AMINO ACIDS IN BROILERS AND LAYERS

- Amino acids are structural components of proteins.

- Animals need 22 amino acids for protein synthesis.

- Amino acids which cannot be synthesized by animals are must be supplied in the diet.

- A.a Synthesized by animals are – Non-essential amino acids.
- A.a which can not be synthesized are – Essential amino acids.
- Some A.a can be synthesized from essential amino acids – semi essential amino acids.

Essential Amino Acids/ Indispensable Amino Acids	Synthesised from limited substrates	Readily Synthesised By Poultry
Arginine Lysine Leucine Histidine Isoleucine Valine Methionine Threonine Tryptophan phenylAlanne	Tyrosine Cysteine Hydroxy Lysine Phenyl Alanine-Tyrosine Methionine - Cysteine	Alanine Aspertate Aspergine Glutamate Glutamine OH Proline Glysine Serine Proline

- Arginine, isoleucine, threonine, lysine, methionine and tryptophan are practically very low in diets- Critical amino acids.

- Methionine is 1st & Lysine is 2nd limiting A.a.

Limiting amino acid: The amino acid in a feed that is most deficient relative to a birds requirement is referred to as the first limiting amino acid.

Amino acid present in protein source

- LAA = ----------

Requirement of amino acid

- 1st limiting AA - Methionine
- 2nd limiting AA - Lysine
- 3rd limiting AA - threonine – costliest AA
- 4th limiting AA - Tryptophan
- 5th limiting AA - Valine

Complementary feeds:

- By Careful ingredient selection can avoid deficiencies of Limiting AA.

- Maize – soya bean
- Soya bean - sesame
- Blood meal – corn gluten meal 1:4
- (rich Lys & Trypt, def Isoleucine) (def Lys & Trypt, rich Isoleucine)

Protein and amino acid requirements for layers; NRC 1994

		White-Egg-Laying Strains			
Nutrient	Unit	0 to 6 Weeks; 450 g[a] 2,850[b]	6 to 12 Weeks; 980 g[a] 2,850[b]	12 to 18 Weeks; 1,375 g[a] 2,900[b]	18 Weeks to First Egg; 1,475 g[a] 2,900[b]
Protein and amino acids					
Crude protein[c]	%	18.00	16.00	15.00	17.00
Arginine	%	1.00	0.83	0.67	0.75
Glycine + serine	%	0.70	0.58	***0.47***	***0.53***
Histidine	%	0.26	0.22	0.17	0.20
Isoleucine	%	0.60	0.50	0.40	0.45
Leucine	%	1.10	0.85	0.70	0.80
Lysine	%	0.85	0.60	0.45	0.52
Methionine	%	0.30	0.25	0.20	0.22
Methionine + cystine	%	0.62	0.52	0.42	0.47
Phenylalanine	%	0.54	0.45	0.36	0.40
Phenylalanine + tyrosine	%	1.00	0.83	0.67	0.75
Threonine	%	0.68	0.57	0.37	0.47
Tryptophan	%	0.17	0.14	0.11	0.12
Valine	%	0.62	0.52	0.41	0.46

Protein and amino acid requirements for Broilers; NRC 1994

Ingredient %	Pre – starter 0-3 w	Starter 3-6 w	Finisher 6-8 w
Crude protein %	23	20	18
Arginine	1.25	1.1	1.0
Glycine + Serine	1.25	1.14	0.97
Histidine	0.35	0.32	0.27
Isoleucine	0.8	0.73	0.62
Leucine	1.2	1.09	0.93
Lysine	1.1	1	0.85
Methionine	0.5	0.38	0.32
Methionine + cystine	0.9	0.72	0.6
Phenyl alanine	0.72	0.65	0.56
Proline	0.6	0.55	0.46
Threonine	0.8	0.74	0.68
Tryptophan	0.2	0.18	0.16
Valine	0.9	0.82	0.70

BIS 2007

	Broiler feed				Layer feed		
Ingredient %	Prestarter 0-2 w	Starter 2-4w	Finisher 4-6w	Chick 0-8w	Grower 9-20w	Layer phase I 21-45w	Layer phase II 46-72w
CP	23	22	20	20	16	18	16
Lysine	1.3	1.2	1.0	1.0	0.7	0.7	0.65
Methionine	0.5	0.5	0.45	0.4	0.35	0.35	0.3
M+C	0.9	0.9	0.85	0.7	0.6	0.6	0.55

	Broiler breeder feed				Layer breeder feed			
Ingredient %	Chick	Grower	Layer	Male	Chick	Grower	layer	Male
CP	20	16	16	15	20	16	17	16
Lysine	1.0	0.8	0.85	0.8	0.95	0.7	0.7	0.8
Methionine	0.45	0.4	0.45	0.4	0.4	0.4	0.4	0.4
M+C	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6

Forms of amino acids

- Optical Isomers
  - D Amino acid
  - L Amino Acid
  - D L Racemic mixture
- Usually all amino acids are available in salts of hydrochloric acid.

Absorption of amino acids:

- Peptides - Jejenum.
- Amino acids - ileum.

- L- isomers are rapidly absorbed than D- isomers.

- Transport across membrane is Sodium & B6 dependent.

- Competition for structurally similar amino acids.

Synthesis of non-essential amino acids:

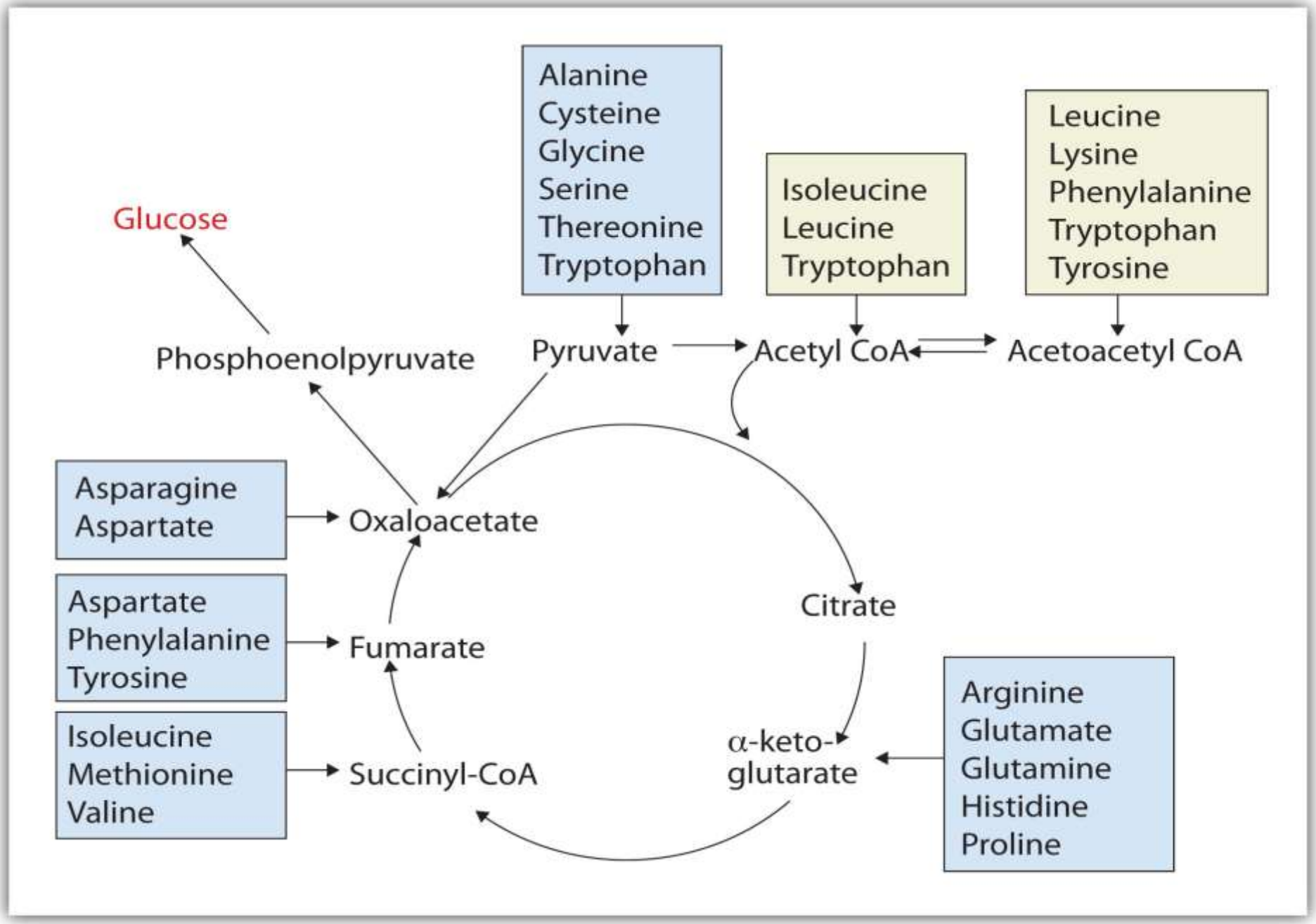
Carbon skeletons of A.A from intermediates of CHO metabolism.

- 3-phosphoglyceric acid → serine & glycine.
- Pyruvic acid → Alanine
- Oxaloacetate → Aspartic acid
- α – Ketogluatarate → Glutamic acid
- Glutamic acid → Proline and Hydroxyproline

GLUCOGENIC / KETOGENIC AMINO ACIDS

Glucogenic and Ketogenic Amino Acids

Glucogenic	*Glucogenic and Ketogenic*	*Ketogenic*
Alanine	Isoleucine	Leucine
Arginine	Phenylalanine	Lysine
Asparagine	Threonine	
Aspartate	Tryptophan	
Cysteine	Tyrosine	
Glutamine		
Glutamate		
Glycine		
Histidine		
Hydroxyproline		
Methionine		
Proline		
Serine		
Valine		


Alanine
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Leucine
Tryptophan
Leucine
Lysine
Phenylalanine
Tryptophan
Tyrosine
Glucose
Phosphoenolpyruvate
Pyruvate
Acetyl CoA
Acetoacetyl CoA
Asparagine
Aspartate
Oxaloacetate
Aspartate
Phenylalanine
Tyrosine
Fumarate
Citrate
Isoleucine
Methionine
Valine
Succinyl-CoA
α-keto-
glutarate
Arginine
Glutamate
Glutamine
Histidine
Proline

Degradation products of selected amino acids:

Amino acid	Products of metabolism
Methionine	Homocysteine, cysteine, cystine and methyl group of compounds such as creatine, choline and carnitine
Cysteine	Glutathione, taurine and the sulfate in chondroitin sulfate and other mucopolysaccherides
Arginine	Ornithine, creatine and urea
Histidine	Histamine
Lysine	Carnitine, desmosine
Phenylalanine & Tyrosine	Thyroxine, adrenalin, noradrenalin, dopamine, melanin pigments

- Excesses of A.A beyond the need are degraded.
- Amino acid  carbon skeleton + Nitrogen

- Glucose, fat, Co_2 + H_2O Uric acid

- Linear relation between CP and AA degradation, utilization never be 100 %.

- Degradation of most of AA occurs in Liver & Kidney except for leucine, isoleucine and Valine which degrade in muscle.

- Morris et al.,1999 suggest amino acid requirements, will increase with % of CP in diet by regression analysis.

- % lysine = 0.057% CP

- % tryptophan = 0.012% CP

- Methionine = 0.025% CP

Mcdonald and Morris (1985) used predict amino acid needs of layer pullets:

The specific AA is predicted in mg/bird/day

Lysine = 9.99E + 73W

Methionine = 4.77E + 31W

Tryptophan = 2.62E + 11W

E – daily egg mass

W – Body weight

Amino acid interaction:

- Lysine and Arginine
- Leucine, Isoleucine and Valine
- Methionine and Threonine
- Methionine ,Glycine and Arginine

Lysine & Arginine : increased kidney arginase activity

- decreased resorption of arginine
- competition at absorption site

- histidine- leucine - ↑es arginase activity.

Methionine – threonine: Increase methionine

Increase in Thr & Ser dehydrase

Threonine deficiency

The concept of ideal protein was first given by Mitchell (1964).

- Ideal AA ratios, with lysine as the reference amino acid.

- The ideal ratios, unlike the requirements, would not change based on whether diets contained high or low levels of energy or protein.
- chickens can only utilize about 40% of the dietary protein, it seems logical to decrease the level of protein in the diet (Lopez and Leeson, 1995)

Ideal ratios (%) of essential amino acids for broiler chicks as proposed by various investigators.

Amino acid	Baker (1997)[a]	NRC (1994)[b]	Mack *et al.* (1999)[c]	Baker *et al.* (2002)[d]
Lysine	100	100	100	100
Methionine	36	42	ND[e]	ND
Cystine	36	33	ND	ND
SAA[f]	72	75	70	ND
Threonine	67	67	59	56
Valine	77	75	76	78
Isoleucine	67	67	66	61
Leucine	109	100	ND	ND
Tryptophan	16	17	17	17
Arginine	105	104	104	105
Histidine	35	29	ND	ND
Phe + Tyr	105	112	ND	ND

Author	Methodology	Conclusion
Novak et al.,2016	Phase I (20 to 43 wk) 18.9, 17.0, and 14.4 g of protein/hen per day and 0.97, 0.85, and 0.82 TSAA:Lys. phase II (44 to 63) 16.3, 14.6, and 13.8 g of protein/hen per day and 0.92, 0.82, and 0.72 TSAA:Lys.	- Egg production decreased from 83.7 to 82.2%, feed consumption 98.8 to 95.6 g, respectively. - Feed efficiency improved from 1.680 to 1.645 g of feed/g of egg mass with decreasing dietary protein. - In phase II egg weight 13.8 g fed group has low compared to 14.6 & 16.3 groups. - Overall, hens consuming 16.3 or 14.6 g of protein/hen per day performed similar to hens consuming 18.9 and 17.0 g of protein/hen per day during P1 and P2, respectively. - Hens with higher 0.97, 0.92 TSAA: Lys have goo shell strength. - Egg production losses were 2 % avge.

Author	Methodology	Conclusion
Zhai et al.,2016	2 Lys levels 100 and 120% of RL 4 Met levels (80, 100, 120, and 140% of RL), were fed from 21 to 42 d of age in broilers	- Lys at 100% RL, feed conversion ratio (FCR) was lowest when diets containedMet at 120% RL. - Lys at 120% RL, FCR was linearly reduced as the inclusion of dietary Met increased. - Higher lys:met (120: 120)diets were have lower cost of production. - 0.478% meth

Author	Methodology	Conclusion
Kumari et al.2016	Two protein levels (13.36 and 15.78 %) each with 5 % concentration of lysine (0.50, 0.55, 0.60, 0.65, and 0.70) and a control with 17 % CP and 0.70 %, lysine. 2700 kcal energy in all.	- At 13.36 % cp with 0.65% (91.4%)& 0.7% (89.4%) of lysine, egg production & egg weight (53.4 vs 51.2) were higher with diff 1.5%. - At 15.78% cp with 0.65% (90.4%)& 0.7% (89.02%) of lysine, egg production & egg weight (51.4 vs 52.2) were higher with diff 1.5%. - Conclusion at both levels 0.7% lysine opt.

Author	Methodology	Conclusion
Manwa et al.,2017	- Group 1 without any natural & synthetic methionine supplement. - Group 2 with herbal methionine with 500g/ton of feed - From 0 to 38 weeks layers.	- Hen housed egg production (HHEP) was also found to be higher in Methiorep supplemented birds (76.06) as compared to control group (70.80). - Fcr for dozen eggs 1.49 vs 1.64

Author	Methodology	Conclusion
Awad et al.,2017	- 5 levels of cp 22.2, 20.7, 19.2, 17.7 and 16.2 - All diets adjusted to 1.1 % lysine, rest of AA were same acc to NRC.	- Body weights (BW), weight gains (WG), feed intake and feed conversion ratio of groups with 19.2, 20.7 and 22.2% were not significantly different. - BW and WG suppressed ($P<0.05$) with 16.2 and 17.7%.

Conclusion:

- We can reduce the CP levels in broilers up to 15 – 16% and in layers up to 14 %.
- While reducing we should balance the essential amino acids
- Lowered CP levels (14%) must supplied with min of 0.7% lysine.

References:

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3) Zhai, W., Peebles, E. D., Schilling, M. W., & Mercier, Y. (2016). Effects of dietary lysine and methionine supplementation on Ross 708 male broilers from 21 to 42 d of age (I): Growth performance, meat yield, and cost effectiveness. *Journal of Applied Poultry Research*, *25*(2), 197-211.