Table S1 — Classical / Clinically Used Semi-Synthetic Artemisinin in Thyroiditis

Compound	Alias / Notes	Development status	Possible associated chemokines (First author et al., year)	Function in thyroiditis via chemokines (First author et al., year)	Chemokine network nodes potentially affected (ligand→receptor) (First author et al., year)
Artemisinin	QHS; parent scaffold	Clinical source compound / extract	↓CXCL10/CCL20/CCL2 in inflammatory models (Xie et al., 2024; Long et al., 2024)	Likely ↓Th1 recruitment (CXCL10) and ↓monocyte influx (CCL2) in AIT; NF-κB dampening (Long et al., 2024)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin	DHA; artenimol	Clinical (active metabolite in ACTs)	Blocks CXCL10–CXCR3 signaling; ↓NF-κB/PI3K-AKT (Liu et al., 2017)	Attenuates AIT via CXCR3 axis inhibition; ↓serum CXCL10 as PD marker (Liu et al., 2017; Ferrari et al., 2023)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artesunate (sodium)	Artesunic acid hemisuccinate; IV/PO	Clinical (severe malaria; anti-inflammatory)	Reports of ↓CXCL10/↓CCL2; NF-κB inhibition (Long et al., 2024)	Potential ↓macrophage/T-cell influx via CCL2/CXCL10 lowering in AIT (Ferrari et al., 2023; Long et al., 2024)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

Artemether	DHA methyl ether	Clinical (oral/IM; ACT partner)	CXCL10 modulation suggested in combination studies (Long et al., 2024)	Possible ↓Th1 chemotaxis by dampening CXCL10 signaling in AIT (Ferrari et al., 2023)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Arteether (β-arteether; artemotil)	DHA ethyl ether (β-isomer)	Clinical (IM in select regions)	Class-level NF-κB/chemokine suppression (Long et al., 2024)	Probable ↓CXCL10/CCL2 output from innate cells in AIT (Ferrari et al., 2023; Long et al., 2024)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artelinic acid	Benzoate analog of DHA	Clinical-exploratory / research	Class-level chemokine effects (Long et al., 2024)	Potential ↓NF-κB-driven chemokines (CXCL10/CCL2) in thyroiditis; needs direct data (Ferrari et al., 2023; Long et al., 2024)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artesunic acid (free acid)	Parent of artesunate salts	Preclinical/chemistry	As artesunate; NF-κB/chemokine suppression (Long et al., 2024)	Expected ↓CXCL10/CCL2; monitor serum CXCL10 as PD (Ferrari et al., 2023)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

					CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artemisinin B	Natural analog	Research	Class-level ↓CXCL10/CCL2/CCL20 (Xie et al., 2024)	Likely mirrors artemisinin's chemokine-lowering in AIT context (Ferrari et al., 2023; Xie et al., 2024)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artesunate (rectal)	Rectal AS	Clinical formulation	As artesunate; systemic NF-κB/chemokine suppression (Long et al., 2024)	Formulation variant; function per artesunate (Ferrari et al., 2023)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA dispersible	Pediatric oral DHA	Clinical formulation	As DHA (Liu et al., 2017)	Same thyroiditis mechanism via CXCL10/CXCR3 axis (Liu et al., 2017; Ferrari et al., 2023)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

Dihydroartemisinin acetate	DHA acetate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin propionate	DHA propionate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin butyrate	DHA butyrate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin valerate	DHA valerate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

			NF-κB inhibition (Long et al., 2024)		CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin caproate	DHA caproate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin pivalate	DHA pivalate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroartemisinin benzoate	DHA benzoate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

Dihydroarte misinin p-chloroben zoate	DHA p-chlorobenzo ate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroarte misinin cinnamate	DHA cinnamate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Dihydroarte misinin carbonate	DHA carbonate	Research/prodrug	No direct chemokine data; assumed DHA-like ↓CXCL10/↓CCL2 via NF-κB inhibition (Long et al., 2024)	Possible ↓Th1 recruitment (CXCL10 axis) in AIT after conversion to DHA (Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA methyl ether	Artemether — see #4	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

			suppression (Long et al., 2024)		CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA ethyl ether	Arteether — see #5	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA propyl ether	C-10 propyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA isopropyl ether	C-10 i-propyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA butyl ether	C-10 butyl ether	Research (chemistry)	No direct chemokine data; class-level	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6;

			NF-κB/chemokine suppression (Long et al., 2024)	clinically (Ferrari et al., 2023; Liu et al., 2017)	CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA pentyl ether	C-10 pentyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA benzyl ether	C-10 benzyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA allyl ether	C-10 allyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

DHA propargyl ether	C-10 propargyl ether	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA benzylidene acetal	C-10 acetal variant	Research (chemistry)	No direct chemokine data; class-level NF-κB/chemokine suppression (Long et al., 2024)	Potential ↓CXCL10/CCL2 output; prioritize DHA/AS clinically (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artesunate α-epimer	Stereoisomeric form	Research/formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artesunate β-epimer	Stereoisomeric form	Research/formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

				(Ferrari et al., 2023; Liu et al., 2017)	CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Artemether lipid formulation	Lipid-based AM	Clinical formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
Sodium artelinate	Salt of artelinic acid	Research/clinical-exploratory	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA hemisuccinate	Pro-drug	Research/formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

DHA hemiglutarate	Pro-drug	Research/formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA phosphate	Pro-drug	Research/formulation	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA nicotinate	Pyridyl ester	Research	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA salicylate	Aryl ester	Research	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

				(Ferrari et al., 2023; Liu et al., 2017)	CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)
DHA ibuprofenate	Hybrid NSAID ester	Research	Class-level: ↓CXCL10/CCL2 via NF-κB pathway (Long et al., 2024; Xie et al., 2024)	Possible ↓thyroidal chemokines; extrapolated from DHA/AS data (Ferrari et al., 2023; Liu et al., 2017)	IFN-γ–inducible CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL8(IL-8)→CXCR1/2; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Metzemaekers et al., 2018; Kleist et al., 2025)

Notes: ↓ indicates decreased, reduced, or suppressed expression/activity; → indicates a ligand-to-receptor chemokine axis or signaling relationship. These symbols are used only as directional/relational shorthand and do not imply quantitative effect size.

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Table S2. Amino-artemisinins & Water-soluble Immunomodulatory Analogs in Thyroiditis

Compound	Alias / Notes	Development status	Possible associated chemokines (First author et al., year)	Function in thyroiditis via chemokines (First author et al., year)	Chemokine network nodes potentially affected (ligand→receptor) (First author et al., year)
Artemisone	10-amino-artemisinin sulfone; enhanced stability	Advanced preclinical / early clinical	↓NF-κB-driven chemokines (e.g., CXCL10/CCL2) at class level (Xie et al., 2024; Long et al., 2024)	Predicted ↓Th1 (CXCL10/CXCR3) and monocyte (CCL2/CCR2) traffic in AIT; propose CXCL10 PD monitoring (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemiside	10-amino-artemisinin thio-morpholine; prodrug of artemisone	Preclinical	Class-level chemokine reductions via NF-κB/PI3K-AKT modulation (Xie et al., 2024)	Potential AIT benefit via ↓CXCL10/CCL2; mechanistic alignment with DHA (Liu et al., 2017)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemisox	Oxime analog in artemisone/ide tetrad	Preclinical	Class-level (Xie et al., 2024)	Possible ↓CXCL10/CCL2; requires targeted AIT studies (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

M1 (artemisone metabolite)	Active metabolite informing systemic exposure	Preclinical	Class-level (Xie et al., 2024)	Expected to mirror artemisone chemokine effects; candidate PD marker tie-in (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-aza-artemisinin (prototype 9)	Amino-functionalized scaffold	Preclinical (Singh et al., 2014)	Class-level; network-relevant reductions in CXCL10/CCL2 (Xie et al., 2024)	Hypothesized ↓CXCL10/CXCR3 axis in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-aza-artemisinin derivatives 12a-g	Amino/hydroxy derivatives	Preclinical (Singh et al., 2014)	Class-level chemokine impact (Xie et al., 2024)	Predicted ↓Th1/monocyte recruitment via CXCL10/CCL2 (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-aza-artemisinin derivatives 13a-g	Amino/hydroxy derivatives	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	Predicted AIT benefit via CXCL10/CCL2 modulation (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

11-aza-artemisinin derivatives 14a-g	Amino/hydroxy derivatives	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-aza-artemisinin derivatives 15a-c	Amino/hydroxy derivatives	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
WHN-11	Newer amino-artemisinin lead	Preclinical	Class-level (Long et al., 2024)	Potential ↓CXCL10/CCL2; warrants testing in AIT assays (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM934	β-amino-arteether maleate; water-soluble	Preclinical in autoimmunity (Tong et al., 2022)	↓NF-κB/TLR signaling; reported ↓pro-inflammatory cytokines/chemokines (Tong et al., 2022)	Likely ↓CXCL10/CCL2 in AIT; Treg↑/Th1/Th17↓ suggests upstream chemokine dampening (Tong et al., 2022; Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

SM905	Water-soluble artemisinin derivative	Preclinical/RA models (Wang et al., 2007; 2008)	↓Inflammatory mediators; immunosuppressive (Wang et al., 2007; Wang et al., 2008)	Potential ↓CXCL10/CCL2 and ↓cell recruitment in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM735	3-(12-β-artemisininoxy) phenoxyl succinic acid	Preclinical (Zhou et al., 2005)	Strong immunosuppression; class-level chemokine dampening assumed (Zhou et al., 2005)	Hypothesized ↓Th1 trafficking (CXCL10) in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemisone-pheroïd	Delivery platform enhancing exposure	Preclinical	Improved delivery may enhance chemokine suppression (Long et al., 2024)	Potential stronger ↓CXCL10 PD response in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin urea analog A1	Aryl-urea amino-artemisinin	Preclinical	Class-level NF-κB/chemokine reductions (Xie et al., 2024)	Possible ↓CXCL10/CCL2 in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Amino-artemisinin amide analog A2	Aryl-amide amino-artemisinin	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin series B (B1-B4)	Series placeholder (literature)	Preclinical	Class-level (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin series C (C1-C4)	Series placeholder (literature)	Preclinical	Class-level (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin series D (D1-D4)	Series placeholder (literature)	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Amino-artemisinin series E (E1-E4)	Series placeholder (literature)	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM933	Related SM series amino-artemisinin	Preclinical (reported in series reviews)	Class-level (Tong et al., 2022)	Potential ↓CXCL10/CCL2 in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM736	Related to SM735 (series)	Preclinical	Class-level (Zhou et al., 2005)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM737	Related series analog	Preclinical	Class-level (Zhou et al., 2005)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM738	Related series analog	Preclinical	Class-level (Zhou et al., 2005)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4;

					CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM939	Related SM series analog	Preclinical	Class-level (Tong et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemisone analogue AN-1	10-amino variant	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemisone analogue AN-2	10-amino variant	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemiside analogue AI-1	10-amino variant	Preclinical	Class-level (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari

					et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemiside analogue AI-2	10-amino variant	Preclinical	Class-level (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-azaartemisinin ether E-1	Ether derivative of 11-aza	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-azaartemisinin ether E-2	Ether derivative of 11-aza	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
11-azaartemisinin linker dimer L-1	Linker-based dimer from 11-aza	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

11-azaartemisinin linker dimer L-2	Linker-based dimer from 11-aza	Preclinical (Singh et al., 2014)	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM934 salt (maleate)	Clinical salt form	Preclinical/processing (Tong et al., 2022)	As SM934 (Tong et al., 2022)	As SM934 (Tong et al., 2022; Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
SM905 sodium	Water-soluble salt	Preclinical (Wang et al., 2007; 2008)	As SM905 (Wang et al., 2007; Wang et al., 2008)	As SM905 (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin nanoparticle NP-1	Formulation to improve exposure	Preclinical	Enhanced delivery may enhance chemokine lowering (Long et al., 2024)	Potential stronger CXCL10 PD response (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Amino-artemisinin nanoparticle NP-2	Formulation to improve exposure	Preclinical	As above (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin PEGylate PG-1	Solubility-enhanced conjugate	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Amino-artemisinin PEGylate PG-2	Solubility-enhanced conjugate	Preclinical	Class-level (Xie et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Artemisone-cyclodextrin complex	Solubilized complex	Preclinical	Potential for increased chemokine suppression (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Artemiside-cyclodextrin complex	Solubilized complex	Preclinical	As above (Long et al., 2024)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Notes: ↓ indicates decreased, reduced, or suppressed expression/activity; ↑ indicates increased or enhanced expression/activity; → indicates a ligand-to-receptor chemokine axis or signaling relationship. These symbols are used only as directional/relational shorthand and do not imply quantitative effect size.

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Table S3. Fully Synthetic Ozonides / Trioxolanes in Thyroiditis

Compound	Alias / Notes	Development status	Possible associated chemokines (First author et al., year)	Function in thyroiditis via chemokines (First author et al., year)	Chemokine network nodes potentially affected (ligand→receptor) (First author et al., year)
OZ277	Arterolane; RBx11160; synthetic trioxolane	Clinical (approved combo in some regions)	Class-level ↓NF-κB-driven chemokines plausible; indirect evidence via peroxide MoA (Ismail et al., 2016; Giannangelo et al., 2019)	Potential ↓CXCL10/CCL2 output and ↓Th1/monocyte influx in AIT (Ferrari et al., 2023; Rotondi et al., 2007)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ439	Artefenomel; long t½ (~50 h)	Clinical (phase 2); long-acting ozonide	Peroxide-driven redox/protein alkylation may lower pro-inflammatory chemokines (Ismail et al., 2016; Siddiqui et al., 2022)	Sustained network modulation hypothetically ↓CXCL10/CCL2 in AIT; needs direct study (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Arterolane-piperaquine	Fixed-dose combination	Clinical (phase 3)	As arterolane class; indirect chemokine suppression via NF-κB	Potential adjunct to dampen CXCL10/CCL2 signals in inflammatory	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

			reduction (Giannangelo et al., 2019)	contexts (Ferrari et al., 2023)	CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ493	Second-gen trioxolane	Preclinical	Class-level peroxide effects; network consequences plausible (Ismail et al., 2016)	Hypothesized ↓CXCL10/CCL2; monitor CXCL10 PD if tested (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ609	Second-gen trioxolane	Preclinical	As above (Ismail et al., 2016)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ655	Second-gen trioxolane	Preclinical	As above (Ismail et al., 2016)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ657	Second-gen trioxolane	Preclinical	As above (Ismail et al., 2016)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

OZ418	Trioxolane lead (library)	Preclinical	As above (Giannangelo et al., 2019)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ401	Trioxolane analog	Preclinical	As above (Giannangelo et al., 2019)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ277 maleate	Salt form of arterolane	Clinical	As arterolane (Saha et al., 2014)	As arterolane (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-3107	OZ439 regioisomer lead	Preclinical	Peroxide protein-alkylation/redox disruption (Siddiqui et al., 2022)	Potential prolonged ↓chemokine output vs monomers (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-4735	Next-gen trioxolane	Preclinical	As above (Siddiqui et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6;

					CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-5764	Enantiopure form of RLA-4735	Preclinical	As above (Siddiqui et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-4801	Next-gen library member	Preclinical	As above (Siddiqui et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-4825	Next-gen library member	Preclinical	As above (Siddiqui et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
RLA-4860	Next-gen library member	Preclinical	As above (Siddiqui et al., 2022)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

					CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-1	Medicinal-chemistry exemplar	Preclinical	Protein alkylation/redox targeting (Ismail et al., 2016; Siddiqui et al., 2022)	Possible ↓CXCL10/CCL2 network activity (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-2	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-3	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-4	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Trioxolane T-5	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-6	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-7	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-8	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Trioxolane T-9	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Trioxolane T-10	Medicinal-chemistry exemplar	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Clickable trioxolane probe P-1	Chemical proteomics probe	Preclinical/tool	Maps peroxide targets; network implications indirect (Ismail et al., 2016)	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Clickable trioxolane probe P-2	Chemical proteomics probe	Preclinical/tool	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Clickable trioxolane probe P-3	Chemical proteomics probe	Preclinical/tool	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Clickable trioxolane probe P-4	Chemical proteomics probe	Preclinical/tool	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Clickable trioxolane probe P-5	Chemical proteomics probe	Preclinical/tool	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ439 capsule (fasted)	Artefenomel clinical formulation	Clinical (volunteer studies)	Prolonged exposure; potential sustained immunomodulation (Phyo et al., 2016; McCarthy et al., 2017)	If repurposed, could produce durable ↓CXCL10 PD signal (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

OZ439 with food	Artefenomel food-effect	Clinical (PK interaction)	Higher exposure with food (Abd-Rahman et al., 2024)	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ439 high-dose (≥800 mg)	Single-dose exposure	Clinical (PK/PD)	Long t½ supports sustained effects (Rosenthal, 2016)	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ282	Trioxolane series member	Preclinical (series; Giannangelo et al., 2019)	Peroxide MoA; indirect chemokine impact plausible	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ302	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ407	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6;

					CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ608	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ656	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ660	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ661	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7;

					CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
OZ665	Trioxolane series member	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Notes: ↓ indicates decreased, reduced, or suppressed expression/activity; → indicates a ligand-to-receptor chemokine axis or signaling relationship; ≥ indicates greater than or equal to. These symbols are used only as directional/relational shorthand and do not imply quantitative effect size.

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Table S4 — Function of Dimeric / Hybrid Artemisinins in Thyroiditis

Compound	Alias / Notes	Development status	Possible associated chemokines (First author et al., year)	Function in thyroiditis via chemokines (First author et al., year)	Chemokine network nodes potentially affected (ligand→receptor) (First author et al., year)
Dimer diphenyl phosphate 838	Most selective anti-CMV dimer; irreversible CMV inhibitor	Preclinical antiviral (anti-CMV)	Class-level ↓pro-inflammatory chemokines plausible via NF-κB dampening; early-life-cycle inhibition suggests upstream signaling effects (He et al., 2013; Mott et al., 2013)	Hypothesized ↓CXCL10/CCL2 in thyroiditis; monitor CXCL10 as PD (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer sulfone 4-carbamate 832-4	High SI anti-CMV; benchmark dimer	Preclinical antiviral	As above; potent series suggests stronger network impact than monomers (He et al., 2011; Mott et al., 2013)	Potential ↓Th1/monocyte trafficking via CXCL10/CCL2 in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer alcohol 760	Parent of 832-4; series comparator	Preclinical	Series-level effects (He et al., 2011; Çapcı et al., 2021)	Possible ↓CXCL10/CCL2; hypothesis for AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1

					(Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer alcohol 606	Parent of 838 (phosphate); early active dimer	Preclinical	Series-level (He et al., 2011)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Deoxy dimer 574	Series analog	Preclinical	Series-level (Çapcı et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer 800-3	Series analog	Preclinical	Series-level (Çapcı et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer 800-4	Series analog	Preclinical	Series-level (Çapcı et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Dimer phosphate 838-1	Diphenyl phosphate series analog	Preclinical	SAR supports high potency; class-level chemokine dampening expected (Mott et al., 2013)	Potential ↓CXCL10/CCL2 (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer phosphate 838-2	Diphenyl phosphate series analog	Preclinical	As above (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer sulfone carbamate 832-5	832-series analog	Preclinical	As above (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline hybrid-dimer 1	Artemisinin–4-aminoquinoline hybrid	Preclinical (antimalarial/anticancer)	Hybridization can modulate NF-κB/chemokines; class-level (Peter et al., 2021; Marchesi et al., 2023)	Potential ↓CXCL10/CCL2 in AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

ART–quinoline hybrid-dimer 2	Artemisinin–4-aminoquinoline hybrid	Preclinical	As above (Lombard et al., 2010; 2012)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline triazole hybrid H-T1	Triazole-linked hybrid	Preclinical	As above (Peter et al., 2021; Marchesi et al., 2023)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline triazole hybrid H-T2	Triazole-linked hybrid	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline hybrid 163A	Optimized hybrid (Quadros et al.)	Preclinical efficacy PK/PD	Hybrids with strong potency suggest upstream inflammatory pathway effects (Peter et al., 2021)	Hypothesized ↓CXCL10 PD if repurposed to AIT (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

ART–isoquinoline hybrids set A	C–H activation route	Preclinical	Potent activity across panel; class-level network implications (Çapcı et al., 2019)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–isoquinoline hybrids set B	C–H activation route	Preclinical	As above (Çapcı et al., 2019)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer phosphate DP-3	Series member	Preclinical	Series-level anti-CMV SAR (Mott et al., 2013)	Potential ↓CXCL10/CCL2 (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer phosphate DP-4	Series member	Preclinical	As above (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer sulfone	Series member	Preclinical	As above (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4;

carbamate SC-2					CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–ferrocene hybrid F-1	Organometallic hybrid	Preclinical (reviewed)	Potential immunomodulatory impacts; class-level (Peter et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–ferrocene hybrid F-2	Organometallic hybrid	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–coumarin hybrid C-1	Photopharmacology angle	Preclinical	As above (Peter et al., 2021; Marchesi et al., 2023)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–coumarin hybrid C-2	Photopharmacology angle	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1

					(Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–chalcone hybrid CH-1	Michael acceptor hybrid	Preclinical	NF-κB/chemokine axis plausible (Peter et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–chalcone hybrid CH-2	Michael acceptor hybrid	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–indole hybrid I-1	Indole-linked hybrid	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–indole hybrid I-2	Indole-linked hybrid	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

ART–quinazoline hybrid QZ-1	EGFR-targeting hybrid concept	Preclinical	As above (Marchesi et al., 2023)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinazoline hybrid QZ-2	EGFR-targeting hybrid concept	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–benzimidazole hybrid BZ-1	Hybrid scaffold	Preclinical	As above (Peter et al., 2021)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–benzimidazole hybrid BZ-2	Hybrid scaffold	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–pyridine	Hybrid scaffold	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4;

hybrid PY-1					CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–pyridine hybrid PY-2	Hybrid scaffold	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–triazine hybrid TZ-1	Hybrid scaffold	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–triazine hybrid TZ-2	Hybrid scaffold	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer phosphate DP-5	Series member	Preclinical	Series-level (Mott et al., 2013)	Potential ↓CXCL10/CCL2 (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1

					(Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer phosphate DP-6	Series member	Preclinical	Series-level (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline hybrid-dimer L-2010-1	From Lombard et al. sets	Preclinical	Hybrid potency supports upstream chemokine effects (Lombard et al., 2010; 2012)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
ART–quinoline hybrid-dimer L-2010-2	From Lombard et al. sets	Preclinical	As above	As above	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer sulfone 4-carbamate 832-6	832-series analog	Preclinical	Series-level (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Dimer 838 phenyl variant PV-1	Phosphate variant	Preclinical	Series-level (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).
Dimer 838 phenyl variant PV-2	Phosphate variant	Preclinical	As above (Mott et al., 2013)	As above (Ferrari et al., 2023)	Autoimmune thyroiditis–focused axes: CXCL9/10/11→CXCR3; CCL2→CCR2; CCL5→CCR5; CCL20→CCR6; CXCL12→CXCR4; CXCL13→CXCR5; CCL19/CCL21→CCR7; CX3CL1→CX3CR1 (Ferrari et al., 2023; Rotondi et al., 2007; Kimura et al., 2007; Domberg et al., 2008; Shin et al., 2023).

Notes: ↓ indicates decreased, reduced, or suppressed expression/activity; → indicates a ligand-to-receptor chemokine axis or signaling relationship. These symbols are used only as directional/relational shorthand and do not imply quantitative effect size.

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Table S5. Chemokine receptors, thyroid localization, and immunoregulatory functions in autoimmune thyroiditis (AIT)

Receptor	Key ligand(s)	Main locations in thyroid	Associated cell types (receptor-bearing and/or ligand-producing)	Functions in autoimmune thyroiditis	Representative evidence	Notes
CXCR3	CXCL9, CXCL10, CXCL11	Lymphocytic infiltrates in thyroid interstitium and around damaged follicles; perivascular inflammatory cuffs.	Th1-polarized CD4+ T cells, CD8+ T cells, NK cells expressing CXCR3; thyrocytes and stromal cells producing CXCL9/10/11.	Drives Th1-skewed recruitment of effector T and NK cells into thyroid tissue; sustains IFN-γ/TNF-α–driven positive feedback loop with CXCL10; higher CXCL10/CXCR3 activity correlates with more aggressive HT and GD.	García-López et al., 2001; Rotondi et al., 2007; Ferrari et al., 2023; Antonelli et al., 2004; Rubinstein et al., 2024	Central axis in AIT; CXCR3+ lymphocytes preferentially migrate toward supernatants of stimulated thyrocytes.
CCR2	CCL2 (MCP-1), CCL7, CCL8, CCL13	Thyroid stroma, perivascular areas, and inter-follicular regions enriched in mononuclear infiltrates; fibroblast-rich niches.	Inflammatory monocytes, macrophages, DC precursors expressing CCR2; thyrocytes, fibroblasts, endothelial and stromal cells secreting CCL2.	Mediates monocyte/macrophage influx into inflamed thyroid; supports differentiation into tissue macrophages and antigen-presenting cells; links stromal chemokine production with lymphocytic infiltration and tissue damage in HT.	García-López et al., 2001; Liu et al., 2008; Zhang et al., 2022; Fang et al., 2024; Chen K. et al., 2005	Genetic/trait studies implicate CCR2-related pathways in HT; CCL2 is strongly upregulated in thyroid stromal cells in experimental AIT.
CCR5	CCL3 (MIP-1α),	Perivascular and interfollicular lymphoid	Activated Th1/Tc cells and some Treg subsets	Promotes accumulation and retention of Th1-polarized T cells	García-López et al., 2001; Weetman, 2004;	CCR5+ T cells are enriched in thyroid-

	CCL4 (MIP-1β), CCL5 (RANTES)	aggregates; intrathyroidal T-cell clusters in nodules with coincident HT.	expressing CCR5; thyrocytes and infiltrating leukocytes producing CCL3/4/5.	and cytotoxic T cells within thyroid parenchyma; participates with CXCR3 in driving cell-mediated injury of thyrocytes.	Jiskra et al., 2016; Liu et al., 2008	infiltrating vs peripheral lymphocytes and mark Th1-biased responses in AIT.
CCR6	CCL20	Inflammatory foci and ectopic lymphoid structures in AITD, particularly Graves' thyroid tissue.	Th17 cells, some B cells and DC subsets expressing CCR6; thyrocytes and infiltrating leukocytes producing CCL20.	Supports recruitment and positioning of Th17 cells and related effector populations, contributing to IL-17–driven inflammation and tissue remodeling in AITD.	Li et al., 2013; Tabarkiewicz et al., 2015; Kimura et al., 2007	Evidence strongest in GD but likely contributes to Th17 axis in HT as part of mixed Th1/Th17 pathology.
CCR7	CCL19, CCL21	High endothelial venule–like vessels, thyroid-draining lymph nodes, and ectopic lymphoid follicles within HT thyroids.	Naïve and central memory T cells, regulatory T cells, and DCs expressing CCR7; stromal cells, endothelial cells, and thyrocytes expressing CCL19/CCL21 in HT tissue.	Guides T cell and DC trafficking between thyroid and draining lymph nodes; promotes ectopic lymphoid neogenesis, structured follicles, and chronicity of autoimmune inflammation.	Kimura et al., 2007; Goulvestre et al., 2002; Gui et al., 2025; Carragher et al., 2008	Serum CCL21 and CCR7 levels associate with HT risk and antibody/thyroid functional status.
CXCR 5	CXCL13	Ectopic germinal center-like follicles within thyroid	B cells and T follicular helper (Tfh) cells expressing CXCR5;	Orchestrates compartmentalization of B and Tfh cells into ectopic germinal centers; supports affinity	Aust et al., 2004; Gensous et al., 2018; Pan	Blockade of CXCL13 reduces ectopic follicle formation in models of

		parenchyma and perivascular regions in HT and GD.	follicular dendritic cells, macrophages, and sometimes thyrocytes producing CXCL13 in ectopic follicles.	maturation and production of anti-thyroid autoantibodies (TPOAb, TgAb, TRAb).	et al., 2022; Harrer et al., 2022	tertiary lymphoid structures.
CXCR 1 / CXCR 2	CXCL8 (IL-8); CXCR2 also binds CXCL1, CXCL2, CXCL3, CXCL5, CXCL6, CXCL7	Perivascular and interstitial inflammatory areas where neutrophils accumulate; regions of intense thyrocyte activation.	Neutrophils and some MDSC-like myeloid cells expressing CXCR1/2; thyrocytes and infiltrating immune cells producing CXCL8 and related ELR+ CXC chemokines.	Mediates recruitment and activation of neutrophils into the thyroid; contributes to local tissue damage, angiogenesis, and remodeling of the thyroid microenvironment.	Rotondi et al., 2013; Ferrari et al., 2019	CXCR2 antagonists are explored preclinically to limit neutrophil-driven damage in thyroid and other autoimmune settings.
CXCR 4 (±ACK R3)	CXCL12 (SDF-1)	Thyroid follicles, ectopic lymphoid follicles, and perivascular stromal areas; CXCL12 strongly expressed by thyrocytes in AIT.	T and B lymphocytes, plasma cells, and DCs expressing CXCR4; thyrocytes, stromal cells, and follicular structures producing CXCL12; endothelial	Supports retention and organization of lymphocytes in thyroid tissue and tertiary lymphoid structures; CXCR4 antagonism with AMD3100 reduces lymphocytic infiltration and thyroid damage in experimental AIT;	Liu et al., 2016; García-Cuesta et al., 2019; Kimura et al., 2007; Zhang et al., 2022	CXCL12, together with CXCL13/CCL19/CCL 21, is a key homeostatic chemokine in thyroid lymphoid neogenesis.

			and stromal cells expressing ACKR3 (CXCR7).	ACKR3 modulates CXCL12 availability and CXCR4 signaling.		
CX3CR1	CX3CL1 (fractalkine)	Endothelial surfaces and possibly thyrocyte membranes in inflamed thyroid microvasculature and interfollicular regions.	Cytotoxic CD8+ T cells, NK cells, and inflammatory monocytes expressing CX3CR1; endothelial and epithelial-like cells expressing membrane-bound CX3CL1.	Mediates firm adhesion and chemotaxis of CX3CR1+ cytotoxic and monocyte subsets to inflamed thyroid tissue; may enhance epithelial–immune synapse interactions and cytolytic injury.	Jones et al., 2012; Ferrari et al., 2019; Ferrari et al., 2023	CX3CL1/CX3CR1 axis is increasingly recognized in endocrine inflammation and cancer, with potential relevance to AIT severity.
XCR1	XCL1, XCL2	Interstitial areas and perivascular regions enriched in conventional type 1 dendritic cells (cDC1) within thyroid and draining lymph nodes.	Cross-presenting cDC1 expressing XCR1; activated CD8+ T cells and NK/T cells producing XCL1.	Facilitates targeted recruitment and positioning of cDC1, enhancing cross-presentation of thyroid antigens and priming of cytotoxic T-cell responses; may contribute to epitope spreading and chronic cytotoxicity in AIT.	Kroczek et al., 2012; Bordon, 2010; Audsley et al., 2020	Data are largely extrapolated from other organ-specific autoimmune models but mechanistically relevant to thyroid autoimmunity.
ACKR1 / ACKR2 /	Scavenged chemokines (e.g., ACKR2: multiple	Microvasculature, lymphatic endothelium, and stromal/mesenchymal	Endothelial cells, lymphatic endothelial cells, and stromal fibroblasts expressing	Shape and buffer chemokine gradients without classical G-protein signaling; limit excessive leukocyte recruitment, fine-tune	García-Cuesta et al., 2019; Torphy et al., 2022; Yen et al., 2022; Melgrati et al., 2023	ACKR2 and ACKR3, in particular, regulate availability of inflammatory CC

ACKR 3 / ACKR 4	inflammatory CC chemokines; ACKR3: CXCL12, CXCL11; ACKR1/4: CCL19, CCL21, CCL25, CCL27, others)	compartments adjacent to lymphoid infiltrates and follicles.	atypical chemokine receptors; a broad range of chemokine-producing leukocytes and thyrocytes providing ligands.	compartmentalization of T and B cells, and influence resolution versus persistence of thyroid inflammation.		chemokines and CXCL12, respectively, thereby indirectly modulating CCR/CXCR-driven trafficking in AIT.

Notes: + after a receptor or cell marker denotes marker-positive cells or receptor expression. These symbols are used only as descriptive shorthand and do not imply quantitative effect size.

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