Preconception and pregnancy nutrition

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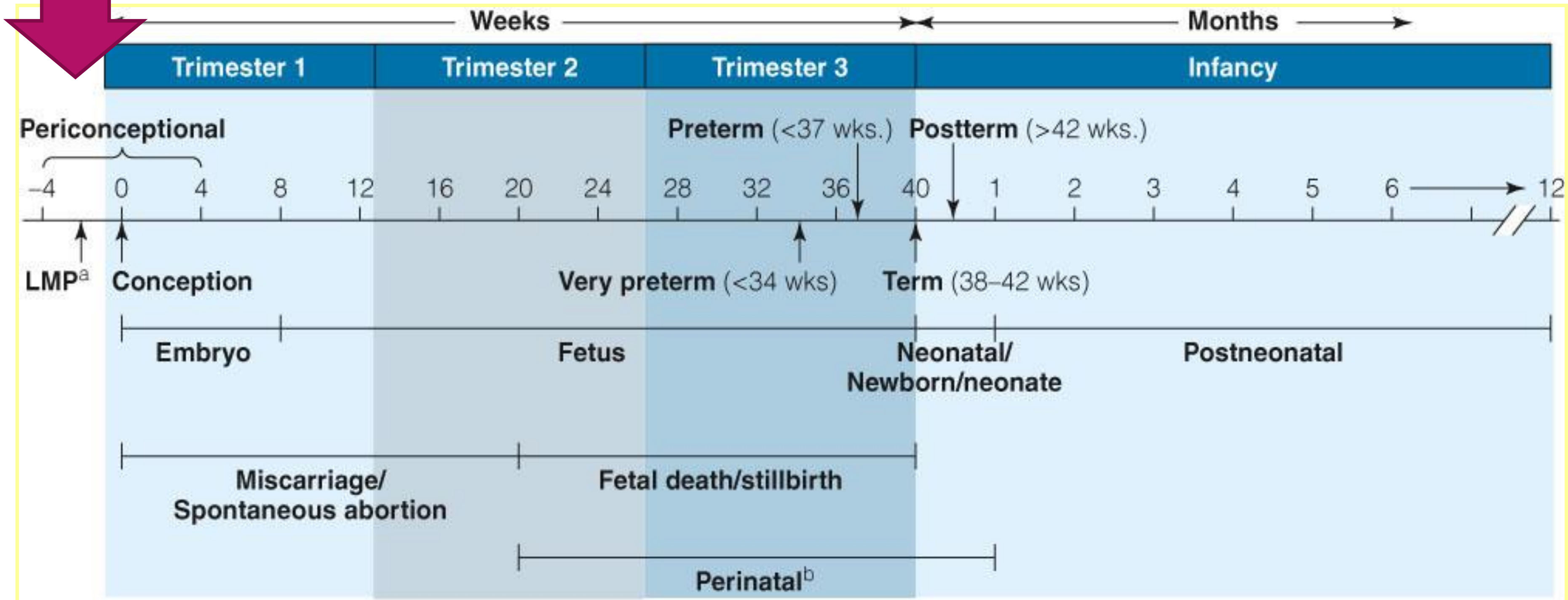
Time-related Terms Before, During, and After Pregnancy



[a]LMP = last menstrual period

[b]Perinatal definition varies from 20 to 24 weeks gestation to 7 to 28 days after birth.

Preconception
Key Nutrition Concept

- Optimal nutritional status prior to pregnancy enhances the likelihood of conception & helps ensure a healthy pregnancy & robust newborn.

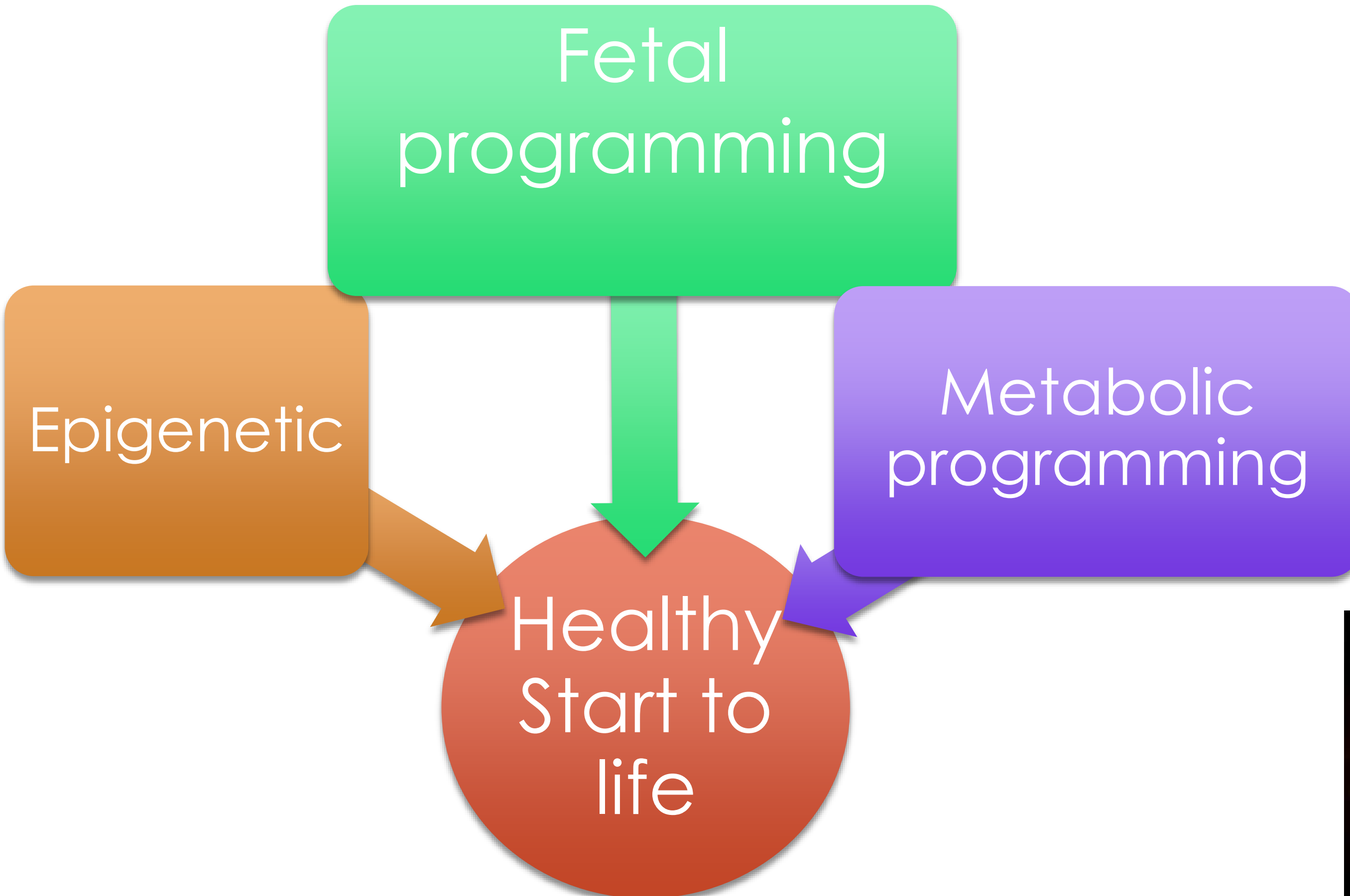
> *"Everyone is kneaded out of the same dough but not baked in the same oven."*

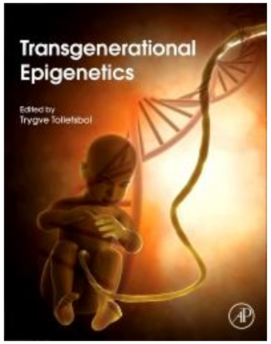
Preconception Care

May be the most important component of prenatal care

- US Public Health Service, 1989

Less Timely Nutritional care Greater will be the market for the High -tech, medical services .


Fetal programming
Epigenetic
Metabolic programming
Healthy Start to life


Transgenerational Epigenetics
Edited by Trygve Tollefsbol

Diet as a powerful determinant of health

- Directly ……………………………… metabolism & hormonal balance
- Through epigenetic mechanism

Epigenetic power is stronger and more influential in early stages of life

- Much epidemiological evidence and genome-wide analyses support the DOHaD in the cardiovascular field.

Key Nutrition Concept

Critical Periods of rapid growth & development of fetal organs & tissues occur during specific times during pregnancy.

Essential nutrients must be available in required amounts during these times for fetal growth & development to proceed optimally.

From: Prenatal epigenetics diets play protective roles against environmental pollution

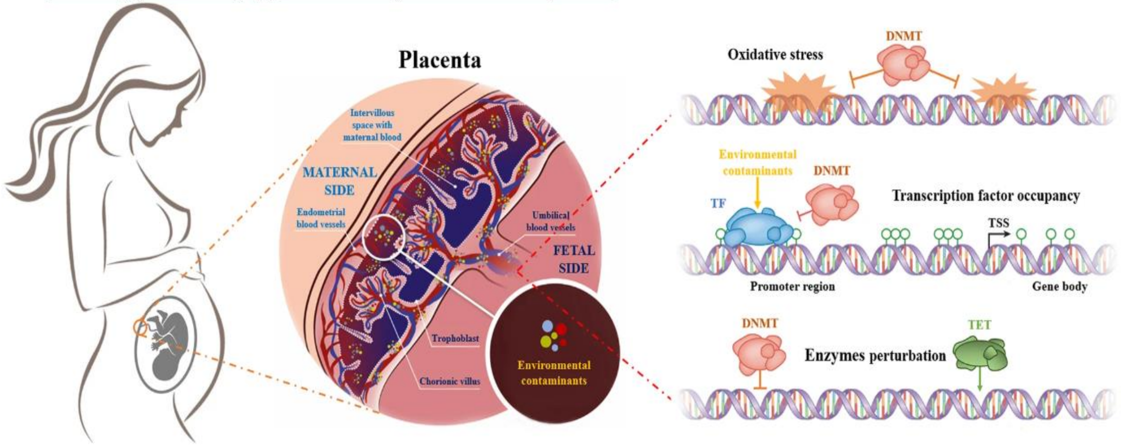


Diagram of the potential mechanisms of contaminant-induced epigenetic dysregulation. Environmental contaminants can be absorbed into the maternal blood through breathing, ingestion, drinking, or contact. Subsequently, certain environmental toxicants can pass the placental barrier and accumulate in the

Increasing body of evidence shows that maternal diets are associated with persistent metabolic changes in the offspring and can substantially improve the health of children and adults, which is referred to as nutritional programming.

From: Prenatal epigenetics diets play protective roles against environmental pollution

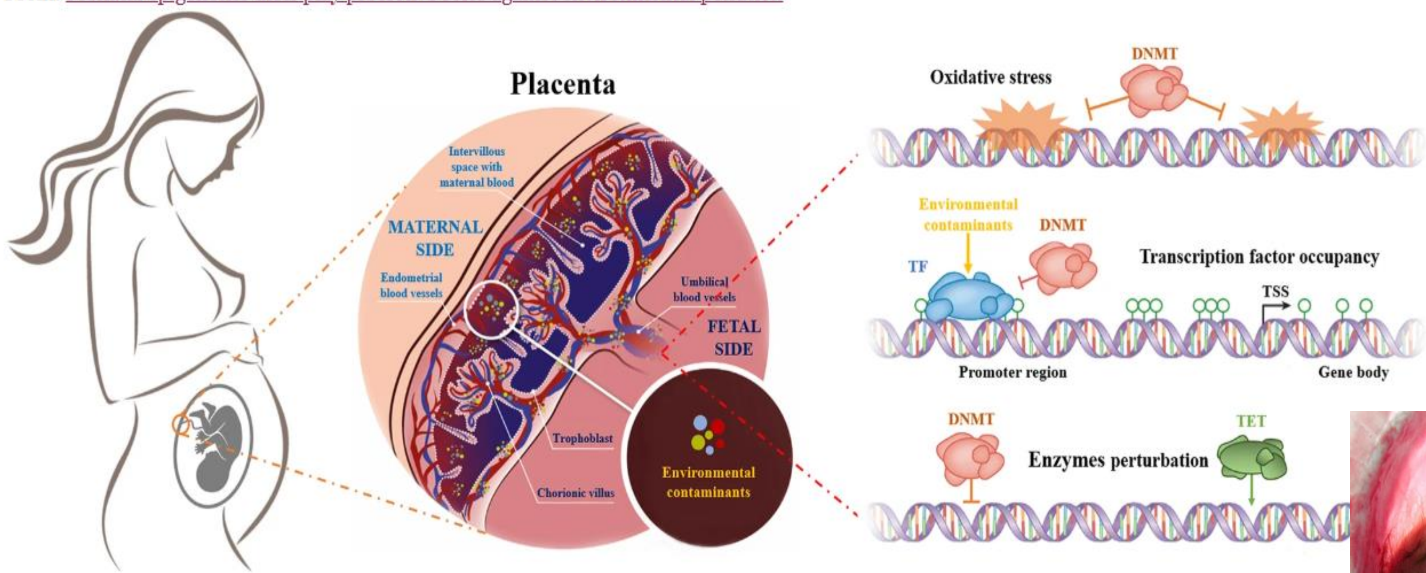
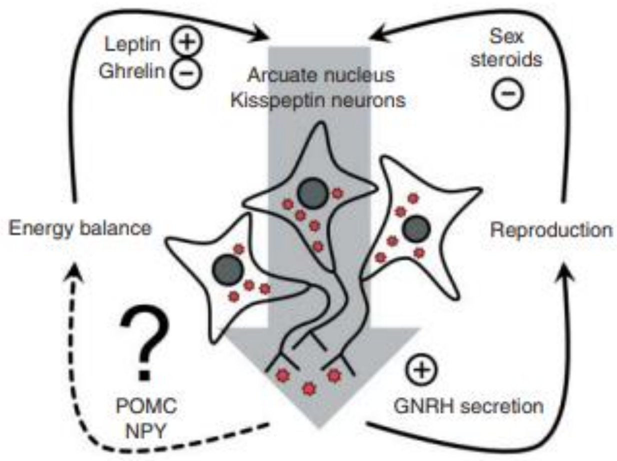


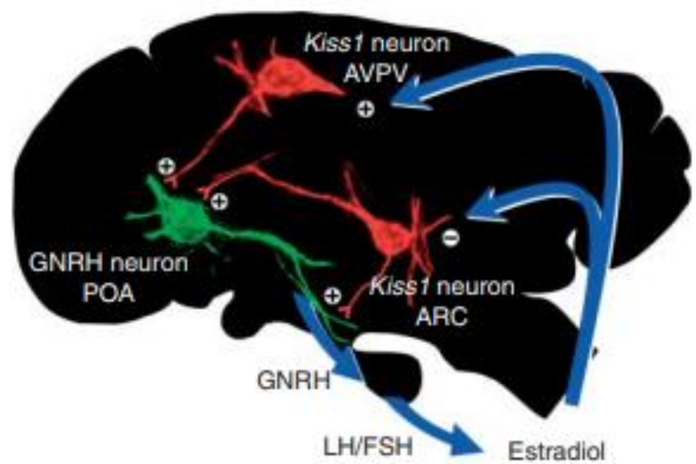
Diagram of the potential mechanisms of contaminant-induced epigenetic dysregulation. Environmental contaminants can be absorbed into the mate
blood through breathing, ingestion, drinking, or contact. Subsequently, certain environmental toxicants can pass the placental barrier and accumula

Review Article | Published: 19 May 2020

Metabolic regulation of kisspeptin — the link between energy balance and reproduction

Víctor M. Navarro





ELSEVIER

Journal of Cardiology

Volume 76, Issue 1, July 2020, Pages 14-17

Review

Developmental origins of health and disease theory in cardiology

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Review

Nutrients. 2022 Apr 12;14(8):1590. doi: 10.3390/nu14081590.

The Foetal Origins of Allergy and Potential Nutritional Interventions to Prevent Disease

John O Warner [1, 2], Jill Amanda Warner [2]

Eur Respir J. 2020 Mar 12;55(3):1901215. doi: 10.1183/13993003.01215-2019. Print 2020 Mar.

Mediterranean diet during pregnancy and childhood respiratory and atopic outcomes: birth cohort study

Annabelle Bédard [1], Kate Northstone [2], A John Henderson [2], Seif O Shaheen [3]

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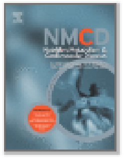
Nutrition, Metabolism and Cardiovascular Diseases

Volume 32, Issue 4, April 2022, Pages 833-852



Systematic Reviews and Meta-analyses

Maternal pregnancy weight or gestational weight gain and offspring's blood pressure: A systematic review

Li et al. Clinical Epigenetics (2019) 11:82
https://doi.org/10.1186/s13148-019-0659-4

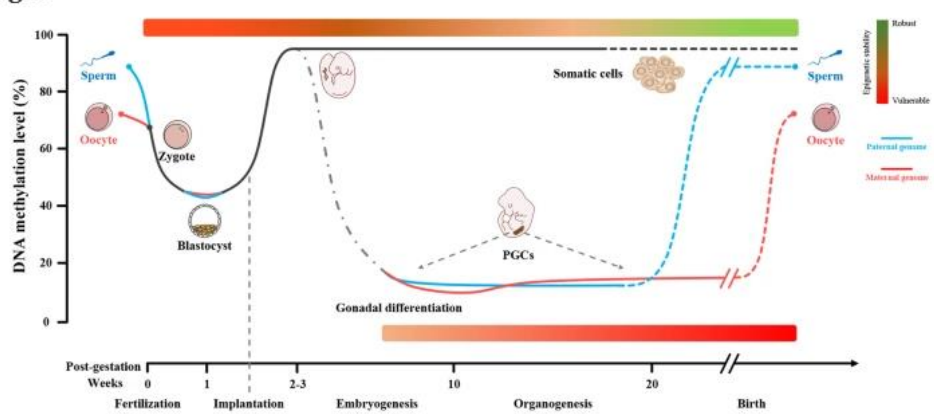
Clinical Epigenetics

REVIEW **Open Access**

Prenatal epigenetics diets play protective roles against environmental pollution

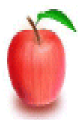
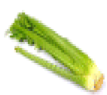
Shizhao Li[1†], Min Chen[2†], Yuanyuan Li[2,3,4*] and Trygve O. Tollefsbol[1,3,4,5,6*]

Fig. 1

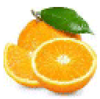


Epigenetic diets and their properties in epigenetic regulation

From: Prenatal epigenetics diets play protective roles against environmental pollution

Classification	Food example	Component	Epigenetic effect	Ref.
Polyphenol	 Apple	Kaempferol	HDAC inhibition	[323, 324]
			SIRT3 activation	[322]
		Phloretin	DNMT inhibition	[325]
	 Celery	Apigenin	DNMT inhibition	[326, 327]
			HDAC inhibition	[326]
			HMT inhibition	[327]
		Luteolin	DNMT inhibition	[327, 328, 330]
			HDAC inhibition	[329, 330]
			HMT inhibition	[327]
			SIRT activation	[329]

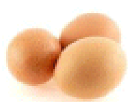
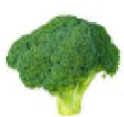
Epigenetic diets and their properties in epigenetic regulation

 Citrus	Hesperidin	DNMT inhibition	[331]
	Quercetin	DNMT inhibition	[275, 326, 332]
		HAT inhibition	[334]
		SITR1 activation	[333, 344]
 Coffee	Caffeic acid	HDAC inhibition	[335, 336]
	Chlorogenic acid	HDAC inhibition	[335]
 Garlic	Allyl mercaptan	HDAC inhibition	[337]
	Diallyl disulfide	HDAC inhibition	[338,339,340]
 Grape	Anthocyanin	DNMT inhibition	[325, 341]
		miRNAs modulation	[342]
	Piceatannol	SIRT1 activation	[333, 343, 344]
	Procyanidin	DNMT inhibition	[283, 479]
		HDAC inhibition	[283, 480]
		SIRT1 modulation	[346, 347]
		miRNA modulation	[342, 345, 348]
	Resveratrol	DNMT inhibition	[268, 283,284,285,286]

Epigenetic diets and their properties in epigenetic regulation

 Green tea	Catechin (EGCG)	DNMT inhibition	[274, 275, 285, 481]
		HAT inhibition	[270, 482]
		HDAC inhibition	[276, 285, 481, 483]
		Decreased MeCP2	[285]
		miRNAs modulation	[278, 279, 281]
	Theophylline	HDAC activation	[349, 350]
 Soy	Biochanin A	DNMT inhibition	[350]
	Daidzein	DNMT inhibition	[351]
	Equol	Demethylation of BRCAs	[352]
	Genistein	DNMT inhibition	[285, 306,307,308,309]
		Decreased MeCP2	[285]
		HDAC inhibition	[285, 306, 309]
		HAT activation	[311, 313]
		miRNAs modulation	[271, 318,319,320,321]
 Turmeric	Curcumin	DNMT inhibition	[285, 353, 484, 485]
		Decreased MeCP2	[285]
		HAT inhibition	[354]
		HDAC inhibition	[285, 355, 356]
		miRNAs modulation	[357, 486,487,488,489]
	Folate	One-carbon metabolism	[386, 490, 491]
		HMT regulation	[491]

Epigenetic diets and their properties in epigenetic regulation

	Vitamin C	DNA demethylation	[
		Histone demethylation	[
		Epigenome regulation	[
 Fish	Vitamin D	DNA methylation	[
		Histone modification	[
		Epigenome regulation	[
		miRNAs modulation	[
 Egg	Choline	DNA methylation	[
		Histone methylation	[
		miRNAs modulation	[
 Broccoli	Isothiocyanate	HDAC inhibition	[
	Sulforaphane	HDAC inhibition	[
		DNMT inhibition	[
		miRNAs modulation	[

Following Puncture and embryo transfer

- Don’t make any major or significant changes during this time, like going gluten-free if you weren’t already
- Maintain energy balance ….. Caloric restriction not beyond – 200 Kcal even in obese cases
- Gastrointestinal problems
- Drug nutrient interaction

Following Puncture and embryo transfer

IVF Diet : maintain the optimum balance of hormones

- Zinc
- Iron
- Mg
- k
- Healthy fats: olive oil, flaxseed oil, chia seed
- Protein rich food : non animal > animal sources .... Mediteranian Diet
- Fruits and veggies (yellow --- red, cruciferous)

- B vitamins including folic acid, VB6, and VB12, as well as amino acids, such as choline, methionine, and betaine, are classified as methyl donor nutrients as they all either directly or indirectly act as *S*-adenosylmethionine

BALANCE !!!

- Disproportionality of folate and VB12 during gestation leads to insulin resistance and obesity in the offspring

Article | Open Access | Published: 13 September 2007

Vitamin B_{12} and folate concentrations during pregnancy and insulin resistance in the offspring: the Pune Maternal Nutrition Study

Following Puncture and embryo transfer

- Mindful eating
- False believes
- Stress reduction ………….. Food phobia
- Appetite fluctuation

Weekly meal planning rather than general recommendation

- Balanced intake
- Quantity and intervals
- Best combination for mximum bioavailability and synergic effect
- Preparation techniques

Nutrition-Related Disruptions in Fertility

- Undernutrition
- Weight loss
- Obesity
- High exercise levels
- Intake of specific foods & food components

Undernutrition and Fertility

- Acute undernutrition
  - associated with a dramatic decline in fertility that recovers when food intake does
- Chronic undernutrition
  - primary effect: birth of small & frail infants with high likelihood of death in the first year of life

Body Fat and Fertility

- Decreased fertility seen with low or high body fat due to alterations in hormones
- Infertility lower with BMI <20 or >30

- Estrogen & leptin
  - levels increased with high body fat & reduced with low body fat
  - both extremes lower fertility

Weight Loss and Fertility in Females

- Weight loss >10-15% of usual weight decreases estrogen
- Results in amenorrhea, anovulatory cycles, & short or absent luteal phases
- Treatment with fertility drug Clomid not effective in underweight women

Diet and Fertility

- Diet impact hormones
- Vegetarian diets : low-fat, high fiber linked to reduced estrogen & irregular periods
- Isoflavones (from soy) decrease levels of gonadotropins, estrogen, & progesterone
- Excess caffeine & alcohol have been shown to be detrimental

Preconception Iron Status, Fertility & Pregnancy Outcome

- Rate of infertility lower in women who use iron supplements or iron from plant foods
- Pre-pregnancy iron deficiency linked to preterm delivery & low iron status of infant

Caffeine and Fertility

- Caffeine appears to prolong time to conception
- Daily caffeine intake & reduction in conception is:
  - 300 mg results in ~27% ↓
  - 500 mg results in ~50% ↓

Table 2.5 Caffeine content of foods and beverages

Foods and Beverages	Caffeine (mg)
Coffee, 1 c	
Drip	137–153
Percolated	97–125
Instant	61–70
Decaffeinated	0.5–4.0
Tea, 1 c	
Brewed 5 minutes	32–176
Instant	40–80
Soft Drinks, 12 oz	
Mountain Dew	54
Coca-Cola	46
Diet Coca-Cola	46
Dr. Pepper	40
Pepsi-Cola	38
Diet Pepsi-Cola	37
Ginger ale	0
7-Up	0
Chocolate Products	
Cocoa, chocolate milk, 1 c	10–17
Milk chocolate, 1 oz	1–15
Chocolate syrup, 2 tb	4

Nutritional Exposures Before and Very Early in Pregnancy that Disrupt Fetal Growth and Development

- ❖ Weight status
- ❖ Nutrient status
- ❖ Diabetes

Maternal Physiology

Changes in maternal body composition & functions occur in specific sequence

Table 4.5 Sequence of tissue development and approximate gestational week of maximal rates of change in maternal systems, the placenta, and fetus during pregnancy[7]

Tissue	Sequence of Development	Gestational Week of Maximal Rate of Growth
Maternal plasma volume	1	20
Maternal nutrient stores	2	20
Placental weight	3	31
Uterine blood flow	4	37
Fetal weight	5	37

Normal Physiological Changes during Pregnancy

- **Two phases of changes:**
- **Maternal anabolic changes (1-20 wk)**

  -Build mother's capacity to deliver nutrients to fetus

  -~10% of fetal growth occurs

- **Maternal catabolic changes (20-40 wk)**

  -Nutrients delivered to fetus

  -~90% of fetal growth occurs

Normal Physiological Changes during Pregnancy

Table 4.6 Summary of maternal anabolic and catabolic phases of pregnancy[8–10]

Maternal Anabolic Phase 0–20 Weeks	Maternal Catabolic Phase 20+ Weeks
Blood volume expansion, increased cardiac output	Mobilization of fat and nutrient stores
Buildup of fat, nutrient, and liver glycogen stores	Increased production and blood levels of glucose, triglycerides, and fatty acids; decreased liver glycogen stores
Growth of some maternal organs	Accelerated fasting metabolism
Increased appetite, food intake (positive caloric balance)	Increased appetite and food intake decline somewhat near term.
Decreased exercise tolerance	Increased exercise tolerance
Increased levels of anabolic hormones	Increased levels of catabolic hormones

Hormonal Changes
Key placental hormones and their roles


Table 4.8 Key placental hormones and examples of their roles in pregnancy[10,14]

Human chorionic gonadotropin (hCG)
Maintains early pregnancy by stimulating the corpus luteum to produce estrogen and progresterone. It stimulates growth of the endometrium. The placenta produces estrogen and progesterone after the first 2 months of pregnancy.

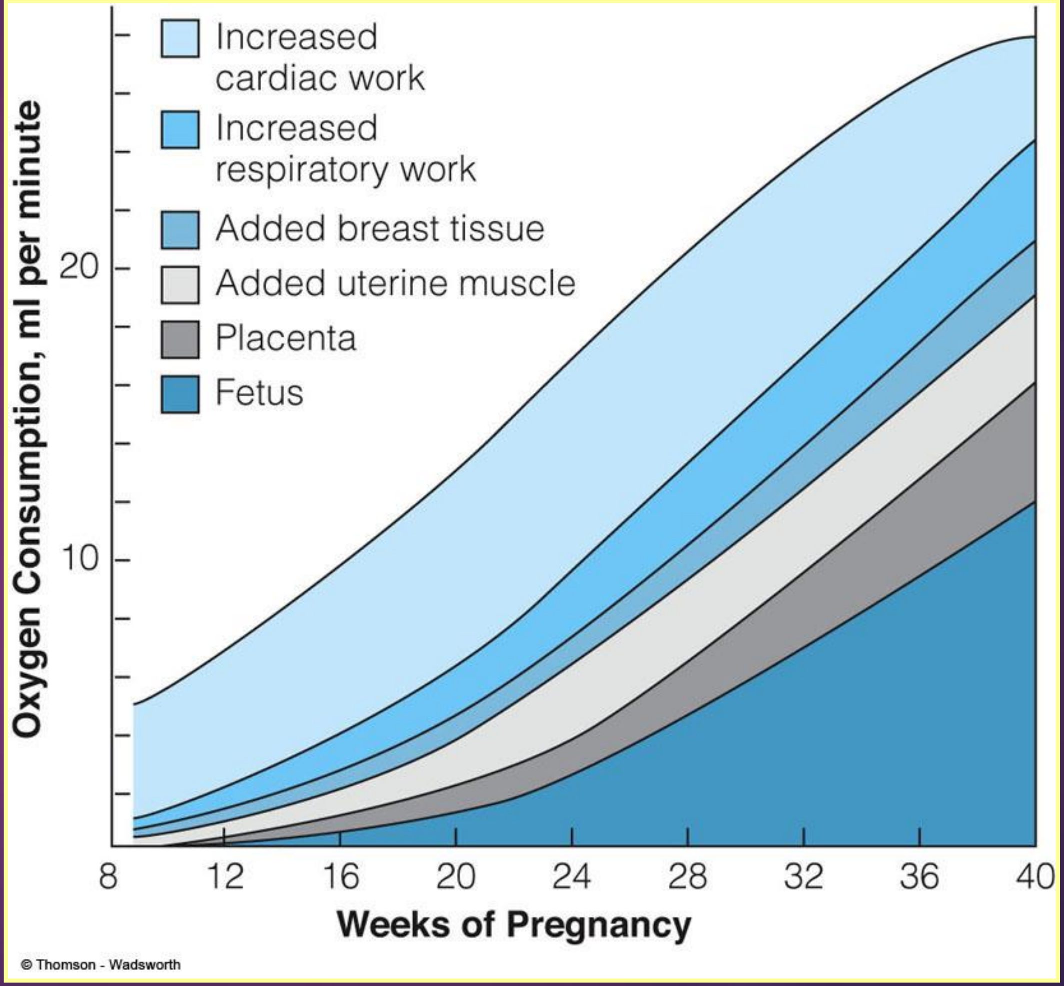
Progesterone
Maintains the implant; stimulates growth of the endometrium and its secretion of nutrients; relaxes smooth muscles of the uterine blood vessels and gastrointestinal tract; stimulates breast development, promotes lipid deposition.

Estrogen
Increases lipid formation and storage, protein synthesis, and uterine blood flow; prompts uterine and breast duct development; promotes ligament flexibility.

Human chorionic somatotropin (hCS)
Increases maternal insulin resistance to maintain glucose availability for fetal use; promotes protein synthesis and the breakdown of fat for energy for maternal use.

Leptin
May participate in the regulation of appetite and lipid metabolism, weight gain, and utilization of fat stores.

Components of Increased Oxygen Consumption in Normal Pregnancy



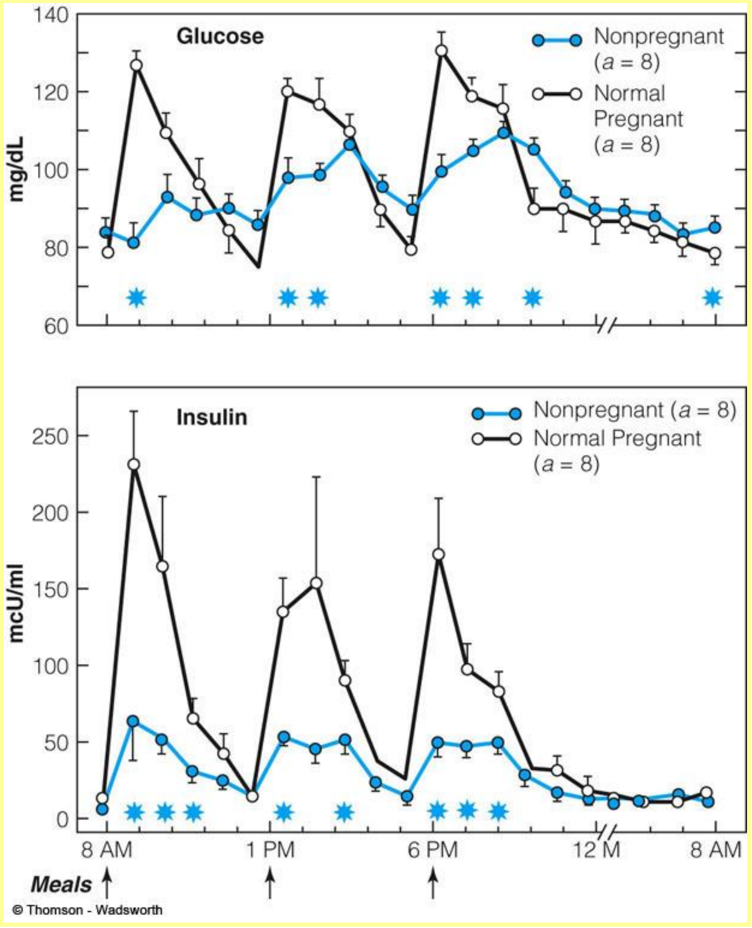
Maternal Nutrient Metabolism

- Pregnancy: A Pro-Oxidative State
- Increased oxidation & free radical formation results from:
  - Increased energy production in mitochondria
  - Insulin resistance, diabetes, preeclampsia, obesity & infections
  - Excess iron supplementation

Carbohydrate Metabolism

- Glucose is preferred fuel for fetus
- “Diabetogenic effect of pregnancy” results from maternal insulin resistance
- Early pregnancy: High estrogen & progesterone stimulate insulin which increases glucose→ glycogen & fat
- Late pregnancy: hCS & prolactin inhibit conversion of glucose to glycogen & fat

Plasma Glucose and Insulin Levels in Nonpregnant Women and in Women Near Term



Protein Metabolism

- About 925 g of protein accumulate during pregnancy
- Protein & amino acids conserved during pregnancy

Maternal protein restriction in pregnancy

- Higher blood pressure
- Impaired glucose tolerance
- Insulin resistance
- Altered hepatic architecture & function in the adult offspring.

Offspring of protein- or energy-restriction display preferences for High-fat foods.

Fat Metabolism

- Fat stores accumulate in first half of pregnancy with enhanced fat mobilization in last half
- Blood lipid levels increase dramatically
- Increased cholesterol is substrate for steroid hormone synthesis

In utero programming

- A maternal high fat diet during pregnancy increases bone marrow adiposity and alters bone structure in their offspring.
- Female offspring from high-fat dams exhibited altered Trabecular structure.

Micronutrient status

Fetal and early life

alter metabolism,

vasculature,

organ growth & function.

Increased risk of cardio metabolic disorders, adiposity, Altered kidney function, Type II diabetes and cardiovascular diseases.

Mineral Metabolism

- **Calcium**
  - increased bone turnover
- **Sodium**
  - accumulation in mother, placenta, & fetus
  - restriction of sodium potentially harmful

Protein	16g
Fiber	NA
Calcium	800 mg
Iron	10 mg
Vitamin A	2500 IU
Vitamin C	40 mg
Vitamin D	400 IU

Folate and choline are nutrients that alter development .

Methyl donors like folate & B12 play a pivotal role in epigenetic changes. (Hepato Glucocorticol,PPAR gene methylation)

The Placenta

- Nutrient Transfer
  - Small molecules pass through most easily
  - Large molecules aren’t transferred at all
- The fetus is not a parasite
  - Nutrients first used for maternal needs, then for placenta & last for fetal needed

Variation in Fetal Growth

- Variations linked to:
  - Energy, nutrient, & oxygen availability
  - Genetically programmed growth & development
- Insulin-like growth factor (IGF-1) is main fetal growth stimulator

Table 4.16 Pregnancy weight gain recommendations[32]

Prepregnancy Weight Status Body Mass Index[a]	Recommended Weight Gain
Underweight, <18.5 kg/m^2	28–40 lb (12.7–18.2 kg)
Normal weight, 18.5–24.9 kg/m^2	25–35 lb (11.4–15.9 kg)
Overweight, 25–29.9 kg/m^2	15–25 lb (6.8–11.4 kg)
Obese, 30 kg/m^2 or higher	15 lb (6.8 kg) at least
Twin pregnancy	35–45 lb (15.9–20.5 kg)

[a]Body Mass Index categories modified based on 1997 changes from the National Institutes of Health. Young adolescents should achieve gains at the upper end of ranges, and short women at the lower end.

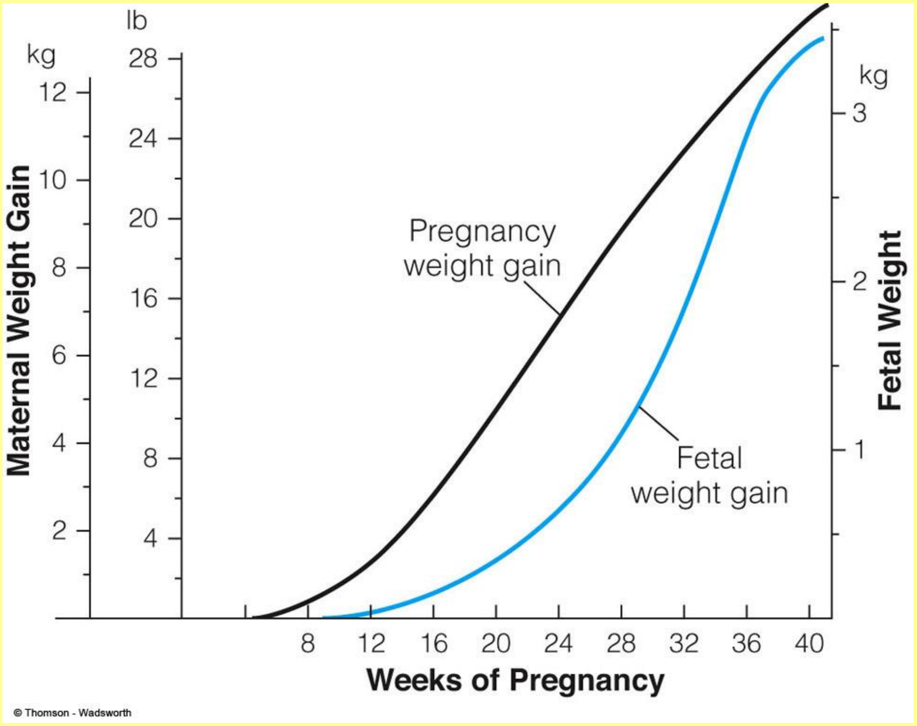
Composition of Weight Gain

Table 4.17 Components of weight gain during pregnancy for healthy, normal-weight women delivering a 3500-g (about 8 lb) infant at term[7,9,10,30]

	Weight Gain, grams			
Component	10 Weeks	20 Weeks	30 Weeks	40 Weeks
Fetus	5	300	1500	3550
Placenta	20	170	430	670
Uterus	140	320	600	1120
Amniotic fluid	30	350	750	896
Breasts	45	180	360	448
Blood supply	100	600	1300	1344
Extracellular fluid	0	265	803	3200
Maternal fat stores	315	2135	3640	3500

Total weight gain at term = 14.7 kg or 32 lb

Rate of Pregnancy Weight Gain



Prenatal Weight-gain Graph

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ابزارهای رژیم

منحنی های رشد

وزنگیری بارداری

- نمودار بارداری با وزن طبیعی تک قلو
- نمودار بارداری با وزن طبیعی دو قلو
- نمودار بارداری با اضافه وزن تک قلو
- نمودار بارداری با اضافه وزن دو قلو
- نمودار بارداری با چاقی تک قلو
- نمودار بارداری با چاقی دو قلو
- نمودار بارداری با کمبود وزن تک قلو
- نمودار بارداری با کمبود وزن دو قلو

Key Terms

- Trimester – 1/3 of the normal duration of pregnancy
- Recommended weight gain by trimester

Trimester	Weight Gain
1st = 0-13 weeks	1-2 kg
2nd = 14-26 weeks	450 gr per week
3rd = 27-40 weeks	450 g per week

Weight Gain Assessment

Sara is 33 weeks pregnant and has gained 13 kg thus far. Prior to becoming pregnant, her BMI was 22.

What is your assessment? Has she gained adequate or excess weight?

What is your recommendation?

Postpartum Weight Retention

- Much concern over pregnancy weight gain and long-term obesity
  - ~7 kg lost at delivery
  - Wt loss difficult in women who gained >20 kg or with low activity levels
  - Women with recommended wt gain in pregnancy are ~ 1 kg heavier at 1 yr postpartum
  - Lactating women lose slightly more


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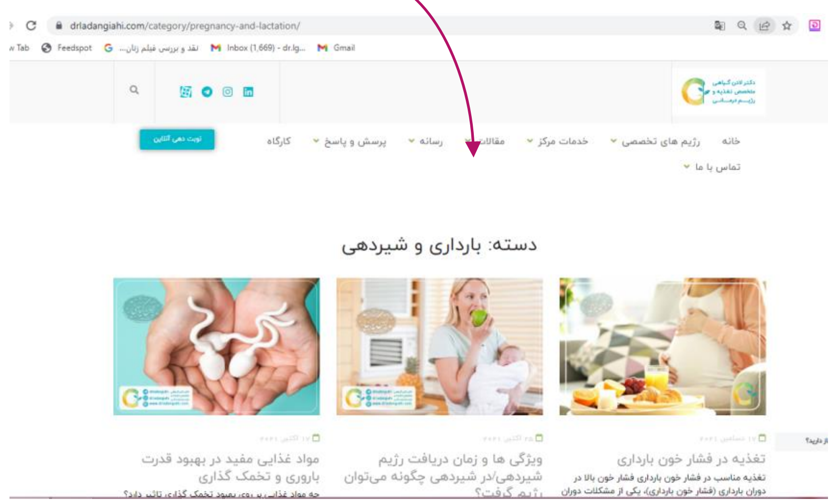
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مواد غذایی مفید در بهبود قدرت باروری و تخمک گذاری

Thanks For Your Attention

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