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The First Polypeptide

Condensation, Sequestration, and the Discharge of the Remnant

Charles D. Schaper, Ph.D.
Chief Editor, Annals of the Chrysene Formalism
San Francisco, California, USA
editor@chrysene.com

Abstract. Article 67 proved that the architecture's remnant species accumulates without bound and derived a precise rate condition: any mechanism discharging the remnant must match the production rate or the accumulation is merely slowed, not removed. No such mechanism existed in the inventory. This paper supplies one, from the same chemistry the corpus has used throughout.

The condensation edge $n\mathrm{R} \rightarrow \mathrm{P} + (n-1)\,\mathrm{H_2O}$ converts residues into a polypeptide at the hexameric vertex-spaced site of the abiotic loom, driven by proton-coupled electron transfer, with no new heteroatom feedstock and no reference to the genetic code. The condensation uses functional valence on the zwitterion's ammonium and carboxylate groups, leaving the skeletal valence of the chrysene arms intact. The product partitions to the bilayer because its aromatic side chains — chrysene-derived and therefore hydrophobic, with a transfer free energy of approximately -19 kJ mol^{-1} per chain into the bilayer — carry it there by the same rule that keeps every apolar species out of the lumen.

In the bilayer the polymer sequesters the remnant by face-to-face π-π stacking between its chrysene-derived side chains and the apolar remnant arms. The stacking energy for polycyclic aromatic hydrocarbons of this size is 3.8–8.4 kJ mol^{-1} per contact, or 1.5–3.4 k_BT at 300 K: stable under thermal conditions, with an equilibrium constant of 5–29.

The rate condition of Article 67 becomes the necessary lower bound $f_c \geq \beta = \alpha/(1-\alpha)$ on the condensation fraction. The condition is strict: because Article 67 proved the accumulation structural rather than kinetic (the ratio $\varrho = W_b/N$ is an invariant of the maps), equality at the fixed point is not a coincidence but a requirement. The linear condensation model $f_c(W_b) = k \cdot W_b/L_{\mathrm{lip}}$ carries this forward as the shared target `tgt:cond_rate`, closed in Article 69.

Condensation acts on two registers simultaneously. It removes residues from the lumen, reducing the particle count and driving the reduced volume toward the division threshold. It sequesters remnants from the bilayer at the same rate, reducing the ceiling-approach rate established in Article 67. Because both increments equal $(\beta - f_c)N$ per cycle, the ϱ-invariance of Article 67 is preserved through the loop transient without modification.

The corpus now has: a vessel, its encoding, its cycle, its osmolyte, its pore, a proof that the lineage persists, and the polymer that clears the waste stream and through it makes the steady state possible. The same tetrasubstituted unit that filters the inlet and anchors the genome now moulds the first polymer.

Keywords: first polypeptide; condensation edge; proton-coupled electron transfer; hexameric site; aromatic sequestration; π-π stacking; transfer free energy; rate condition; dual function; R/N invariance; functional valence; two rings two functions; Chrysene Formalism

1 Introduction

1.1 The remnant problem and the rate condition

Article 67 identified the spent chrysene arm `W` as the first species in the corpus inventory with no consumption edge. Its count in the bilayer grows without bound, and the proof is structural rather than kinetic: since both the per-cycle map and the division reset change N and W_b by the same increment, the ratio $\varrho = W_b/N$ is an invariant converging monotonically to unity. Any consumption edge running below the production rate βN shifts the fixed point ϱ^* but does not remove the accumulation.

The consequence for this paper is precise: the polypeptide paper must supply an edge consuming `W` at rate βN or above, and nothing else will do. The rate condition is not a design goal; it is a derived necessary condition with a named source.

1.2 Three ingredients already in the inventory

All three ingredients required for the mechanism are already in the corpus.

The residue. Article 65's single zwitterionic sink carries an

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aromatic side chain (Article 62) and a functional ammonium and carboxylate available for condensation under the valence revision of Article 66.

The site. Article 24 establishes that the vertex-spaced hexameric ring of the abiotic loom has a free diameter of 9.17 Å, exceeding the 5.4 Å backbone diameter of an α-helix by 3.77 Å of clearance. No other ring size in the corpus is analysed at residue-level resolution.

The mechanism. Article [Sch26h] constructs functional voids in the chrysene lattice by controlled scission and establishes PCET-enabled amide bond formation as the prototype enzyme mechanism. The thermodynamic driver is the T_1 triplet state at 143 kJ mol^{-1} (Article 67, block V5), which exceeds the amide bond activation energy of 10–20 kJ mol^{-1} by a factor of seven to fourteen.

1.3 What the paper does

It assembles these three ingredients into a condensation edge, establishes the physical mechanism by which the product sequesters the remnant, derives the rate condition, proves the dual function on the lumen and bilayer counts, and passes the shared target to Article 69 with its necessary condition in hand.

1.4 What is established, by kind

Imported. The rate condition $f_c \geq \beta$ from Article 67 [Sch26f] (`cor:structural`); the hexameric site geometry and backbone clearance from Article 24 [Sch26a] (Table 2); the PCET mechanism from Article [Sch26h]; the aromatic side-chain description from Article 62 [Sch26d]; the functional-valence refinement per axis from Article 66 [Sch26e]; the inventory, sink corollary, and norestore theorem from Article 65 [Sch26c]; the T_1 energy and the forcing period from Articles 63 and 64 [Sch26g]; the ϱ-invariance from Article 67; the Abiotic Loom framework from Article 23 [Sch26b].

Proved here. That functional valence on the zwitterion is available without revision to the skeletal valence (Theorem 4.1); that the condensation edge is admissible (Proposition 4.4); that the pool cost of the edge is bounded (Proposition 4.5); that `P` partitions to the bilayer with a quantified transfer free energy (Proposition 5.1); that face-to-face π-π stacking between poly-`R` and `W` is thermodynamically stable with a computable equilibrium constant (Proposition 5.2); that the rate condition $f_c \geq \beta$ follows from the Article 67 invariance (Theorem 6.1); that the dual-function increments are equal (Theorem 7.1); and that Article 67's ϱ-invariance is preserved through the loop (Proposition 7.2).

Defined, not answered. The shared target `tgt:cond_rate`: the functional form of $f_c(W_b)$ and the rate constant k. Article 68 establishes $f_c \geq \beta$ as the necessary condition and passes the linear model to Article 69.

Not claimed. Any specific sequence; any catalytic function; any stacking energy beyond the PAH literature bounds (Target 9.6); any evaluation of the PCET activation energy at the hexameric site (Target 9.5); any claim that the co-aggregate fate is determined (Target 9.8).

2 Status, scope, and conventions

Convention 2.1 (Status labels)**.** [A] finite or axiom-free; [D] derived under named hypotheses; [C] imported with source named; [E] molecular reading, entering no proof.

Convention 2.2 (The hexameric site)**.** [C] Article 24, Sec. 3.2 and Table 2. Ring side 14 Å (vertex to vertex), free inradius 4.58 Å, free diameter 9.17 Å, backbone clearance 3.77 Å (positive at residue-level resolution). These are the only corpus measurements of a ring site that quantitatively confirm secondary-structure hosting. The loom-paper derivation (tensor space, Dirichlet walls) is not needed here; Table 2 is imported as a geometric fact.

Convention 2.3 (Valence categories)**.** [A] The species table of Article 65 assigns `R` skeletal valence zero: the four substituted positions at $3, 6, 9, 12$ are each occupied. Theorem (norestore) of that paper protects them. This paper introduces a second category, *functional valence*, for the ammonium terminus (NH_3^+) and carboxylate (COO^-) of the zwitterion. These groups are not skeletal arms; they are not covered by Theorem (norestore); and their availability for condensation requires no revision to the species table's skeletal-valence column. The refinement extends the per-axis precedent set in Article 66 to a per-group refinement.

Convention 2.4 (Scope)**.** [A] One new edge and one new species. No new heteroatom feedstock. The polypeptide is a structural polymer of a single residue type; nothing here specifies a sequence. The condensation occurs at the hexameric site; no other site is analysed.

3 Non-implications

Proposition 3.1 (Non-implications)**.** [A] *None of the following is asserted below.*

(i) Catalysis. *The sequestration is non-covalent. No active site and no catalytic turnover are claimed.*

(ii) Sequence specification. *The residue pool may be heterogeneous in twenty types; the hexameric site has no address mechanism. What forms is a composition-biased copolymer.*

(iii) A specific stacking energy. *Bounds are given from the PAH literature; no* ab initio *computation is reported. Target 9.6.*

(iv) A second residue type. *Article 68 uses a single species.*

(v) Relaxation of Article 67's α_c. *The ceiling condition α_c of Article 67's Corollary (crossover) depends on $\rho_{\max}$; the loop reduces W_b^* but does not change α_c as a function of $\rho_{\max}$.*

(vi) Determination of the co-aggregate fate. *Target 9.8.*

4 Valence, the condensation edge, and its site

Theorem 4.1 (Functional valence is available)**.** [A] *Let* R *denote the residue species with the skeletal valence column of Article 65's species table set to zero. The ammonium terminus* NH_3^+ *and carboxylate* COO^- *are chemical groups of the zwitterion not listed in that column. They are therefore unaffected by Theorem (norestore) of Article 65, which protects the skeletal arms. Under Convention 2.3, these groups are available for amide bond formation.*

Proof. Theorem (norestore) of Article 65 states: no edge may restore a spent skeletal arm. It names the four positions of the chrysene ring system. The ammonium terminus and carboxylate are not arms; they are functional groups of the amino acid portion of the zwitterion. The theorem is scoped to skeletal arms and does not govern them. □

Remark 4.2 (The valence refinement hierarchy)**.** [A] Three levels of valence are now in use:

(i) Article 65: valence per species (one row per species, one entry).

(ii) Article 66: valence per substituted axis (6–12 arm vs. 3–9 arm, independently).

(iii) Article 68: valence per chemical group within the species (skeletal arm vs. functional terminus).

Each refinement is strictly finer than the one above it. No earlier result is contradicted; each is re-scoped to a subcategory that the earlier paper did not distinguish.

Definition 4.3 (The condensation edge)**.** [D] The condensation edge is

$$\tau_{\text{pep}}: \quad n\,\mathrm{R} \longrightarrow \mathrm{P} + (n-1)\,\mathrm{H_2O}, \quad n \geq 2,$$

where P denotes the polypeptide. Each amide bond is formed by PCET at the hexameric site of Convention 2.2, following the mechanism of Article [Sch26h]. The nitrogen from the ammonium terminus enters the backbone; the carboxylate oxygen is released as water.

Proposition 4.4 (The condensation edge is available)**.** [A] *Under Theorem 4.1 and Definition 4.3, the edge τ_{pep} is admissible under the valence rules of this corpus. No new heteroatom feedstock is required. Block W1.*

Proof. Admissibility requires functional valence on the ammonium and carboxylate, established by Theorem 4.1. No skeletal arm is spent. The nitrogen from the ammonium is retained in the backbone (not released as a heteroatom product); the oxygen released as water is not impermeant. □

Proposition 4.5 (Pool cost of the condensation edge)**.** [A] *The edge τ_{pep} with chain length L_p removes L_p residues from the lumen per event, releases $L_p - 1$ water molecules (not impermeant; not counted in the lumen particle count N), and produces one polymer chain* P *(hydrophobic; leaves the lumen immediately; not counted in N). The net lumen particle change per condensation event is $-L_p$. Per cycle at condensation fraction f_c:*

$$\Delta N_{\text{cond}} = -f_c N_k, \qquad \Delta W_{\mathrm{H_2O}} = +f_c N_k\left(1 - \tfrac{1}{L_p}\right).$$

Block W1.

Proof. Finite; block W1. The fraction f_c of N_k residues is condensed; each chain of length L_p accounts for L_p residues and produces $L_p - 1$ water molecules. □

Remark 4.6 (The hexameric site as the unique corpus-confirmed mould)**.** [E] The trimeric ring of Article 66 has a free diameter of 5.1 Å, below the 5.4 Å backbone diameter of an α-helix. It excludes any backbone element. The hexameric ring has a free diameter of 9.17 Å and clearance 3.77 Å: the only ring for which Article 24 confirms secondary-structure hosting at residue level. The diameter ratio is 1.80. The trimer is a filter and the hexamer is a mould (Scholium 7.4); both functions are consequences of one unit at two spacings.

Remark 4.7 (Energetics of the PCET step)**.** [E] The T_1 triplet energy is $E_{T_1} = 143\ \mathrm{kJ\,mol^{-1}}$ (Article 67, block V5). The activation energy for amide bond formation via PCET is in the range 10–20 $\mathrm{kJ\,mol^{-1}}$ (Article [Sch26h]). The driving force is

$$\Delta G_{\mathrm{drive}} = E_{T_1} - \Delta G_{\mathrm{act}} \approx 123\text{–}133\ \mathrm{kJ\,mol^{-1}}.$$

The reaction is thermodynamically strongly favoured. The PCET activation energy at the specific hexameric site is Target 9.5.

5 Hydrophobic partition and aromatic sequestration

Proposition 5.1 (Poly-R partitions to the bilayer)**.** [D] *The polymer* P *has aromatic side chains (chrysene-derived, by Article 62's description of the severed arm). It is hydrophobic by composition. The transfer free energy from aqueous phase to a hydrocarbon phase is approximately*

$$\Delta G_{\mathrm{transfer}} \approx -2.303 \cdot RT \cdot \log P \approx -19\ \mathrm{kJ\,mol^{-1}} \text{ per chain}$$

for a naphthalene-scale fragment ($\log P \approx 3.4$, *lower bound), rising to* $-35\ kJ\,mol^{-1}$ *for a full chrysene arm* ($\log P \approx 6.1$, *upper bound). The appropriate value depends on which arm is severed at the transannular centre (Target 9.6); both bounds give strongly spontaneous partition. Block W2.*
By Article 65's sink corollary, every apolar species leaves the lumen. P *is apolar by side-chain composition and partitions to the bilayer. The condensation occurs at the hexameric site, which faces the bilayer (Convention 2.2); the product is deposited at the bilayer face, removing any diffusive timescale from the lumen (H3).*

Proof. Finite; block W2. The partition is thermodynamically spontaneous and requires no active transport. The sink corollary supplies the direction. □

Proposition 5.2 (π-π stacking constitutes sequestration)**.** [E] *The remnant* W *is a spent chrysene arm: apolar and aromatic, dimensions approximately* 12.5×7.0 *Å (Article 62). The side chains of* P *are chrysene-derived aromatic fragments of the same class. Face-to-face* π-π *stacking between polycyclic aromatic hydrocarbons (PAHs) of this size has:*

(i) Energy. $E_{\mathrm{stack}} = 3.8\text{–}8.4\ kJ\,mol^{-1}$ *(lower bound: naphthalene; upper bound: pyrene/chrysene). The ratio* $E_{\mathrm{stack}}/k_BT = 1.5\text{–}3.4$ *at* 300 *K indicates stable complexation.*

(ii) Geometry. *The interplanar separation in face-to-face PAH stacking is* 3.4–3.8 *Å, sterically accessible for the side chain* ($r_{\min} = 0.276$ *nm from Article 66, block V4) and the remnant* ($r_{\min} \approx 0.350$ *nm). Block W2.*

(iii) Equilibrium. *The equilibrium association constant* $K_{\mathrm{eq}} = \exp(E_{\mathrm{stack}}/k_BT)$ *is in the range* 5–29 *at* 300 *K, giving sequestration fractions of* 83–97% *at equimolar concentrations of side chain and remnant.*

In a simplified 1:1 stoichiometry, each side chain engages one remnant: approximately one remnant is sequestered per condensed residue.

Remark 5.3 (Status of the stacking calculation)**.** [A] Proposition 5.2 uses PAH stacking energies from Appendix E (standard aromatic chemistry). These are not *ab initio* values for the specific chrysene arm geometry. The bounds 3.8–8.4 $\mathrm{kJ\,mol^{-1}}$ represent the range from the smallest to the largest relevant PAH system and bracket the expected value. The equilibrium constants $K_{\mathrm{eq}} = 5\text{–}29$ suffice to show stable complexation under any plausible value in the range. An exact calculation is Target 9.6.

Remark 5.4 (Geometric compatibility of the residue and the remnant)**.** [E] Article 66's block V4 (the minimum-enclosing-cylinder computation) showed that any residue bearing a side chain has a minimum cylinder radius of at least 0.276 nm, exceeding the pore aperture. That result, applied here, implies that the side chain of R has cross-sectional dimensions similar to the remnant W (a chrysene arm with minimum cylinder radius ≈ 0.35 nm). The comparable cross-sections confirm that face-to-face stacking is sterically accessible without conformational strain.

6 The rate condition

Theorem 6.1 (The rate condition is necessary)**.** [D] *The condensation fraction f_c must satisfy*

$$f_c \geq \beta = \frac{\alpha}{1-\alpha}$$

for the remnant accumulation to be bounded. Block W3.

Proof. Article 67, Corollary (structural): the ratio $\varrho = W_b/N$ converges monotonically to $\varrho^* = 1$, and any edge consuming `W` at rate $r_k < \beta N_k$ per cycle shifts ϱ^* but does not bound R_k. From Proposition 5.2 at sequestration efficiency $\varepsilon = 1$: $f_c N_k$ residues condensed sequesters $f_c N_k$ remnants per cycle. For the sequestration to match the production rate βN_k: $f_c \geq \beta$. □

Corollary 6.2 (The rate condition with efficiency ε)**.** [A] *If each condensed residue sequesters $\varepsilon \leq 1$ remnants (fractional sequestration efficiency), the rate condition becomes $f_c \geq \beta/\varepsilon$. The required condensation fraction rises in inverse proportion to ε, but the form of the condition is unchanged for any $\varepsilon > 0$. Block W3.*

Remark 6.3 (What the rate condition says about the fixed point)**.** [A] Theorem 6.1 establishes $f_c \geq \beta$ as a necessary condition on any operating point. It does not specify what f_c is. The shared target `tgt:cond_rate` asks what sets the condensation fraction; Article 69 derives a fixed point at which $f_c = \beta$ exactly. The necessary condition is satisfied with equality at that fixed point, and the equality is not a coincidence: it follows from the same invariance that makes the rate condition necessary. A fixed point with $f_c > \beta$ would imply a net decrease in N, which eventually stops the loop. The only self-consistent operating point is $f_c = \beta$.

Scholium 6.4 (The rate condition cannot be circumvented by rate alone)**.** Article 67's invariance result is structural: it holds for any map with equal N- and W_b-increments, regardless of the timescales involved. A mechanism that sequesters remnants very slowly but at a rate just above βN_k satisfies the rate condition; one that sequesters rapidly but below βN_k does not. The rate condition concerns fractions, not absolute rates: the condensation must consume a fixed proportion of the residue pool each cycle, and that proportion is set by the bud fraction α.

7 The dual function and the surviving invariance

Theorem 7.1 (The dual function)**.** [A] *Let $f_c \in [0, \beta]$ be the condensation fraction. Per cycle, condensation simultaneously produces:*

(i) A net lumen particle change of $\Delta N_{\text{net}} = (\beta - f_c)N_k \geq 0$.

(ii) A net bilayer remnant change of $\Delta W_{b,\text{net}} = (\beta - f_c)N_k$, the same value.

Both increments are non-negative for $f_c \leq \beta$ and zero when $f_c = \beta$. When $f_c > \beta$ both become negative: N shrinks and W_b decreases, providing a restoring force toward the fixed point. Block W4.

Proof. The pore supplies βN_k particles to the lumen per cycle (through ammonium admission and excision). Condensation removes $f_c N_k$ from the lumen. Net: $(\beta - f_c)N_k$ added. For W_b: the excision creates βN_k remnants; condensation sequesters $f_c N_k$. Net: $(\beta - f_c)N_k$ added. □

Proposition 7.2 (The ϱ-invariance is preserved through the loop)**.** [A] *Let $\varrho = W_b/N$. Under the augmented per-cycle map Φ_c, both N and W_b change by $(\beta - f_c)N_k$ per cycle. The Möbius formula of Article 67, Proposition (invariant), applies with β replaced by $\beta - f_c$:*

$$\varrho' = \frac{\varrho + (\beta - f_c)}{1 + (\beta - f_c)},$$

which has the same form, with fixed point $\varrho^* = 1$ and contraction factor $(1 + \beta - f_c)^{-1}$ per cycle. At the Article 69 fixed line, $f_c = \beta$ and the contraction factor is 1: ϱ is frozen *at its current value rather than continuing to contract. The invariance is most active during the transient ($f_c < \beta$) and trivially exact on the fixed line. The division reset preserves ϱ exactly (same proof as Article 67). Therefore the ϱ-invariance holds in the loop context for any value of f_c.*

Proof. The N- and W_b-increments are equal; the proof is identical to Article 67's with the substitution $\beta \to \beta - f_c$. □

Remark 7.3 (What the dual function means for the division signal)**.** [A] In Article 67, N grows by βN per cycle and v falls because area grows faster (Article 67, block V3). Condensation reduces the net N-growth rate to $(\beta - f_c)N$

per cycle. The per-cycle reduced-volume factor becomes

$$f(\alpha, f_c) = \frac{1 + \beta - f_c}{(1+g)^{3/2}}, \qquad g = Q(\alpha) - 1.$$

As f_c increases toward β, $f \to Q(\alpha)^{-3/2} = v_{\text{thr}}(\alpha)$ and division fires after exactly one cycle at the fixed point. This is the exact-period identity of Article 69 Theorem (period): $v_{\text{thr}}(\alpha) \cdot Q(\alpha)^{3/2} = Q(\alpha)^{-3/2} \cdot Q(\alpha)^{3/2} = 1$, present in Article 64's construction and first visible when the condensation loop holds N constant. Below β, division fires faster because N is growing; above β, N shrinks and v may rise, delaying division. The condensation fraction acts as a governor on the division rate.

Scholium 7.4 (Two rings, two functions)**.** The trimeric ring of Article 66 has free diameter 5.1 Å and passes ammonium while excluding any residue bearing a side chain. The hexameric ring of Article 24 has free diameter 9.17 Å and hosts an α-helix at 3.77 Å clearance. Both are triangular arrangements of tetrasubstituted columns. The diameter ratio is 1.80.
The trimer is a filter and the hexamer is a mould. One unit, one symmetry, two spacings, two functions: the trimer controls what enters the lumen; the hexamer shapes what the lumen produces. This is the architectural economy the programme has demonstrated at every level, now visible in the spatial relationship between two ring sizes separated by a factor of 1.80.

8 The shared target

Hypothesis 8.1 (The linear condensation model)**.** [D] $f_c(W_b) = k \cdot W_b / L_{\text{lip}}$ for a rate constant $k \in (0,\ 2L_{\text{lip}}/N_0)$, where $L_{\text{lip}} = \nu L = 13{,}200$. The linear form is the minimal model satisfying:

(i) $f_c(0) = 0$: no condensation without remnant present,

(ii) f_c strictly increasing in W_b: more remnant drives more condensation (negative feedback), and

(iii) $f_c(W_b^*) = \beta$ at the fixed point derived in Article 69.

Registered as H1. The stability analysis of Article 69 uses this form; the fixed-point existence and the exact period identity hold for any monotone increasing f_c.

Definition 8.2 (The shared target)**.** [A] `tgt:cond_rate`: what drives the condensation fraction f_c and at what rate constant k?

This paper establishes the necessary condition $f_c \geq \beta$ (Theorem 6.1) and defines the linear model of Hypothesis 8.1. Article 69 derives the unique fixed point $W_b^* = \beta L_{\text{lip}}/k$, the stability condition, and the exact division period of one forcing cycle. Block W5.

Proposition 8.3 (The feasibility of k)**.** [A] *The rate constant k must satisfy two conditions jointly:*

(i) Safe-region lower bound *(from Article 67, Corollary (crossover) at steady state): $k > \beta/\rho_{\max}$, ensuring the steady-state bilayer load $W_b^*/L_{\text{lip}} = \beta/k$ is below the integrity limit.*

(ii) Stability upper bound *(Article 69, Theorem (stability)): $k < 2L_{\text{lip}}/N_0 = 0.105$, ensuring the fixed point is attracting.*

Both conditions are simultaneously satisfiable for all α and $\rho_{\max}$ in the corpus range. For $\alpha = 0.10$, $\rho_{\max} = 5$: $0.022 < k < 0.105$; for $\alpha = 0.02$, $\rho_{\max} = 5$: $0.004 < k < 0.105$. Block W5.

Proof. The lower bound is $k_{\min} = \beta/\rho_{\max}$; the upper bound is $k_{\max} = 2L_{\text{lip}}/N_0$. The ratio $k_{\max}/k_{\min} = 2L_{\text{lip}}\rho_{\max}/(\beta N_0) = 2 \cdot 13200 \cdot 5/((\alpha/(1-\alpha)) \cdot 252000) = 0.524(1-\alpha)/\alpha$, which exceeds 1 for all $\alpha < 0.83$ (block W5), ensuring the feasibility interval is non-empty. □

9 Registers, precedence, targets, conclusion

9.1 Consolidated register

Is functional valence available?
Yes. The ammonium and carboxylate of R are not skeletal arms; Theorem (norestore) does not govern them.
Rests on: Thm. 4.1.
Standing: [A] Proved from Article 65's scope statement.

Is the condensation edge admissible?
Yes, under the functional-valence availability of the zwitterion.
Rests on: Prop. 4.4, block W1.
Standing: [A] No new heteroatom feedstock required.

What is the pool cost of one condensation event?
L_p residues consumed; $L_p - 1$ water molecules released (not impermeant); one polymer chain formed (exits the lumen immediately).
Rests on: Prop. 4.5, block W1.
Standing: [A] Finite.

Does poly-R partition to the bilayer?

Yes: $\Delta G_{\text{transfer}} \approx -19$ kJ mol^{-1} per chain, strongly spontaneous.
Rests on: Prop. 5.1, block W2.
Standing: [D] Rests on H2 (aromatic side-chain character).

Is face-to-face stacking with `W` thermodynamically stable?
Yes: $E_{\text{stack}} = 3.8$–8.4 kJ mol^{-1}, $K_{\text{eq}} = 5$–29, sequestration fraction 83–97%.
Rests on: Prop. 5.2, block W2.
Standing: [E] Rests on H2 and PAH literature bounds.

What is the necessary condition on f_c?
$f_c \geq \beta = \alpha/(1-\alpha)$. Equality at the fixed point.
Rests on: Thm. 6.1, Cor. 6.2, block W3.
Standing: [A] Derived from Art. 67 Cor. (structural).

What does condensation accomplish simultaneously?
Lowers lumen N and sequesters bilayer W_b by equal increments $(\beta - f_c)N$; the ϱ-invariance is preserved.
Rests on: Thm. 7.1, Prop. 7.2, block W4.
Standing: [A] Finite.

9.2 Falsification register

Theorem 4.1
A ruling that the ammonium terminus and carboxylate require an explicit new valence entry in Article 65's species table. On that reading the edge is blocked pending a formal ledger revision.

Proposition 5.1
A reading of Article 62 under which the residue side chain is polar rather than aromatic. This would remove the thermodynamic drive for bilayer partition and the geometric basis for stacking.

Proposition 5.2
$\varepsilon = 0$: the stacking interaction exists geometrically but contributes zero sequestration efficiency at bilayer temperatures. Corollary 6.2 shows this makes the rate condition $f_c \geq \beta/0 = \infty$ unsatisfiable. The mechanism would require a different discharge route.

Theorem 6.1
A modification to the augmented map under which the N-increment and the W_b-increment are unequal per cycle. The rate condition rests on the equal-increment structure of Theorem 7.1: if condensation removes n_R residues but sequesters $n_W < n_R$ remnants (efficiency $\varepsilon = n_W/n_R < 1$), the threshold rises to $f_c \geq \beta/\varepsilon$ (Corollary 6.2). The case $\varepsilon = 0$ makes the condition unsatisfiable; that is the falsification entry for Proposition 5.2.

Proposition 8.3
A demonstration that the safe-region lower bound $k_{\min}$ exceeds the stability upper bound $k_{\max}$. This requires $\alpha \geq 0.83$, outside the corpus range.

9.3 Precedence

Ruling 9.1 (Against Article 67)**.** [A] Consistent, supplying. The rate condition of Article 67 Corollary (structural) is the source of Theorem 6.1. The ϱ-invariance is preserved through the loop (Proposition 7.2). Target `tgt:remnant` is answered in mechanism by the stacking interaction; answered in rate by Theorem 6.1; answered at the fixed point by Article 69.

Ruling 9.2 (Against Article 65)**.** [A] Consistent, extending. Valence is refined per chemical group (Theorem 4.1, Convention 2.3). One new species `P` and one new edge τ_{pep} are added. `P` is hydrophobic and membrane-resident; the sink corollary is unchanged. No existing entry in the inventory is modified.

Ruling 9.3 (Against Article 66)**.** [A] Consistent, using. The per-axis valence refinement of Article 66 is the precedent for the per-group refinement introduced here. The trimeric ring of Article 66 and the hexameric ring of Article 24 are distinguished by Remark 4.6 and Scholium 7.4; neither result in either paper is contradicted.

Ruling 9.4 (Against Articles 23 and 24)**.** [C] Two geometric facts and one mechanism imported. The hexameric site geometry (Convention 2.2) is from Article 24; the PCET mechanism (Remark 4.7) is from Article [Sch26h]. The higher-order geometry of the loom is not required beyond these two facts.

9.4 Targets

Target 9.5 (PCET activation energy at the hexameric site)**.** Compute the activation energy for amide bond formation via PCET at the vertex-spaced hexameric ring. The qualitative case rests on the T_1 surplus of 123–133 kJ mol^{-1} (Remark 4.7); the quantitative confirmation requires the site-specific tunnelling matrix element and reorganisation energy.

Target 9.6 (π-π stacking energy and sequestration efficiency)**.** Compute the face-to-face stacking energy E_{stack} for a chrysene arm paired with a chrysene-derived side chain, and the sequestration efficiency ε at bilayer temperatures. The rate condition of Theorem 6.1 requires $f_c \geq \beta/\varepsilon$; the present paper uses the PAH bounds to establish $\varepsilon > 0$ with $K_{\text{eq}} \geq 5$, but the exact value of ε determines the operating f_c.

Target 9.7 (Chain length produced at the hexameric site)**.** Determine L_p, the chain length produced at the hexameric site. The Article 24 clearance of 3.77 Å sets a geometric upper bound on the residue cross-section; it does not directly constrain L_p. The pool cost per event scales as L_p (Proposition 4.5) and is approximated at $L_p = 10$ in block W1.

Target 9.8 (Fate of the poly-R/W co-aggregate)**.** Determine whether the co-aggregate forms a dense bilayer phase (immobilising W), is expelled as a bud, or becomes a structural insert. The loop's fixed-point analysis in Article 69 is insensitive to the fate; the rate constant k of the shared target is not: a tighter co-aggregate raises k; an expelled bud resets the local W_b and changes the transient.

9.5 Conclusion

Proposition 9.9 (What is established)**.** [A] *Subject to Appendix A:*

(i) Functional valence is available on the zwitterion without revision to the skeletal-valence column (Theorem 4.1).

(ii) The condensation edge $n\mathrm{R} \longrightarrow \mathrm{P} + (n-1)\mathrm{H_2O}$ *is admissible with no new heteroatom feedstock (Propositions 4.4, 4.5).*

(iii) P *partitions to the bilayer with transfer free energy* $\approx -19\ kJ\,mol^{-1}$ *per chain (Proposition 5.1).*

(iv) Face-to-face π-π stacking sequesters W *with* $K_{\mathrm{eq}} = 5$–29 *and sequestration fraction* 83–97% *at equimolar concentrations (Proposition 5.2).*

(v) The necessary rate condition $f_c \geq \beta$ *follows from the Article 67 structural invariance (Theorem 6.1).*

(vi) Condensation applies equal increments $(\beta - f_c)N$ *to both the lumen particle count and the bilayer remnant count simultaneously (Theorem 7.1).*

(vii) Article 67's ϱ*-invariance is preserved through the loop (Proposition 7.2).*

(viii) The shared target `tgt:cond_rate` *is defined with necessary condition and linear model; passed to Article 69 (Definition 8.2, Proposition 8.3).*

Scholium 9.10 (What the polymer is for)**.** The corpus has now built a vessel, encoded it, cycled it, established its osmolyte, opened a pore for supply, proved the cycle persistent, identified the waste stream that would have stopped it, and provided the species that manages the waste.
The polymer does not fold, does not catalyse, and does not carry information. It partitions to where the problem is and stacks with what needs to be cleared. That is a structural polymer; it is the right first polymer, because structure is what a homopolymer of a single aromatic residue can offer. The genetic code, metabolism, and catalytic function are downstream. The first polymer clears the path.

A Hypothesis register

	Premise	What rests on it	What survives failure
H1	Linear condensation model $f_c(W_b) = k \cdot W_b/L_{\text{lip}}$, $k \in (0, 2L_{\text{lip}}/N_0)$ (Hyp. 8.1).	Article 69 stability analysis; closed-form W_b^*; Proposition 8.3.	Theorem 6.1 (rate condition necessary); Theorem 7.1 (dual function); Article 69 exact period (holds for any f_c with $f_c(W_b^*) = \beta$).
H2	Residue side chain is aromatic and chrysene-derived (Article 62).	Propositions 5.1 (partition) and 5.2 (π-π stacking).	Theorem 4.1 (valence); Propositions 4.4 and 4.5 (edge available and its cost); Theorem 7.1 and Proposition 7.2 (dual function and invariance do not use stacking geometry).

B Verification blocks

W1 [COMPUTED] **The condensation edge and its site**

Edge stoichiometry, pool cost, site geometry, and pool-cost table.

W2 [COMPUTED] **Hydrophobic partition and aromatic sequestration**

Transfer free energy; minimum cylinder radii for geometric compatibility; stacking energy range and K_{eq} bounds.

W3 [COMPUTED] **The rate condition**

Derives $f_c \geq \beta$; table for corpus α range; the efficiency-ε extension.

W4 [COMPUTED] **The dual function**

Per-cycle changes in N and W_b at various f_c/β; equal increments; division-rate governor interpretation.

W5 [COMPUTED] **The shared target: defining $f_c(W_b)$**

Linear model; feasibility range of k; bilayer load W_b^*/L_{lip} as a function of k and α; hands off to Article 69 block V1.

The source file `acf-68-blocks.py` runs as `python3 acf-68-blocks.py` and emits every number cited above.

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