastric cancer, pancreatic cancer	▪ In pancreatic cancer: ↑B3GNT6 → ↑MUC1 glycosylation → ↓ α2β1 expression → ↓ tumor growth and metastasis[96]
B4GALNT3	N (mainly)/O		Colorectal cancer, neuroblastoma	▪ In colon cancer cells: ↑B4GALNT3 → ↑ stemness and invasion *via* EGFR O-glycosylation[65]
C1GALT1	O		Breast cancer, pancreatic cancer, colorectal cancer	▪ ↑C1GALT1 → ↑ EGFR O-glycosylation → ↑ tumor progression[66]
FUT3	N/O		Colorectal cancer, gastric cancer	▪ ↑ fucosylation of TGF-β receptors by FUT3 → ↑ Smad activation, receptor signaling and metastasis[68]

FUT6	N/O – SLe^X antigen		Head and neck cancer, colorectal cancer, lung cancer	▪ In head and neck cancer: FUT6 regulates proliferation, migration and EMT though EGFR/ERK/STAT signaling[67] ▪ ↑ fucosylation of TGF-β receptors by FUT6 → ↑ Smad activation, receptor signaling and metastasis[68]
FUT8	N		Breast cancer, hepatocellular carcinoma, lung cancer	▪ In breast cancer cells: ↓FUT8 → ↑E-cadherin function → ↓ migration and invasion[57] ▪ ↑ fucosylation of TGF-β receptors by FUT8 → ↑ Smad activation, receptor signaling and metastasis[68,71] ▪ Dysregulation of FUT8 expression → Alteration of the ability of T cells to interaction with regulatory lectins → Modification of activation thresholds, cytokine production and survival[103]
GALNT1	O		Breast cancer, prostate cancer	▪ ↑GALNT1 → ↑ O-glycosylation of CD44 → Activation of Wnt/β-catenin signaling → ↑ proliferation, migration and invasion[64]
MGAT3 (GnT-III)	N		Melanoma, breast cancer, hepatocellular carcinoma	▪ ↑MGAT3 → ↓ TGF-β–driven cell motility and EMT[74] ▪ In melanoma: ↑MGAT3 → ↓ cell adhesion, invasiveness and motility[92]

MGAT5 (GnT-V)	N		Fibrosarcoma, gastric cancer, melanoma, breast cancer, colorectal cancer, …	▪ In fibrosarcoma: ↑MGAT5 → ↓ function of N-cadherin/E-cadherin → ↓ homotypic adhesion of cancer cells to neighboring cells[55] ▪ In gastric cancer cells: ↑ glycosylation by MGAT5 of E-cadherin → Disruption of its cellular localization, cis-dimer formation, molecular assembly, adhesion junction stability and cell-cell aggregation[56] ▪ ↓MGAT5 → ↓ TGF-β–induced EMT[73] ▪ In melanoma: ↑MGAT5 → ↑ β1-6-branched structures on N-glycans → ↑ metastasis[92] ▪ Dysregulation of MGAT5 expression → Alteration of the ability of T cells to interaction with regulatory lectins → Modification of activation thresholds, cytokine production and survival[103]
POFUT1	O – EGF repeats		Colorectal cancer, leukemia	▪ ↑POFUT1 and POGLUT1 → ↑ NOTCH surface expression, activation and transcription of target genes[77]
POGLUT1	O – EGF repeats		Colorectal cancer, leukemia	

ST3GAL4	N (mainly)		Colorectal cancer, gastric cancer	▪ ↓ST3GAL4 → ↑ transition toward an inflammatory dendritic cell phenotype[102]
ST6GAL1	N		Non-small cell lung cancer, colorectal cancer, pancreatic cancer, breast cancer, ovarian cancer	▪ ↓ST6Gal1 → ↓ Mesenchymal phenotype[72] ▪ In non-small cell lung cancer cells: ↓ST6Gal1 → ↓ NOTCH1 expression → ↓ proliferation, invasion and metastasis[78] ▪ In colon cancer cells: ↑ST6Gal1 → ↑ β1 integrin and talin sialylation → ↑ collagen IV expression → ↑ invasion and motility[95] ▪ ↓ST6Gal1 → ↑ transition toward an inflammatory dendritic cell phenotype[101,102] ▪ Dysregulation of ST6Gal1 expression → Alteration of the ability of T cells to interaction with regulatory lectins → Modification of activation thresholds, cytokine production and survival[103]

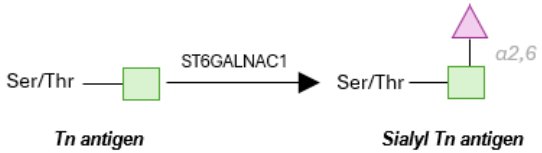
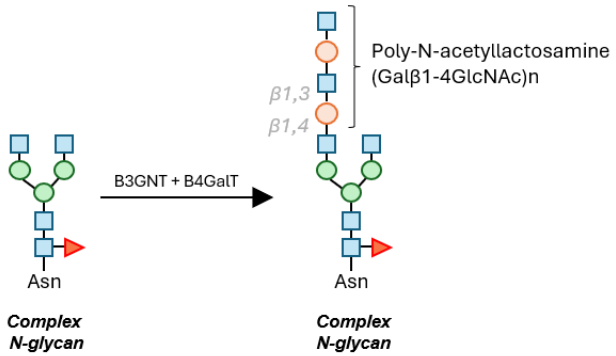
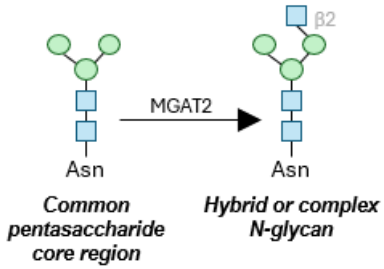
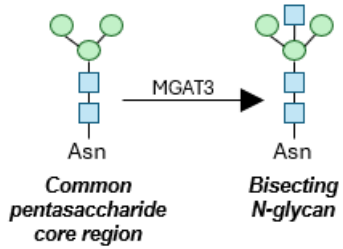
ST6GALNAC1	O		Breast cancer, bladder cancer, colorectal cancer	▪ In breast cancer cells: ↑ST6GALNAC1 → ↓E-cadherin + ↑mesenchymal markers (N-cadherin, Snail, ZEB1) → ↑cancer aggressiveness[53]

Table 2. Platelet-mediated glycoprotein remodeling in cancer cells as a driver of inflammation and metastasis.

Glycosyltransferase	N- or O-glycosylation	Catalyzed reaction	Type(s) of cancer	Biological consequences
Extracellular glycosylation				
B3GNT3	O (mainly)		Colorectal cancer, gastric cancer, lung adenocarcinoma, cervical cancer	▪ In lung adenocarcinoma: ↑B3GNT3 → ↑ immune cell infiltration[140] ▪ In cervical cancer: ↑B3GNT3 → ↑ pelvic lymph node metastasis[141]
B4GALT	N/O		Breast cancer, colorectal cancer, hepatocellular carcinoma	-[122]
MGAT2 (GnT-II)	N		Hepatocellular carcinoma, colorectal cancer, neuroblastoma	▪ In neuroblastoma: ↑MGAT2 → ↑ complex N-glycan branching → ↑ proliferation and invasion[138]
MGAT3 (GnT-III)	N		Breast cancer, hepatocellular carcinoma, melanoma	▪ In breast cancer and melanoma: ↑MGAT3 → ↓EMT → ↓ metastasis and dissemination[92,139]

ST3GAL1	O		Breast cancer, ovarian cancer	-[122]

Legend: