The Canine Gut Fix, Nutrition Engine, v1.0

Single Source of Truth, Developer Specification

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1) Scope and Goals

• Compute science-based nutrient targets for dogs only across:

• Growth

• Adult maintenance

• Gestation

• Lactation

• Output targets in three expressions:

1. Per kg Dry Matter (DM)

2. Per 1,000 kcal Metabolizable Energy (ME)

3. Per metabolic body weight (BW^0.75)

• Respect NRC categories: MR minimal requirement, AI adequate intake, RA recommended allowance, SUL safe upper limit.

• Include NRC conversion assumptions and exceptions so the engine stays correct when diet energy density ≠ 4,000 kcal ME/kg DM.

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2) Canonical Definitions, must be coded

• MR = minimal concentration of a bioavailable nutrient that supports a defined physiological state.

• AI = used when MR is unknown; best available concentration to sustain a given life stage.

• RA = diet concentration to reliably meet needs, typically MR or AI plus a bioavailability safety factor.

• SUL = maximal intake not associated with adverse effects (often missing, especially for vitamins and minerals, must be nullable).

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3) Global NRC Assumptions, constants and baselines

• Standard energy density: 4,000 kcal ME/kg DM.

• Standard reference animals (dogs only):

• Adult maintenance: 15 kg, 1,000 kcal/day

• Puppy (growth): 5.5 kg, 1,000 kcal/day

• Lactating bitch: 22 kg with 8 puppies, 5,000 kcal/day

Why this matters: These define the NRC table values and the math for converting nutrient units by DM, energy, or metabolic body weight.

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4) Data Model

4.1 Entities

Species: {dog}

LifeStage: {growth, adult\_maintenance, gestation, lactation}

NutrientClass: {energy, protein\_amino\_acids, fat\_fatty\_acids, macrominerals, trace\_minerals, vitamins}

NutrientRecord

• id

• life\_stage

• nutrient\_name

• unit\_dm\_basis, value\_dm\_MR, value\_dm\_AI, value\_dm\_RA, value\_dm\_SUL (nullable)

• unit\_per\_1000kcal, value\_1000kcal\_MR, AI, RA, SUL (nullable)

• unit\_metabolic\_bw, value\_bwm\_MR, AI, RA, SUL (nullable)

• notes [array of strings] for footnotes and constraints

• source\_reference (e.g. “NRC 2006, Table 15-5”)

• updated\_at

DietContext

• energy\_density\_kcal\_per\_kg\_dm

• moisture\_fraction

• feeding\_intake\_kcal\_per\_day

• body\_weight\_kg

• expected\_mature\_bw\_kg (for growth only)

• breed (optional overlays later)

RuleFlag

• arginine\_extra\_needed (boolean)

• iron\_copper\_oxide\_disallowed (default true)

• epa\_dha\_ratio\_cap (default true)

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5) Core Formulas and Algorithms

5.1 Energy density adjustment

adjusted\_amt\_per\_kg\_DM = table\_amt\_per\_kg\_DM \* (actual\_kcal\_ME\_per\_kg\_DM / 4,000)

5.2 Daily amount from per-1,000 kcal

daily\_amt = value\_per\_1000kcal \* (feeding\_intake\_kcal\_per\_day / 1000)

5.3 Metabolic body weight basis

Dogs use BW^0.75.

5.4 Energy requirement equations (dogs only)

• Maintenance: kcal ME per kg BW^0.75 per day.

• Gestation: same basis, adjusted per stage.

• Lactation: depends on BW^0.75, absolute BW, and number of puppies.

• Growth: maintenance × factor that depends on actual BW ÷ expected mature BW.

5.5 Special nutrient rules

1. Arginine bonus for puppies

• Add 0.01 g arginine for each g crude protein above thresholds:

• 4–14 weeks: threshold = 180 g MR / 225 g RA.

• 14 weeks: threshold = 140 g MR / 175 g RA.

2. EPA:DHA guardrail

• EPA must not exceed 60% of total EPA+DHA.

3. Iron and copper oxide forms

• Must be rejected (bioavailability too low).

4. Vitamin conversions

• Vitamin A: 1 μg retinol = 3.333 IU, 1 IU = 0.3 μg retinol.

• Vitamin D3: 1 μg cholecalciferol = 40 IU.

• Vitamin E: 1 IU = 1 mg all-rac-α-tocopheryl acetate.

5. Tyrosine hair coat note

• For black coat color, tyrosine requirement may be 1.5–2× standard.

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6) Algorithm, end-to-end

Inputs:

• life\_stage, body\_weight\_kg, expected\_mature\_bw\_kg (for growth), diet\_energy\_density\_kcal\_per\_kg\_DM, intake\_kcal\_per\_day (optional), rule\_flags.

Steps:

1. Compute intake if unknown (energy requirement formulas).

2. Load NRC nutrient records for life stage.

3. Adjust per-kg DM values if diet ≠ 4,000 kcal ME/kg DM.

4. Convert to daily amounts.

5. Apply rules: arginine, EPA:DHA, iron/copper oxide exclusion, vitamin conversions.

6. Validate SULs (error if exceeded, null = warning).

7. Output MR, AI, RA, SUL in all units + daily values + notes/warnings.

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7) File and API Contracts

7.1 CSV schema (dogs only)

• life\_stage, nutrient, class

• unit\_dm, dm\_MR, dm\_AI, dm\_RA, dm\_SUL

• unit\_1000kcal, k\_MR, k\_AI, k\_RA, k\_SUL

• unit\_bwm, bwm\_MR, bwm\_AI, bwm\_RA, bwm\_SUL

• footnotes, source\_table, source\_page

Populate with NRC Chapter 15 (dogs only):

• 15-2, 15-3: Puppy growth

• 15-4, 15-5: Adult maintenance

• 15-6, 15-7, 15-8: Gestation and lactation

7.2 REST API Example

Request:

{

"species": "dog",

"life\_stage": "adult\_maintenance",

"body\_weight\_kg": 18,

"diet\_energy\_density\_kcal\_per\_kg\_dm": 3800,

"intake\_kcal\_per\_day": null,

"rule\_flags": {

"iron\_copper\_oxide\_disallowed": true,

"epa\_dha\_ratio\_cap": true

}

}

Response:

• Returns nutrient targets (MR, AI, RA, SUL) per DM, per 1,000 kcal, per BW^0.75, plus daily values and warnings.

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8) Validation Rules & Warnings

• Energy intake sanity: must match BW^0.75 equation.

• Gestation: fallback to lactation values adjusted for calories if direct data missing.

• SUL missing: must be nullable, warn only.

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9) Footnote Logic & Examples

• Arginine add-on: if RA = 225 g/kg DM, diet provides 250 g/kg DM → +0.25 g arginine per kg DM.

• EPA limit: enforce DHA ≥40% of EPA+DHA.

• Vitamin conversion helpers: normalize brand data.

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10) UI Notes

• Show RA as default. MR/AI in advanced mode.

• Display red cap for SUL; “no established upper limit” if null.

• Include puppy age-band selector for arginine rule.

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11) Testing Checklist

• Validate energy-density conversions (e.g., 3,200 vs 4,500 kcal/kg DM).

• Puppy daily amounts correct via per-1,000 kcal formula.

• Arginine add-on triggers correctly.

• EPA:DHA ratio enforced.

• Iron/copper oxides rejected.

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12) Known Gaps & Handling

• Gestation values limited → fallback to lactation adjusted by calories.

• Missing SULs → keep null.

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13) Quick-Reference Equations

adj = table\_per\_kg\_DM \* (diet\_kcal\_per\_kg\_DM / 4000)

daily = per\_1000kcal \* intake\_kcal / 1000

maintenance = c \* BW^0.75

arginine\_add = 0.01 g \* max(0, protein\_g\_per\_kg\_DM − threshold)

EPA <= 0.60 \* (EPA + DHA)

14) Source Map

• NRC, Nutrient Requirements of Dogs and Cats, Chapter 15 (dog tables only).