Translational Immunology in Oncology: From Mechanisms to Clinical Outcomes

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ABSTRACT

Introduction: Fundamental knowledge from tumor immunology, including tumor antigenicity, mechanisms of immune evasion, and the tumor microenvironment, is informing the clinical development of immunotherapy strategies.

Methodology: Databases searched include Scopus, PubMed, Embase, Web of Science.

Foundations of Tumor Immunology: Tumors develop via mutagenesis, and mutations may lead to alterations in coding and non-coding sequences, eventually producing neoantigens that can trigger T-cell recognition.

Mechanisms Linking Immunology to Therapeutic Outcomes: Immunoediting, a process viewed as an adaptation driven equally by the immune system and tumor, leads to tumor heterogeneity. The establishment of preclinical models that adequately recapitulate the interplay between the immune system, the tumor, and the therapeutic options employed.

Translational Approaches in Oncology: Translational approaches encompass biomarker discovery, patient stratification, preclinical modelling, and clinical trial design. Successful translation of preclinical observations into routinely used clinical applications depends on data demonstrating a clear association between the putative biomarker and the desired patient benefit.

Clinical Outcomes of Immuno-Oncology Therapies: Immuno-oncology therapy has created a paradigm shift in the treatment of some advanced-stage cancers and, in certain situations, has become the standard of care. Checkpoint blockade agents can produce long-lasting responses in a subset of patients.

Challenges and Future Directions: Immune evasion appears as an important mechanism for resisting immune-mediated therapies.

Conclusion: Translational immunology seeks to integrate mechanistic knowledge of antitumor immunity with clinical outcomes following therapeutic intervention in cancer patients. Biomedical research is often divided into basic vs applied domains, but translational work crosses freely between both. Translational immunology aims to pave the way for basic to bidirectional exploration around antitumor immunity and therapy.

Key words; Immunology, Oncology, Cancer Immunotherapy.

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INTRODUCTION

Translational immunology contributes to understanding the relationship between antitumor immunity and therapeutic outcomes (1). Fundamental knowledge from tumor immunology, including tumor antigenicity, mechanisms of immune evasion, and the tumor microenvironment, is informing the clinical development of immunotherapy strategies. Tumors expressing diverse neoantigen and established tumor-specific shared antigens, such as mutated onco-viruses, mutant p53, or mutated protein kinases, remain targets of persistent immune responses. Immune recognition of such antigens is influenced by tumor-intrinsic properties, including mutation burden, antigen processing and presentation, T cell receptor (TCR) repertoire diversity, major histocompatibility complex (MHC; also known as human leukocyte antigen [HLA]) diversity, and interferon-gamma (IFN) signaling. Factors extrinsic to the tumor, including biomolecules produced by intratumoral CD8+ T cells, can modulate the expression of immune checkpoints or neoantigen-processing machinery genes. Immune checkpoints (e.g., PD-1/PD-L1, CTLA-4), T cell effector functions, the innate immune microenvironment (e.g., natural killer [NK] cells, macrophages), the gut microbiome, and tumor cell metabolism have all been implicated in the control of immunotherapy response (2). These factors constitute candidate biomarkers to identify patients likely to benefit from immuno-oncological (I-O) therapies and to guide treatment regimens (3, 4, 5, 6, 7, 8, 10, and 11).

METHODOLOGY

Databases searched include Scopus, PubMed, Embase, and Web of Science.

Inclusion and exclusion criteria: included for all peer-reviewed original research articles, clinical trials (phase I–III), meta-analyses, and high-quality narrative/systematic reviews. Exclude conference abstracts, editorials, or non-peer-reviewed sources unless they provide unique insights and studies not focused on cancer immunotherapy.

FOUNDATIONS OF TUMOR IMMUNOLOGY

The successful introduction of immune-based therapies to address an unmet need in cancer treatment has spurred renewed interest in classic principles of tumor immunology put forward by Burnet & Williams (1974) and again emphasized by Dunn et al (12). Translational approaches are now being pursued to link the immune system to treatment response, resistance, and clinical outcomes (13, 14, 15, 16, 17, 18, 19 and 20).

The immune system recognizes tumors via antigens, a term coined by Paul Ehrlich in 1909. Antigens stimulate the immune system and elicit adaptive immune responses (innate immunity represents the first barrier and consists of a diverse array of cells) (21). Tumor antigens can be categorized into two groups: shared and neoantigens. Shared antigens are expressed by tumor cells and healthy tissues, the latter at low levels in the case of oncofetal or tissue-specific antigens. Proteins expressed only by tumor cells, however, are of particular interest and these correspond to mutated proteins, which range from 5 to 60 per tumor, depending on tumor type and mutagen exposure (22). Beyond mutations, tumor-specific antigens can also arise as a consequence of abnormal splicing, gene fusions, or the expression of viral proteins due to infection. Neoantigens have been examined in preclinical studies, and translation into the clinic is actively pursued (23, 24, 25, 26, 27, and 28).

Although tumors can be effectively recognized, they can also evade recognition. Tumor-inflamed tissues feature immunogenic tumor cells, a competent antigen-presenting machinery, a diverse repertoire of neo- and shared antigens, and a pro-inflammatory cytokine milieu. Despite this, T cell infiltration remains shallow due to molecules that inhibit T-cell activation or promote T-cell apoptosis. Intermediate stages of tumor evolution yield variable recognition, lying beyond the pole of complete unrecognition but below that of complete tolerance, a process known as immunoediting (29, 30, 31, 32, 33, 34, 35, and 36).

3.1. Tumor Antigens and Immune Recognition

Microbial dysbiosis can promote resistance to immunotherapy, highlighting the microbiome's regulatory role during cancer. Metabolic checkpoints, such as IDO, arginase, and lactate accumulation, inhibit effector T cells

and correlate with therapy resistance. Tumor-infiltrating species vary across cancers, and specific microbial signatures associate with tumor mutation burden and response to immune checkpoint blockade (37, 38, 39, 40, 41, 42, 43, and 44)

Tumor antigens are crucial for immune recognition and an inciting signal for adaptive immunity in cancer. The origin of tumor antigens differs substantially from that of antigens produced by pathogens. Tumor neoantigens arise from mutations uniquely present in tumor cells, while shared antigens are encoded by unmutated genomic sequences and originate from ectopic gene expression, modification of canonical transcripts, or aberrant splicing (45, 46, and 47). Cancer/testis antigens are the most comprehensively characterized cancer-associated antigens; these antigens are not expressed in normal differentiated tissues outside the testis and are associated with T-cell–mediated immune responses. They have been extensively studied as vaccine antigens. Tumor antigens originating from intronic sequences or via cryptic splicing have also been described; these antigens can be targeted by T cells. Immunoediting shapes and molds the malignant phenotype during tumor evolution, including loss of or mutation in genes encoding tumor antigens (48, 49, 50, 51).

3.2. Immune Suppression in the Tumor Microenvironment

The tumor microenvironment (TME) recruits diverse immunosuppressive cell types and alters the local cytokine milieu to blunt antitumor responses through multiple mechanisms. Myeloid-derived suppressor cells (MDSCs), regulatory T cells (Tregs), and tumor-associated macrophages (TAMs) infiltrate various human tumors (52). TGF-β produced by Tregs and MDSCs, along with IL-10 released by Tregs and TAMs, dampens effector T-cell expansion and functional activity. A prominent T-cell checkpoint is also expressed by Tregs, while MDSCs inhibit T-cell activation via different pathways. Tumor-secreted factors increase Treg influx and MDSC production in the bone marrow, which promote unresponsiveness and tolerance in tumor-draining lymph nodes. Other properties of the TME, including acidity, nutrient scarcity, and adenosine accumulation, further impair T-cell activation (53, 54, and 55). The resultant residual immune activation underlies the poor efficacy of standalone immune checkpoint inhibitors or costimulation-based therapies in most indications. Additional characterization genes, signatures enriched in pre-infiltrated tumor specimens, temporal dynamics, and flow cytometry translatability toward circulating counterparts could enhance the extensive immune landscape. A comprehensive atlas spanning cell types, granular surface markers, and immune regulatory interactions in preclinical models of solid tumors is pivotal to decipher the dynamics of immune component remodeling elicited by therapeutics, benchmark cross-modulatory responses interplaying between innate and adaptive modalities, pinpointing standardized signatures for an early readout of triggering events and ultimately steering translational insights to human oncology (56, 57, 58, and 59).

3.3. Immune Editing and Tumor Evolution

Tumors develop via mutagenesis, and mutations may lead to alterations in coding and non-coding sequences, eventually producing neoantigens that can trigger T-cell recognition. Such antigens are exclusively unique to the tumor, contrasting with shared neoantigens, which include mutated antigens formed by missense mutations, fusion antigens generated from chromosomal rearrangement, and viral antigens resulting from integrated viral DNA into the host genome—antigens present not only on cancer cells but also on normal cells in the organism (60, 61, 62, and 63). Tumor cells expressing elevated and/or aberrant levels of associated antigens may elicit immune recognition. Additional immunogenicity evinced by “strongest allergopeptide” criteria confers greater susceptibility to immune surveillance (64, 65, 66, 67, and 68).

Tumor cells may escape from immune recognition through several mechanisms: a decrease in the major histocompatibility complex (MHC) class I expression level, or mutations and loss of the MHC (II) locus; a drop in co-stimulatory molecules, such as B7 family proteins; an up-regulation of coinhibitory ligands, such as programmed death ligand-1 (PD-L1) on tumor cells; and alterations that eliminate or drastically reduce the expression of the antigenic protein. Such diverse escape strategies may induce and drive heterogeneous tactics for tumor evolution. Immune editing that ultimately bypasses or fails tumor immune-evasion determines clonal proliferation and represents escape mechanisms toward high-frequency passenger mutations and/or low-frequency driver mutations, analogous to broad resistance (69, 70, and 71). Consequently, activation of the

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anticancer immune system and elimination of tumor cells by immune checkpoint blockade enable further release-deletion-acquisition dynamics and may consequently accelerate clonal evolution (72, 73, 74, and 75).

MECHANISMS LINKING IMMUNOLOGY TO THERAPEUTIC OUTCOMES

The investigation of biomarkers capable of predicting therapeutic efficacy is crucial. In preclinical studies and analyses of biological samples from clinical trials, distinct molecular signatures associated with the response to regimens such as anti-PD-1, anti-PD-L1, anti-CTLA-4, and oncolytic viruses have been identified (76, 77, and 78). Immune checkpoint inhibitors represent the most successful category of immuno-oncology therapies to date, having demonstrated efficacy across various malignancies and treatment lines. Nevertheless, only a minority of patients exhibit an objective response, and in some indications, a significant proportion of responders later relapse, either acquiring new resistance mechanisms or reverting to pre-existing ones. These critical clinical issues underscore the importance of characterizing both incremental and acquired resistance mechanisms and synergistic combinations capable of overcoming them (79, 80, 81, 82, 83, and 84)

Immunoediting, a process viewed as an adaptation driven equally by the immune system and tumor, leads to tumor heterogeneity. The establishment of preclinical models that adequately recapitulate the interplay between the immune system, the tumor, and the therapeutic options employed, however, remains a daunting challenge in translational cancer immunology (85, 86). Approximately five oncoimmunology therapies have been found capable of mediating a cure in a wide range of human tumors, attesting to the possibility of immunological rejection despite tumor heterogeneity. Thus, three hallmark questions in oncoimmunology clinical trials inquiry continue to arise: what mechanisms govern escape from the immune system after the initial therapeutic success achieved by anti-PD-L1, oncolytic viruses, or other agents? Which therapeutic interventions can re-enable the immune system to promote tumor regression? Which biomarkers would permit early identification of patients able to reject the tumor after therapeutic administration of a given agent? (87, 88, 89, and 90)

4.1. Immune Checkpoints and Receptor-Ligand Dynamics

The global-oncology community is fully aware that tumor-associated immunogenicity is critical to the success of immunotherapy. Accumulating data from the literature and from clinical practice support the view that tumor immunogenicity comprises two distinct components: immune checkpoint and T cell effector function. Two prominent immune checkpoint pathways, PD-1/PD-L1 and CTLA-4, play key roles in shaping the degree of antitumor immunity and have been particularly useful in the clinic in stratifying cancer patients according to the likelihood of receiving meaningful clinical benefit from monotherapy with checkpoint-blocking agents (91, 92, 93, 94, 95 and 96). The presence of specific T cell effector functions further augments the ability of the immune system to reject tumors. The markers of such effector functions that have been most widely examined in preclinical and clinical studies are the cytotoxic molecules granzyme B and perforin, the T cell cytokines IFN-ı, TNF-α, and IL-2, and the progressively expressed markers of T cell exhaustion (97, 98, 99, 100, and 101)

4.2. Effector Functions of T Cells in Tumor Rejection

The importance of T cells in immuno-oncology has long been recognized, yet simple enumeration or characterization of specific T-cell populations can be misleading. An extensive literature documents the critical role of effector functions in antitumor activity, and studies of cancer models with transgenic TCRs or fluorescent reporters indicate strong correlations between overall effector function and tumor rejection (102, 103 and 104). Immune checkpoint blockade boosts TCL numbers, yet insufficient effector function remains an obstacle to full therapeutic efficacy across many cancers. A large body of work documents T-cell exhaustion and dysfunctional CD8 T-cell states. T cells from tumors or peripheral tissues exhibit various exhaustion markers. Surprisingly, analysis of both mouse and human tumors shows upregulation of select surface receptors among tumor-specific CD4 and CD8 T cells without a concurrent rise in common exhaustion markers (105). The degree of effector activity defines the T-cell fate and postulates a novel dependency of TIL maturation on local intratumor conditions. These findings suggest that immune therapy could benefit from a

deeper understanding of TIL-effector characterization, beyond broad definitions of "exhaustion." (106, 107, 108, and 109)

Recent studies have proposed the notion of T-loops operating within the tumor microenvironment and transferred TCR-transgenic CD8 T-cell fate as immune checkpoints modulating tumor protection following tumor-specific vaccination. Here, work establishing a robust framework for monitoring T-cell activity and intratumoral localization addresses critical aspects of immunotherapy response correlates, notably the specification of TIL functionality. CD8 TIL populations characterized as naïve to effector prime or polarize toward diverse T-effector subtypes pervade diverse tumor types both during spontaneous development and after immunotherapeutic intervention. Direct tumor eradication in some systems requires either the full complement of T-effector subsets or, in other contexts; regulation still unfolds T-cell protection without direct targeting (110, 111 and 112). Tumor engraftment enhances the induction of multiple effector type CD8 TCR-T-cell transgenic and Polyfunctionality remains operative even during chronic antigen stimulation. Transferred T-cell activity remains severely curtailed by diverse TGF-β-related mechanisms, indicating a persisting TGF-β-fueled polarization evident in preclinical models of checkpoint therapy. The characterization framework meets extensive evidentiary support in favor of earlier immune-intervention administration and stimulates T-cell protection concepts during extended T-cell retention therapy, with broader implications for combinatorial therapeutic strategies (113, 114, 115 and 116)

4.3. Innate Immunity and Antitumor Inflammation

Tumors co-opt immune mechanisms to thrive, starting from early stages. Yet, while inflammation can drive early immunoediting, chronic inflammatory cues can trigger pro-tumoral polarization of macrophages and myeloid-derived suppressor cells (MDSCs) that facilitate tumor growth (117, 118, 119, and 120). Accelerated tumor growth can be tracked in preclinical settings, where inhibitory antibodies against checkpoint molecules become less effective. During this pro-tumor phase, Type2 inflammation (the hallmark of allergies) causes immune changes, including new T cell clones and CTLA-4 upregulation (121, 122, and 123). Pro-state myeloid cells have distinct ontogenies and recipients of specific signals as lessons learned in the ongoing design of clinical trials (124, 125, and 126).

4.4. Microbiome, Metabolism, and Immunotherapy Response

Immunotherapy leverages the ability of the immune system to induce an efficient removal of tumors; yet, only a subset of patients benefits from this treatment. Different tumor types have shown distinct responses to immunotherapy; in melanoma, for instance, some antigens involved in the recognition of tumor neoepitopes acquired mutations in responders, suggesting a change in the parameters regulating the immune-tumor dynamics and the immune-checkpoint blockade mechanisms (127, 128, and 129). The composition of the microbiome affects multiple aspects related to the immune system, directly influencing antitumor immunity and impacting the general metabolic state of the hosts. Indeed, components of the microbiome can directly modulate the tumor microenvironment through the production of metabolites or other signaling molecules that commute between resident immune cells or reach distinct distant tissues and organs; microbiota-derived metabolites influence important immunotherapeutic responsiveness parameters; some of these metabolites have been shown to be positively correlated to immune-checkpoint blockade responses or responsiveness to anti-CD20 treatment while others are responsible for restoring anti-tumor T-cell immunity (130, 131). Furthermore, even the entire microbiome composition has been shown to directly impact immune-checkpoint blockade therapy responsiveness (132, 133, and 134).

TRANSLATIONAL APPROACHES IN ONCOLOGY

Translational approaches encompass biomarker discovery, patient stratification, preclinical modelling, and clinical trial design. Successful translation of preclinical observations into routinely used clinical applications depends on data demonstrating a clear association between the putative biomarker and the desired patient benefit, taking into consideration analytical, clinical, and regulatory perspectives (135, 136, and 137). The paralogous MET and RON receptor tyrosine kinases have been investigated extensively as potential drivers of metaphyseal prostate cancer in both preclinical and clinical studies. Both MET and RON have been targeted

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therapeutically in animal models, notably via bispecific antibodies, with evidence of enduring activity. Several studies have then sought to evaluate the clinical relevance of MET and/or RON in human metastatic prostatic disease, but the findings remain inconclusive. Integration of biomarker discovery and therapeutic development along with incorporation of robust patient stratification into clinical trials provides a paradigm for preclinical exploration of therapeutically tractable targets (138, 139, 140, 141, and 142)

5.1. Biomarker Discovery and Validation

Biomarkers are used in oncology to identify the biological characteristics of a patient's cancer for which targeted drugs or specific therapies may be available. Criteria have been developed for cancer biomarkers, which are based on the complexity of human tumor biology (143, 144, and 145). These criteria, summarized according to the tumor-somatic mutation–analyzing pipelines, are expected to contribute to the sensible use of biomarkers in drug discovery and trial design. Moreover, molecular profiling studies, which are currently being widely pursued both within and outside the field of oncology, largely use a set of biological material references (146, 147, and 148). Such guidelines, aimed at the standardization of biosamples and concomitant animal, biological, and storage profiling, are essential for the rapid detection of the effective use of therapy and of the identification of biomarkers against any set of targeted drugs (149, 150, and 151)

Biomarkers have been found to predict the response of tumors to several cancer-attributable infections when the measures of outer populations influence cell growth. The cell-growing capability typically is itself exceeded by intracellular deformations, and indicators have been assembled that may correlate cells' risks of arrangement with outside multi-competitive sources. Therefore, an accurate description of cellular capability may even go against single tagging by tumor markers from different disturbing scenarios (152, 153, 154 and 155).A certain type of models, called universality models, well known in either communication or bioengineering, is therefore considered to analyse cell-change–alluring information on multi-cells for either long- or short-term sample-studying is massively-shortened. A large set of widely-used biomedical approaches indeed strongly sticks on one cell/one tagging or separate-tagging protocols for the detection of cancer (156, 157, 158, 159, and 160).

5.2. Patient Stratification and Companion Diagnostics

Immunotherapies targeting immune checkpoint receptors like CTLA-4, PD-1, and LAG-3 have revolutionized the treatment of certain cancers; however, long-term response rates remain low. Some tumours possess intrinsic features—a phenotype, genotype, or a set of regulatory mechanisms—that strongly predict nonresponse. Identifying and measuring these predictors in the patient population before treatment enables rational patient stratification for clinical trials (161, 162, 163, 164 and 165). Predictive markers can therefore be defined as factors whose presence (or absence) indicates a significantly greater (or lesser) chance of a pre-specified pharmacological effect occurring in a group of patients. Their use allows the design of ultra-permitted first-in-human trials in which the likelihood of systemic pharmacological activity is significantly maximized and uninterpretable safety events avoided (166, 167, 168, and 169)

As tumours evolve during disease progression under therapeutic pressure, such trial designs are possible for either de novo or acquired resistance mechanisms without prior knowledge of the genetic factor(s) involved. Predictive markers for nonresponse are of two major types: bona fide predictive markers for immune checkpoint blockers (cantreat markers such as IDO1 or PTEN) and generic drug-associated factors (unrelated to the pharmacology of the product under study) that pertain to multikine combinatorial regimens (170, 171, 172, 173, 174, 175, 176, 177, 178, and 179)

Use of companion diagnostic tests measuring bona fide predictive markers to calibrate patient access to next-generation immunotherapies and avoid erroneous rejection decisions is also being integrated. Lastly, therapeutic MRI systems responding to genomic and cellular conformational changes or to plaque-inducing treatments represent possible modifications of existing therapeutic approaches that, while still in laboratory development, offer promise for a non-companion-diagnostic approach to surveillance in standard-of-care treatment (180, 181, 182, 183, 184, 185, 186, 187, and 188)

5.3. Preclinical Models and Their Predictive Value

The success of investigational therapies depends on preclinical studies that reliably recapitulate clinical outcomes. Immune-oncology agents have nonetheless made their way into clinical trials without a thorough preclinical assessment of safety and efficacy. Preclinical models thus represent an attractive opportunity for the field of translational cancer immunology (189, 190, and 191). In vitro systems permit dissection of specific mechanistic aspects, but nonclinical animal models remain essential for prediction of safety and efficacy. Murine models remain the most widely used, though humanized models are becoming increasingly valuable for immuno-oncology agents. Capturing the substantial interpatient variability is another important consideration in preclinical studies (192, 193).

5.4. From Bench to Bedside: Clinical Trial Design

Research and development in the field of immuno-oncology have been growing rapidly, uncovering critical biological mechanisms governing the efficacy and safety of these therapies and at the same time opening the door for new treatments. An essential area of translational immunology in oncology aims to create clinical trial designs capable of incorporating biological/biochemical parameters in multiple timeframes without compromising trial integrity, patient safety, operational aspects, or resource utilization. While new agents are developed, earlier phases may employ a biomarker-embedded design to pair maximal biologically active doses with standard endpoints in exploratory large-cohort trials (194, 195 196, 197 and 198). Late stage studies would benefit from designs flexibly accommodating bench-to-bedside dimensions, and from tools elaborating links between biologic effects and clinical endpoints or framework-based adaptive strategies, especially when information is gathered from outside the trial (199, 200, 201, 202, 203, 204, and 205)

CLINICAL OUTCOMES OF IMMUNO-ONCOLOGY THERAPIES

Immuno-oncology therapy has created a paradigm shift in the treatment of some advanced-stage cancers and, in certain situations, has become the standard of care. Checkpoint blockade agents can produce long-lasting responses in a subset of patients, but response rates as monotherapies in the general population remain modestly effective at best. The immunological microenvironment of a patient's tumor has emerged as a critical factor influencing treatment outcomes; the so-called "immunoscore" signature has been shown to be prognostic for outcomes in several malignancies, including melanoma and colorectal cancer (206, 207, and 208). Tumors can generally be classified as “hot,” with robust pre-existing tumor-infiltrating CD8+ T cells and NK cells; “cold,” with scarce or no T cell infiltration, or “immunosuppressive,” with elevated proportions of suppressive myeloid cells. Greater tumor infiltration with CD8+ T cells correlates with clinical responses across different types of immune checkpoint inhibitors. In non-small cell lung cancer patients undergoing PD-L1-targeting therapy, high tumor IFNγ mRNA and PD-L1 protein expression are associated with positive treatment outcome. The strategic incorporation of complementary biomarkers, including tumor mutational burden, tumor microenvironment characteristics, and alterations in host immune system accessibility, has the potential to improve pre-therapeutic prediction of response to various immuno-oncology modalities and combination strategies (209, 210, and 211)

The landscape of early phase oncology trials is evolving with the emergence of novel immune-therapies that possess the potential to drastically improve the rate and efficiency of drug development globally. Although traditional definitions referring to dose-limiting toxicity and maximum tolerated dose remain valid, a key feature of the majority of immuno-oncology trials is that the recommended phase II dose is often based on the maximum administered dose or supporting pharmacokinetic data rather than the conventional consideration of toxicity (212, 213, 214, 215, and 216. Furthermore, enrollment at the end of phase I trials frequently incorporates expansion cohorts that have expanded from original size ranges of 10–15 to upwards of 1000 patients in a proportion of cases. Accordingly, early phase programs increasingly benefit from integration within subspecialty clinics attuned to the management of the distinctive toxicities associated with such treatments. The possibility of dramatic responses in the first-in-human setting also challenges the traditional consecutive phase I/II/III approach, further complicating development pathways due to the introduction of additional combinations and different models of immune response (217, 218, 219, 220, and 221)

Emerging immunotherapeutic developments across a broad spectrum of cancer types have increased the collective hopes of the scientific community to enhance treatment responses. A growing number of patients appear to benefit from single-agent or combination immunotherapy regimens; however, the vast majority of patients have yet to achieve any measurable clinical gain (222, 223,224, and 225). Many of the currently available immunotherapies exhibit appreciable toxicity profiles, and serious adverse effects and complications remain common. Consensus is beginning to form around the need to design novel immunotherapies that are carefully tailored to patients' genetic characteristics and to prioritize the selection of individuals most likely to experience deep, durable therapeutic responses (226, 227, 228, and 229)

6.1. Checkpoint Inhibitors: Efficacy Across Cancers

Immune checkpoint inhibitors have transformed the treatment of advanced malignancies by leveraging the host's immune system against the tumor (230, 231, and 232). In 2011, the anti-CTLA-4 antibody ipilimumab showed durable antitumor activity in metastatic melanoma, leading to the first FDA approval for an immune checkpoint inhibitor. The approval of a PD-1 or PD-L1–targeted agent followed in 2015, with subsequent expansion to several tumor types (233, 234, 235, and 236). Landmark studies with these agents have demonstrated substantial growth in overall survival across solid tumor types, and durable treatment responses lasting beyond the cessation of therapy can occur in over one-third of patients. (237, 238, 239, 240, and 241)

Surprisingly, the percentage of patients responding to immune checkpoint blockade in different tumor types is similar at even the first clinical steps. Current models and studies suggest that antifungal immunity, recognition of virus-induced tumor, and other mechanisms by the innate immune system plus biological phenomena in Cancer Hallmarks may serve as linking mechanisms for about 9 cancers, including breast cancer, prostate cancer and even acute leukaemia. The immune system collectively constructs a complex system. Without innate immune systems, other type of immune systems such as adaptive immunity will be severely affected. Understanding these mechanisms that help link solid tumor cases with elicited immune checkpoint inhibitors plus added on mechanisms in the form of temporal ordering may open many further cancers to pursue immunotherapy options (242, 243, 244, 245, and 246).

6.2. Adoptive Cell Therapies and Cellular Engineering

Adoptive cell therapy mobilizes and expands anti-tumor lymphocytes ex vivo for intravenous reinfusion. Depending on the provenance and engineering of these cells, the specificity of the anti-tumor activity can be pre-defined or adjusted to suit a patient's tumor burden. Products of this therapy include TCR-engineered T cell therapies targeting shared and mutated antigens and engineered CAR T cells targeting associated ligands. Either method exposes the cells to a high-dose anti-PD-1 antibody prior to infusion to enhance reinvigoration (247, 248, 249, 250, 251, 252, 253, 254 and 255)

Unlike CARs, T cell therapy relies on TCR specificity for the selection of the targeted tumor. The attention given to these innovative strategies has often eclipsed the substantial advances achieved with traditional CAR T cells, especially in patients with hematologic cancers, where case removal of malignant cells was established over a decade ago (256, 257 and 258). The community has therefore begun emphasizing enhancements to identify and attack tumor cells effectively in hematologic cancer and solid tumors. (259, 260, 261, 262 and 263)

6.3. Cancer Vaccines and Oncolytic Virotherapy

Proteins derived from mutated DNA sequence, termed neoantigens, may constitute a major class of T-cell-stimulating antigens found in human and murine tumors (264, 265, and 266). Tumor-associated antigens, derived from normal cellular genes overexpressed in tumors, or from viral proteins expressed only in tumor cells, can also elicit T-cell-mediated protective immune responses (267, 268, and 269). Cancer vaccines provide in principle an attractive therapy directed at neoantigens, which may be individualized. Unfortunately, with currently available platforms, identification of neoantigen candidates requires extensive characterization of each tumor. Oncolytic viruses such as vaccinia, adenoviruses, and vesicular stomatitis virus engineered for selective infection of cancer cells can stimulate an immune response to shared and tumor-specific antigens, and

hence are called immune-oncolytic viruses (270, 271). Such viruses have shown efficacy against hematological malignancies, including both acute and chronic lymphocytic leukemia, multiple myeloma, and T-cell lymphomas. Additional studies of an oncolytic virus targeting hematopoietic malignancies were performed in a rigorously disabled humanized mouse model of leukemia. In this model, an oncolytic virus engineered for tumor-selective replication and expressing the membrane-destabilizing immune-oncolytic protein can cure murine leukemia and impacts human patient-derived leukemias (272, 273 and 274)

6.4. Combination Strategies and Sequencing

Combining immuno-oncology agents with standard-of-care therapies harbors the promise of improved clinical outcomes without requiring heightened agent doses that would enhance toxicity (275, 276, 277 and 278). Theoretical synergy can stem from enhancing anti-tumor immunity or counteracting additional immune evasion mechanisms. Among the >800 combination strategies with clinical milestones, the greatest activity thus far stems from blocking immune checkpoints in combination with oncolytic viruses, epigenetic modifiers, and chemotherapy. Combinations of genetically engineered T-cell therapies with immune-checkpoint inhibitors, oncolytic viruses, and various non-cytotoxic agents engender preclinical synergy (279, 280). Combinations of tumor-targeted monoclonal antibodies with immune-checkpoint blockade are either synergistic or independently active across >50 preclinical tumor models; however, indolent antibody combinations can accelerate checkpoint-inhibitor-mediated T-cell infiltration into tumors. Co-administration of hydrophilic and hydrophobic anti-PD-1 antibodies has demonstrated therapeutic benefit without elevating overall exposure (281, 282 and 283).

6.5. Safety, Toxicity, and Management of Immune-Related Adverse Events

Immune-related adverse events (irAEs) refer to a heterogeneous category of autoimmune-like toxicities associated with immuno-oncology therapies. The increasing use of immune checkpoint inhibitors (ICIs) has elevated interest in these phenomena; treatment with anti-PD-1 and anti-CTLA-4 monoclonal antibodies can elicit both predictable and unpredictable irAEs (284, 285 and 286). These may affect virtually any organ in the body, with the skin, gastrointestinal tract, endocrine organs, and liver among the most commonly involved. Generally, the development of rAEs has been linked to therapeutic efficacy; extensive studies have described their clinical features, proposed underlying mechanisms, and provided clinical guidelines for management (287, 288 and 289). In conjunction with preclinical data, these observations inform an evolving understanding of how ICIs alter the immune system (290, 291, and 292).

Immune-related adverse events associated with immuno-oncology therapy emerges as a prominent topic in clinical translational research owing to the increase in indications. Recognizing the statistical prevalence of irAEs in the clinical setting has enabled the implementation of guidelines for mitigation and adjustment in patient monitoring frequency. The general grading framework for irAEs primarily reflects the toxicity level of the event and allows the determination of a symptom-specific mitigation strategy to retain maximal patient benefit (293, 294 and 295). Several studies have examined the role of substances commonly regarded as drugs of abuse and of the precise guidelines for checkpoint inhibitor use in patient populations with a high background rate for the various events of interest. This correspondence highlights a determination of whether the abrogation of careful monitoring mitigates potentially serious adverse health consequences (296, 297 and 298).

CHALLENGES AND FUTURE DIRECTIONS

Immune evasion appears as an important mechanism for resisting immune-mediated therapies. Acquired and intrinsic resistance models have been proposed to explain how tumors can evolve mechanisms to escape immune detection and to address detoxification mechanisms of standard therapies, such as literature defining how epigenetic modifiers can promote immune evasion (299, 300). Acquired resistance can trigger alternative tumorigenesis drivers, such as phenotypic rewiring and activating feedback properties associated with immunoediting (301, 302). For instance, over-activation of oncogenic bypass signaling induced cancer-intrinsic tolerance to naive T-cell recognition, while therapeutic reactivation of this bypass signaling promoted re-sensitization towards immunetolerance (303, 304). Clonal evolution, whether through neutral processes or

selection, requires alternative mechanisms acting subsequently to guarantee the preservation of early fitness trade-offs of disappearance (305, 306 and 307).

Although different types of resistance are increasingly characterized, corresponding countermeasures remain limited. Strategies focusing on restoration of immunity against tumors undergoing evolution but only for early stages have been proposed; for late-stage resistance, boosting off-target immunity counteracting the alternate drivers of tumor-protective immunoediting appears critical (308, 309 and 310). Mathematical frameworks, by identifying stages of resistance and potential cross-immunogenic pro-grammes, enable prioritisation of viable combinations (311, 312, 313, 314, 315 and 316).

7.1. Resistance Mechanisms and Escaping the Immune System

In a neoantigen and immune checkpoint model, coincident mutations or shared non-synonymous mutations collectively enable the development of intrinsic and adaptive resistance strategies, delineating opportunities for therapeutic intervention and immune restoration (317, 318, and 319). During the selective pressures of tumor development, the majority of mutations, including neoantigens, are lost as a consequence of tolerization (320, 321). Tumors learn to suppress lymphocyte activation through the enhanced expression of checkpoint ligands on tumor cells or through the recruitment of checkpoint-bearing regulatory T cells and myeloid-derived suppressor cells, limiting the secretion of IL-2 and TNF-α and promoting the secretion of IL-10 instead (322, 323, and 324). Such results reflect that many tumor cells undergo a selective loss of HLA-1 and class II receptors alongside the loss of immunogenic neoantigens, supporting the model that, as immunity serves as an essential selective pressure during tumor evolution; tumor cells evolve through a differentiative immunoediting process to escape immune destruction (325, 326 and 327).

7.2. Personalization of Immunotherapy

Immune responses to tumors and therapy-induced immune modifications impact clinical outcomes. Tumor recognition by the immune system hinges on the presence of tumor-associated and tumor-specific antigens, termed neoantigens (328, 329). Although cancer neoantigens have limited immunogenicity compared to chronic infections and do not fully account for response heterogeneity, they remain important biomarkers for immuno-oncology and immunotherapy. Advances have focused on methods of tumor antigen detection, from genome to protein analysis, enabling better patient stratification (330 331). Tumor progression occurs in tandem with immune evasive changes or "immunoediting," which are influenced by the tumor microenvironment (TME) and therapeutic intervention; on-treatment changes between pre– and post–therapy biopsies can signal new therapeutic response mechanisms. Immuno-oncology and immunotherapy demand the elucidation of fundamental immuno-oncology mechanisms and careful examination of treatment changes, tumor antigen profiling, and TME analysis (332, 333, and 334)

Immune checkpoints, including programmed cell death protein-1 (PD-1) and cytotoxic T lymphocyte antigen-4 (CTLA-4), represent well-defined immuno-oncology mechanisms and correlates of therapeutic outcome. The PD-1/PD-L1 and CTLA-4 immune checkpoint axes govern antitumor immunity and control primary resistance to immuno-oncology therapies and anticancer interventions, with extensive data characterizing their roles in resistance to immune checkpoint inhibitors (335, 328, and 329). The generation of effector memory T cells after immune checkpoint blockade in preclinical cancer models demonstrates a mechanistic foundation linking initiation of the anticancer immune response to durable long-term therapeutic benefits (327, 318). Additional immune checkpoints, such as LAG-3 and TIM-3, have emerged that regulate T cell differentiation into distinct effector subsets and represent clinically relevant dimensions of immuno-oncology regulation. In preclinical studies and a large cohort of cancer patients, activated resident memory T (Trm) cells increasing in tumors during therapy with immune checkpoint blockers correlate with a positive clinical response. Inverse TCF-1/TOX (thymocyte selection-associated high mobility group box) expression fine-tunes effector T cell differentiation and prevents T cell exhaustion under stimulation by tumor neoantigens, providing a connection linking antigen recognition to T cell clonal expansion, differentiation, and sustained therapy efficacy (239 140).

The innate immune system and signals generated through precursors of macrophages and dendritic cells play significant roles in the initiation and regulation of adaptive immunity. Macrophages influencing the effector function and phenotype of tumor-specific lymphocytes represent important mechanisms of antitumor immunity correlating with treatment outcome in human cancer models (301, 322 and 243). The capacity of TLR4-expressing tumors to activate innate defense pathways and shape the adaptive immune compartment, influencing therapeutic sensitivity across a range of anticancer modalities, illustrates an avenue for expanding the clinical efficacy of cancer therapies. Active Tumor-Associated Macrophage Signaling Systems (aTAMSS) in mouse tumor models analyze the macrophage contribution to anticancer immunity and drive clinical drug development (44, 45). Signals derived from tumor-infiltrating bacterial microbiota have emerged as additional initiators of innate and subsequent adaptive antitumor immunity spanning multiple cancer types in diverse murine contexts. Collectively, the initiation, propagation, and maintenance of antitumor immunity at the level of both the innate and adaptive immune systems shape therapeutic response, therapeutic activity, and mechanisms of resistance (146, 47 and 328).

The microbiome comprises trillions of microorganisms residing in symbiosis on and within the human body and influences human health. Microbial signatures play direct and indirect roles in shaping sustained antitumor immune responses and have emerged as additional biomarkers for patient stratification and prediction of therapeutic outcome across immuno-oncology strategies (149, 250 and 301). Metabolism governs basic cellular processes and generates specialized metabolites that modulate the epigenome and transcriptional programs of both immune and tumor cells. Numerous metabolic checkpoints and associated therapeutic combinations influencing both tumor and immune metabolism shape the response to a range of cancer therapies and represent an avenue for expanding the impact of immuno-oncology (52 and 53). These immune and tumor checkpoints, together with the microbiome and metabolism, constitute a framework for defining the state of germline and adaptive immunity to therapeutic intervention and shaping the patient-specific therapeutic response to cancer treatment (154, 255 and 256).

7.3. Health Disparities and Access to Immunotherapies

To achieve equitable access to immuno-oncology therapies, it is essential to understand the extent of these disparities across cancer types. Information on how the socioeconomic, geographic, and regulatory dimensions of disparities in access to immunotherapy differ between cancer types and Early Assessment Consortium (EAC)-qualified immuno-oncology therapies remains limited (157, 258 and 309). Without such knowledge, directed efforts to address disparities by interventions that target the specific dimensions of disparity present for a given immuno-oncology therapy would be compromised. Strategies that could influence eligibility for immuno-oncology therapies include segmenting underwriting questions by cancer type and therapy. Of certain importance, the role of economic factors in the observed disparities remains uncertain. Economic incentives and disincentives have not yet been examined (60, 301 and 332).

Geographic disparities in access to immuno-oncology therapies also need to be characterized, as weighty restrictions on such therapies have been documented in naturalistic settings compared with their EAC qualification (313, 334, and 335). These disparities are liable to be most pronounced in cancers for which only one type of EAC-qualified immunotherapy is available. Information on the gap between naturalistic and EAC-qualified availability is scant. Moreover, in precisely those cancers where geographic disparities remain remote or absent, a deeper understanding of the nature of the disparities at EAC-qualified approval would provide insight into whether a separate evaluation of geographic disparities might be warranted (66, 167 and 308). Potential geographic dimensions of cancer inequality that might inhibit access to the EAC-qualified designation and impede system-wide equity efforts include those linked to population density, regulatory body density, regulatory budget, and available review time. (9, 70, 271, 332 and 333)

CONCLUSION

Translational immunology seeks to integrate mechanistic knowledge of antitumor immunity with clinical outcomes following therapeutic intervention in cancer patients. Progresses in the immuno-oncology landscape demonstrate the real importance of elucidating such connection to ensure the future advancement of the new paradygm.

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Understanding the full repertoire of tumor antigens and their associated immune recognition is a requisite first step towards improving therapeutic efficacy. Antigens produced by tumor-specific mutations—neoantigens—have gained increasing attention given their association with an objective clinical response to CheckPoint inhibitors. The directions of tumor immune editing, describing a shadowing interplay of recognition and evasion—and immune checkpoint-dependent inhibition of Tcell activity, remain the most investigated determinants of effectiveness. Major lesions impinging on innate signaling and effector T cell functionality emerge as crucial factors across diverse treatment contexts, Translational immunology is expected to deepen the understanding of the mutual inter-relationship between molecular basis of tumorigenesis and immune sufficiency.

Biomedical research is often divided into basic vs applied domains, but translational work crosses freely between both. Translational immunology aims to pave the way for basic to bidirectional exploration around antitumor immunity and therapy.

LIMITATIONS AND FUTURE DIRECTIONS

Limitations of this Review

- **Scope and coverage**: Although this review aimed to provide a comprehensive overview of Immunology in Oncology, the breadth of the field means that some relevant studies may have been inadvertently excluded.
- **Selection bias**: The inclusion criteria focused on peer-reviewed literature in English, which may limit representation of findings published in other languages or in non-indexed journals.
- **Rapidly evolving field**: Immunotherapy is advancing at a pace that outstrips the publication cycle; consequently, some emerging therapies or trial results may not be captured.
- **Narrative synthesis**: As a narrative review, the analysis is interpretive rather than systematic, which introduces potential bias in how evidence is weighted and contextualized.

Future Research Priorities

- **Biomarker development**: Greater emphasis on validating predictive biomarkers to guide patient selection and optimize therapeutic outcomes.
- **Combination strategies**: Rigorous evaluation of rational combinations (e.g., checkpoint inhibitors with targeted therapies or radiotherapy) to overcome resistance mechanisms.
- **Translational pipelines**: Improved alignment between preclinical models and clinical trial design to reduce attrition of promising therapies during translation.
- **Real-world evidence**: Expansion of registries and post-marketing surveillance to capture long-term safety and efficacy data across diverse patient populations.
- **Equity and accessibility**: Research into cost-effectiveness, global access, and disparities in immunotherapy delivery to ensure broader impact.
- **Next-generation modalities**: Continued exploration of novel approaches such as personalized neoantigen vaccines, engineered TCR therapies, and bispecific antibodies.

REFERENCES

1) Dragani, T., Castells, A., Kulasingam, V., P. Diamandis, E., Earl, H., T. Iams, W., M. Lovly, C., P. Michiel Sedelaar, J., and A. Schalken, J. "Major milestones in translational oncology." (2016). ncbi.nlm.nih.gov

2) Suresh, S. and A. O'Donnell, K. "Translational Control of Immune Evasion in Cancer." (2021). ncbi.nlm.nih.gov
3) Thomas, Elaine M., Josephine A. Wright, Stephen J. Blake, Amanda J. Page, Daniel L. Worthley, and Susan L. Woods. "Advancing translational research for colorectal immuno-oncology." British Journal of Cancer 129, no. 9 (2023): 1442-1450. nature.com
4) Recine, Federica, Silvia Vanni, Alberto Bongiovanni, Valentina Fausti, Laura Mercatali, Giacomo Miserocchi, Chiara Liverani et al. "Clinical and translational implications of immunotherapy in sarcomas." Frontiers in immunology 15 (2024): 1378398. frontiersin.org
5) Chew, V., Chuang, C. H., and Hsu, C. "Translational research on drug development and biomarker discovery for hepatocellular carcinoma." Journal of Biomedical Science (2024). springer.com
6) Fu, Z., Zhang, X., Gao, Y., and Fan…, J. "Enhancing the anticancer immune response with the assistance of drug repurposing and delivery systems." Clinical and Translational … (2023). wiley.com
7) Blum, S. M., Rouhani, S. J., and Sullivan, R. J. "Effects of Immune-related adverse events (irAEs) and their treatment on antitumor immune responses." Immunological reviews (2023). [HTML]
8) Zheng, Y., Sun, L., Guo, J., and Ma, J. "The crosstalk between ferroptosis and anti-tumor immunity in the tumor microenvironment: molecular mechanisms and therapeutic controversy." Cancer Communications (2023). wiley.com
9) Lu, S., Wang, C., Ma, J., and Wang, Y. "Metabolic mediators: microbial-derived metabolites as key regulators of anti-tumor immunity, immunotherapy, and chemotherapy." Frontiers in Immunology (2024). frontiersin.org
10) Lou, Shuwei, Wangying Li, Gaoqiang Wang, Huaixing Qian, and Jiahao Zhou. "Microbiome-gut-liver axis in chronic inflammation and cancer immunotherapy: Multi-omics Insights and a translational roadmap toward personalized medicine." Critical Reviews in Oncology/Hematology (2026): 105217. [HTML]
11) Devaraji, Mahalakshmi, and Binoy Varghese Cheriyan. "Immune-based cancer therapies: mechanistic insights, clinical progress, and future directions." Journal of the Egyptian National Cancer Institute 37, no. 1 (2025): 62. springer.com
12) Fanizzi, Fabrizio, Laurent Peyrin-Biroulet, Silvio Danese, and Ferdinando D'Amico. "Targeting the unmet needs in IBD: Emerging therapies beyond biologics and small molecules." Current Opinion in Pharmacology (2025): 102577. [HTML]
13) Jeong, K. Y. "Challenges to addressing the unmet medical needs for immunotherapy targeting cold colorectal cancer." World Journal of Gastrointestinal Oncology (2023). nih.gov
14) Al Assaad, Majd, Houssein Safa, Chiara Mercinelli, Philippe E. Spiess, Andrea Necchi, and Jad Chahoud. "Immune-based therapies for penile cancer." Urologic Clinics 51, no. 3 (2024): 355-365. [HTML]
15) Wang, Kinsley, Alexis Leyba, and Robert Hsu. "Addressing the unmet need in NSCLC progression with advances in second-line therapeutics." Exploration of Targeted Anti-tumor Therapy 5, no. 6 (2024): 1297. nih.gov
16) Mazzilli, Sarah A., Zahraa Rahal, Maral J. Rouhani, Sam M. Janes, Humam Kadara, Steven M. Dubinett, and Avrum E. Spira. "Translating premalignant biology to accelerate non-small-cell lung cancer interception." Nature Reviews Cancer 25, no. 5 (2025): 379-392. [HTML]
17) Marandino, Laura, Riccardo Campi, Daniele Amparore, Zayd Tippu, Laurence Albiges, Umberto Capitanio, Rachel H. Giles et al. "Neoadjuvant and adjuvant immune-based approach for renal cell carcinoma: pros, cons, and future directions." European Urology Oncology 8, no. 2 (2025): 494-509. sciencedirect.com
18) Malak Munir, A. S., Ghazi, S., Yang, E. H., Guha, A., and Epperla…, N. "Cardiotoxicity prevention trials in the era of contemporary cancer therapies: a systematic." (2026). [HTML]
19) Page, D., Bulua Bourla, A., Daniyan, A., Naidoo, J., Smith, E., Smith, M., Friedman, C., N. Khalil, D., Funt, S., N. Shoushtari, A., W. Overwijk, W., Sharma, P., and K. Callahan, M. "Tumor immunology and cancer immunotherapy: summary of the 2014 SITC primer." (2015). ncbi.nlm.nih.gov
20) Jiani, W., Qin, T., and Jie, M. "Tumor neoantigens and tumor immunotherapies." Aging Medicine (2024). wiley.com

21) Goloudina, Anastasia, Fabien Le Chevalier, Pierre Authié, Pierre Charneau, and Laleh Majlessi. "Shared neoantigens for cancer immunotherapy." Molecular Therapy Oncology 33, no. 2 (2025). cell.com
22) Xie, Na, Guobo Shen, Wei Gao, Zhao Huang, Canhua Huang, and Li Fu. "Neoantigens: promising targets for cancer therapy." Signal transduction and targeted therapy 8, no. 1 (2023): 9. nature.com
23) Peri, Aviyah, Nadja Salomon, Yochai Wolf, Sebastian Kreiter, Mustafa Diken, and Yardena Samuels. "The landscape of T cell antigens for cancer immunotherapy." Nature cancer 4, no. 7 (2023): 937-954. elsevierpure.com
24) Hao, Qing, Yuhang Long, Yi Yang, Yiqi Deng, Zhenyu Ding, Li Yang, Yang Shu, and Heng Xu. "Development and clinical applications of therapeutic cancer vaccines with individualized and shared neoantigens." Vaccines 12, no. 7 (2024): 717. mdpi.com
25) Pounraj, Saranya, Shuxiong Chen, Linlin Ma, Roberta Mazzieri, Riccardo Dolcetti, and Bernd HA Rehm. "Targeting tumor heterogeneity with neoantigen-based cancer vaccines." Cancer research 84, no. 3 (2024): 353-363. griffith.edu.au
26) Killick, D. R. "Cancer Immunology." Veterinary Clinical Immunology (2025). [HTML]
27) He, Zehua, Hong Yang, Qingfeng Chen, Yi-Ping Phoebe Chen, Huabo Qin, Wanrong He, and Zhihui Chen. "Role of TAP1 in the identification of immune-hot tumor microenvironment and its prognostic significance for immunotherapeutic efficacy in gastric carcinoma." Journal of Gastrointestinal Oncology 15, no. 3 (2024): 890-907. lww.com
28) Pang, J., Yang, J., Zhu, W., Song, L., Geng, Y., and Yan, Z. "Photosensitive gel vaccine with enzyme-like properties for remodeling tumor microenvironment with STING activation for tumor synergistic therapy." Cancer Nanotechnology (2026). springer.com
29) Alvares-Vilela, Miriam Monteiro, Franciele Schlemmer, Sabrina Simplício de Araújo Romero Ferrari, Mary-Ann Elvina Xavier, and Ricardo Titze-de-Almeida. "Role of tumor-infiltrating lymphocytes and miR-155 in breast cancer: Insights into carcinogenesis and their potential as prognostic biomarkers." Oncology Reports 55, no. 3 (2026): 42. spandidos-publications.com
30) Pierini, Stefano, Rashid Gabbasov, Maria Cecilia Oliveira-Nunes, Rehman Qureshi, Alison Worth, Shuo Huang, Karan Nagar et al. "Chimeric antigen receptor macrophages (CAR-M) sensitize HER2+ solid tumors to PD1 blockade in pre-clinical models." Nature Communications 16, no. 1 (2025): 706. nature.com
31) Pang, J., Yang, J., Zhu, W., Geng, Y., and Yan, Z. "Photosensitive gel vaccines with enzyme-like properties for modulating tumor microenvironment with STING activation for tumor synergistic therapy." (2025). researchsquare.com
32) Wang, Lijian, Yutong Guo, Lingchuan Ma, and Kai Miao. "Cancer Cell-Intrinsic Programs That Shape Tumor Immune Ecosystems." Cancer Biome and Targeted Therapy (2026): 84-118. cancerbiometherapy.com
33) Guo, Xinyu, Zhongwei Zhao, Lingyi Zhu, Shuang Liu, Lingling Zhou, Fazong Wu, Shiji Fang, Minjiang Chen, Liyun Zheng, and Jiansong Ji. "The evolving landscape of biomarkers for systemic therapy in advanced hepatocellular carcinoma." Biomarker Research 13, no. 1 (2025): 60. springer.com
34) Apavaloaei, A., Hardy, M. P., Thibault, P., and Perreault, C. "The Origin and Immune Recognition of Tumor-Specific Antigens." (2020). ncbi.nlm.nih.gov
35) Okafor, Chinaecherem, Victor Akachukwu Ibiam, Bukola Titilayo, Chinwendu Ubani Fagbemi, and Mary Tomi Olorunkosebi. "Microbial dysbiosis and antibiotic resistance in cancer development and therapy." International Journal of Molecular Biology and Biochemistry 6, no. 1 (2024): 68-77. researchgate.net
36) Eiman, Liza, Khadija Moazzam, Sumaira Anjum, Humera Kausar, Elham Abdullatif M. Sharif, and Wisam Nabeel Ibrahim. "Gut dysbiosis in cancer immunotherapy: microbiota-mediated resistance and emerging treatments." Frontiers in Immunology 16 (2025): 1575452. frontiersin.org
37) Yu, Hao, Xing-Xiu Li, Xing Han, Bin-Xin Chen, Xing-Hua Zhang, Shan Gao, Dan-Qi Xu et al. "Fecal microbiota transplantation inhibits colorectal cancer progression: Reversing intestinal microbial dysbiosis to enhance anti-cancer immune responses." Frontiers in microbiology 14 (2023): 1126808. frontiersin.org

38) Almonte, Andrew Allan, Simon Thomas, Valerio Iebba, Guido Kroemer, Lisa Derosa, and Laurence Zitvogel. "Gut dysbiosis in oncology: a risk factor for immunoresistance." Cell Research (2026): 1-18. nature.com
39) Kiousi, Despoina E., Antonia Z. Kouroutzidou, Konstantinos Neanidis, Emmanuel Karavanis, Dimitrios Matthaios, Aglaia Pappa, and Alex Galanis. "The role of the gut microbiome in cancer immunotherapy: current knowledge and future directions." Cancers 15, no. 7 (2023): 2101. mdpi.com
40) Wang, Huiyu, Xiaomin Niu, Zhenning Jin, Shaoxing Zhang, Rong Fan, Hua Xiao, and Shen S. Hu. "Immunotherapy resistance in non-small cell lung cancer: from mechanisms to therapeutic opportunities." Journal of Experimental & Clinical Cancer Research 44, no. 1 (2025): 250. springer.com
41) Chen, Xiang-xiang, Qing Ju, Dan Qiu, Ying Zhou, Yuan Wang, Xin-xin Zhang, Jing-geng Li et al. "Microbial dysbiosis with tryptophan metabolites alteration in lower respiratory tract is associated with clinical responses to anti-PD-1 immunotherapy in advanced non-small cell lung cancer." Cancer Immunology, Immunotherapy 74, no. 4 (2025): 140. springer.com
42) Smith, C. "ADAPTIVE IMMUNITY AND THE TUMOR IMMUNE MICROENVIRONMENT." (2019). [PDF]
43) Sun, S., Liu, L., Zhang, J., Sun, L., Shu, W., and Yang…, Z. "The role of neoantigens and tumor mutational burden in cancer immunotherapy: advances, mechanisms, and perspectives." Journal of Hematology & … (2025). springer.com
44) Ragone, Concetta, Beatrice Cavalluzzo, Angela Mauriello, Maria Tagliamonte, and Luigi Buonaguro. "Lack of shared neoantigens in prevalent mutations in cancer." Journal of Translational Medicine 22, no. 1 (2024): 344. springer.com
45) Aparicio, Belen, Patrick Theunissen, Sandra Hervas-Stubbs, Puri Fortes, and Pablo Sarobe. "Relevance of mutation-derived neoantigens and non-classical antigens for anticancer therapies." Human vaccines & immunotherapeutics 20, no. 1 (2024): 2303799. tandfonline.com
46) Stern, L. J., Clement, C., Galluzzi, L., and Santambrogio, L. "Non-mutational neoantigens in disease." Nature immunology (2024). nih.gov
47) Camisaschi, C., Vallacchi, V., Vergani, E., Tazzari, M., Ferro, S., Tuccitto, A., Kuchuk, O., Shahaj, E., Sulsenti, R., Castelli, C., Rodolfo, M., Rivoltini, L., and Huber, V. "Targeting Immune Regulatory Networks to Counteract Immune Suppression in Cancer." (2016). ncbi.nlm.nih.gov
48) Draghiciu, O., W. Nijman, H., and Daemen, T. "From Tumor Immunosuppression to Eradication: Targeting Homing and Activity of Immune Effector Cells to Tumors." (2011). ncbi.nlm.nih.gov
49) Zheng, Siwei, Wenwen Wang, Lesang Shen, Yao Yao, Wenjie Xia, and Chao Ni. "Tumor battlefield within inflamed, excluded or desert immune phenotypes: the mechanisms and strategies." Experimental Hematology & Oncology 13, no. 1 (2024): 80. springer.com
50) Yan, C. and Wang, X. F. "Tumor immune evasion: Systemic immunosuppressive networks beyond the local microenvironment." Proceedings of the National Academy of Sciences (2025). pnas.org
51) Shen, K. Y., Zhu, Y., Xie, S. Z., and Qin, L. X. "Immunosuppressive tumor microenvironment and immunotherapy of hepatocellular carcinoma: current status and prospectives." Journal of hematology & oncology (2024). springer.com
52) Gao, Fei, Xiaoqing You, Liu Yang, Xiangni Zou, and Bowen Sui. "Boosting immune responses in lung tumor immune microenvironment: A comprehensive review of strategies and adjuvants." International Reviews of Immunology 43, no. 5 (2024): 280-308. [HTML]
53) Yu, J., Kong, X., and Feng, Y. "Tumor microenvironment-driven resistance to immunotherapy in non-small cell lung cancer: strategies for Cold-to-Hot tumor transformation." Cancer Drug Resistance (2025). nih.gov
54) Gill, Gurpreet Singh, Simmi Kharb, Gitanjali Goyal, Prasenjit Das, Kailash Chand Kurdia, Ruby Dhar, and Subhradip Karmakar. "Immune checkpoint inhibitors and immunosuppressive tumor microenvironment: current challenges and strategies to overcome resistance." Immunopharmacology and Immunotoxicology 47, no. 4 (2025): 485-507. researchgate.net
55) Efremova, M., Rieder, D., Klepsch, V., Charoentong, P., Finotello, F., Hackl, H., Hermann-Kleiter, N., Löwer, M., Baier, G., Krogsdam, A., and Trajanoski, Z. "Targeting immune checkpoints potentiates immunoediting and changes the dynamics of tumor evolution." (2018). ncbi.nlm.nih.gov

56) Łuksza, M., M. Sethna, Z., A. Rojas, L., Lihm, J., Bravi, B., Elhanati, Y., Soares, K., Amisaki, M., Dobrin, A., Hoyos, D., Guasp, P., Zebboudj, A., Yu, R., Kaya Chandra, A., Waters, T., Odgerel, Z., Leung, J., Kappagantula, R., Makohon-Moore, A., Johns, A., Gill, A., Gigoux, M., Wolchok, J., Merghoub, T., Sadelain, M., Patterson, E., Monasson, R., Mora, T., M. Walczak, A., Cocco, S., Iacobuzio-Donahue, C., D. Greenbaum, B., and P. Balachandran, V. "Neoantigen quality predicts immunoediting in survivors of pancreatic cancer." (2022). ncbi.nlm.nih.gov
57) López-Calvo, Ismael, Inés Bao-Camacho, Samuel Martín-Revuelta, Cora Rey-Souto, Anahir Franco-Gacio, José Manuel Pérez-Martínez, Iván Sandino-Somoza et al. "Long Non-Coding RNA–Derived Peptides as a Novel Source of Tumor Neoantigens: Expanding the Immunopeptidome Beyond Canonical Coding Regions." Biology 15, no. 7 (2026): 538. mdpi.com
58) Bhajan, Sujay Kumar, Md MN Azim, Atikur Rahman, Akhi Milon, Md Faizullah Al Numan, Rafsun Jany Rahat, Md Ataur Rahman et al. "The "Dark Matter" of Tumors: Functional Roles of Non-Coding Neoantigens in Cancer Immunity." (2026). preprints.org
59) Xiang, Haitao, Xiangyu Guan, Yaohua Wei, Shuzhen Luo, Haibo Zhang, Fanyu Bu, Yixin Yan et al. "Predominant mutated non-canonical tumor-specific antigens identified by proteogenomics demonstrate immunogenicity and tumor suppression in CRC." Cell genomics 6, no. 1 (2026). cell.com
60) Marzani, F. "Molecular characterization of an anti-cancer demethylated cellular vaccine: coding and non-coding sequencing." (2026). unisi.it
61) Rosenberg-Mogilevsky, A., Siegfried, Z., and Karni, R. "Generation of tumor neoantigens by RNA splicing perturbation." Trends in Cancer (2025). [HTML]
62) Caner, A. "Immune escape mechanism of cancer." Current Molecular Biology Reports (2024). [HTML]
63) Dutta, Shovan, Anirban Ganguly, Kaushiki Chatterjee, Sheila Spada, and Sumit Mukherjee. "Targets of immune escape mechanisms in cancer: basis for development and evolution of cancer immune checkpoint inhibitors." Biology 12, no. 2 (2023): 218. mdpi.com
64) Ghorani, E., Swanton, C., and Quezada, S. A. "Cancer cell-intrinsic mechanisms driving acquired immune tolerance." Immunity (2023). cell.com
65) Kallingal, Anoop, Mateusz Olszewski, Natalia Maciejewska, Wioletta Brankiewicz, and Maciej Baginski. "Cancer immune escape: the role of antigen presentation machinery." Journal of cancer research and clinical oncology 149, no. 10 (2023): 8131-8141. springer.com
66) Tufail, M., Jiang, C. H., and Li, N. "Immune evasion in cancer: mechanisms and cutting-edge therapeutic approaches." Signal transduction and targeted therapy (2025). nature.com
67) Galassi, C., Chan, T. A., Vitale, I., and Galluzzi, L. "The hallmarks of cancer immune evasion." Cancer cell (2024). [HTML]
68) van Weverwijk, A. and de Visser, K. E. "Mechanisms driving the immunoregulatory function of cancer cells." Nature Reviews Cancer (2023). [HTML]
69) Isaacs, J., C. Tan, A., A. Hanks, B., Wang, X., Owzar, K., E. Herndon, J., J. Antonia, S., Piantadosi, S., and Khasraw, M. "Clinical Trials with Biologic Primary Endpoints in Immuno-oncology: Concepts and Usage." (2022). ncbi.nlm.nih.gov
70) Yin, Ji, Lin Xu, Shange Wang, Linshuai Zhang, Yujie Zhang, Zhenwei Zhai, Pengfei Zeng, Marcin Grzegorzek, and Tao Jiang. "Integrating immune multi-omics and machine learning to improve prognosis, immune landscape, and sensitivity to first-and second-line treatments for head and neck squamous cell carcinoma." Scientific Reports 14, no. 1 (2024): 31454. nature.com
71) Piper, Miles, Harriet Kluger, Eytan Ruppin, and Siwen Hu-Lieskovan. "Immune resistance mechanisms and the road to personalized immunotherapy." American Society of Clinical Oncology Educational Book 43 (2023): e390290. ascopubs.org
72) Brown, J. R. and Sonpavde, G. "Toward a better pan-tumor predictive signature for unleashing precision immuno-oncology." Journal for Immunotherapy of … (2025). nih.gov
73) Moura, D. S., Lopez-Marti, J., Tawbi, H., and Keung…, E. "Validation of a seven-gene predictive SIGNature for the efficacy of Immuno-Oncology PD-1 inhibitors in patients with Sarcoma (SIGNIOS)." Clinical Cancer … (2026). [HTML]
74) Brlek, Petar, Vedrana Škaro, Nenad Hrvatin, Luka Bulić, Ana Petrović, Petar Projić, Martina Smolić, Parth Shah, and Dragan Primorac. "Advances in Precision Oncology: From Molecular Profiling to Regulatory-Approved Targeted Therapies." Cancers 17, no. 21 (2025): 3500. mdpi.com

75) Desponds, Emma, Davide Croci, Victoria Wosika, Noushin Hadadi, Sara S. Fonseca Costa, Laura Ciarloni, Marco Ongaro et al. "Immuno-Transcriptomic Profiling of Blood and Tumor Tissue Identifies Gene Signatures Associated with Immunotherapy Response in Metastatic Bladder Cancer." Cancers 16, no. 2 (2024): 433. mdpi.com
76) Ren, F., Pang, X., Liu, N., and Zhu, L. "Multiomics evaluation and machine learning optimize molecular classification, prediction of prognosis and immunotherapy response for ovarian cancer." Pathology-Research and Practice (2025). [HTML]
77) Wu, H., Yan, H., Cheng, Y., Yuan, J., and Chen, H. "Biomarkers associated with response to neoadjuvant chemoimmunotherapy in non-small cell lung cancer." Oncologie (2026). degruyterbrill.com
78) Roerden, M. and Spranger, S. "Cancer immune evasion, immunoediting and intratumour heterogeneity." Nature Reviews Immunology (2025). [HTML]
79) Liu, S., Sun, Q., and Ren, X. "Novel strategies for cancer immunotherapy: counter-immunoediting therapy." Journal of hematology & oncology (2023). springer.com
80) Tsai, Chin-Hsien, Yu-Ming Chuang, Xiaoyun Li, Yi-Ru Yu, Sheue-Fen Tzeng, Shao Thing Teoh, Katherine E. Lindblad et al. "Immunoediting instructs tumor metabolic reprogramming to support immune evasion." Cell metabolism 35, no. 1 (2023): 118-133. cell.com
81) Zeng, Shiyan, Li Wang, Wanqin Zeng, and Lei Sun. "Neoantigens in cancer immunoediting: from mechanisms to personalized vaccines in breast cancer." Frontiers in Cell and Developmental Biology 13 (2025): 1733549. frontiersin.org
82) Amin, Tasbir, Amana Hossain, Nusrat Jerin, Imteaz Mahmud, Md Ahasanur Rahman, S. M. Rafiqul Islam, and SM Bakhtiar UL Islam. "Immunoediting dynamics in glioblastoma: implications for immunotherapy approaches." Cancer Control 31 (2024): 10732748241290067. sagepub.com
83) He, X. and Xu, C. "Immune checkpoint signaling and cancer immunotherapy." (2020). ncbi.nlm.nih.gov
84) Barrueto, L., Caminero, F., Cash, L., Makris, C., Lamichhane, P., and R. Deshmukh, R. "Resistance to Checkpoint Inhibition in Cancer Immunotherapy." (2020). ncbi.nlm.nih.gov
85) Escobar, Giulia, Katherine Tooley, Joan Pagès Oliveras, Linglin Huang, Hanning Cheng, Michelle L. Bookstaver, Camilla Edwards et al. "Tumor immunogenicity dictates reliance on TCF1 in CD8+ T cells for response to immunotherapy." Cancer Cell 41, no. 9 (2023): 1662-1679. cell.com
86) Oliveira, G. and Wu, C. J. "Dynamics and specificities of T cells in cancer immunotherapy." Nature Reviews Cancer (2023). nih.gov
87) Luxenburger, Hendrik, Robert Thimme, and Maike Hofmann. "T cell adaptation in chronic infections and tumors." Cellular & Molecular Immunology (2026): 1-17. nature.com
88) Ghiringhelli, F. and Rébé, C. "Using immunogenic cell death to improve anticancer efficacy of immune checkpoint inhibitors: From basic science to clinical application." Immunological Reviews (2024). wiley.com
89) Zhou, Zhaokai, Jiahui Wang, Jiaojiao Wang, Shuai Yang, Ruizhi Wang, Ge Zhang, Zhengrui Li, Run Shi, Zhan Wang, and Qiong Lu. "Deciphering the tumor immune microenvironment from a multidimensional omics perspective: insight into next-generation CAR-T cell immunotherapy and beyond." Molecular cancer 23, no. 1 (2024): 131. springer.com
90) , …, Talbaux, C., Tihista, I., Xu, M., and Guillaudeux, T. "A highly potent anti-VISTA antibody KVA12123-a new immune checkpoint inhibitor and a promising therapy against poorly immunogenic tumors." Frontiers in … (2023). frontiersin.org
91) Aliazis, Konstantinos, Anthos Christofides, Rushil Shah, Yao Yu Yeo, Sizun Jiang, Alain Charest, and Vassiliki A. Boussiotis. "The tumor microenvironment's role in the response to immune checkpoint blockade." Nature cancer 6, no. 6 (2025): 924-937. nih.gov
92) Zhang, A., Fan, T., Liu, Y., Yu, G., Li, C., and Jiang, Z. "Regulatory T cells in immune checkpoint blockade antitumor therapy." Molecular cancer (2024). springer.com
93) Zhang, Meiyin, Chaojun Liu, Jing Tu, Min Tang, Milad Ashrafizadeh, Noushin Nabavi, Gautam Sethi, Peiqing Zhao, and Shijian Liu. "Advances in cancer immunotherapy: historical perspectives, current developments, and future directions." Molecular cancer 24, no. 1 (2025): 136. springer.com
94) Norian, L. and M. Allen, P. "Rapid Maturation of Effector T Cells in Tumors, but Not Lymphoid Organs, during Tumor Regression." (2007). ncbi.nlm.nih.gov

95) Saillard, M., Cenerenti, M., Romero, P., and Jandus, C. "Impact of Immunotherapy on CD4 T Cell Phenotypes and Function in Cancer." (2021). ncbi.nlm.nih.gov
96) Christodoulou, Maria-Ioanna, and Apostolos Zaravinos. "Single-cell analysis in immuno-oncology." International Journal of Molecular Sciences 24, no. 9 (2023): 8422. mdpi.com
97) Patel, Tulsi D., Venkata Gangadhar Vanteddu, and Bawari Sweta. "Current trends in immuno-oncology." Cardiovascular & Hematological Agents in Medicinal Chemistry (Formerly 21, no. 2 (2023): 96-107. [HTML]
98) Sanromán, Ángel Fernández, Kroopa Joshi, Lewis Au, B. Chain, and Samra Turajlic. "TCR sequencing: applications in immuno-oncology research." Immuno-Oncology and Technology 17 (2023): 100373. sciencedirect.com
99) Kumagai, Shogo, Kota Itahashi, and Hiroyoshi Nishikawa. "Regulatory T cell-mediated immunosuppression orchestrated by cancer: towards an immuno-genomic paradigm for precision medicine." Nature Reviews Clinical Oncology 21, no. 5 (2024): 337-353. [HTML]
100) Patel, C. H. and Powell, J. D. "Immune cell metabolism and immuno-oncology." Annual Review of Cancer Biology (2023). annualreviews.org
101) Ricker, Cora A., Kevin Meli, and Eliezer M. Van Allen. "Historical perspective and future directions: computational science in immuno-oncology." Journal for Immunotherapy of Cancer 12, no. 1 (2024): e008306. nih.gov
102) Altun, Izzet, Yusuf M. Demirlenk, Dila Atar, Enes Cevik, Seyda Gunduz, Hassan Albadawi, and Rahmi Oklu. "Advances and challenges in interventional immuno-oncology locoregional therapies." Journal of Vascular and Interventional Radiology 35, no. 2 (2024): 164-172. sciencedirect.com
103) Shou, M., Zhou, H., and Ma, L. "New advances in cancer therapy targeting TGF-β signaling pathways." Molecular Therapy-Oncolytics (2023). cell.com
104) Villar, Víctor H., Tijana Subotički, Dragoslava Đikić, Olivera Mitrović-Ajtić, Felipe Simon, and Juan F. Santibanez. "Transforming growth factor-β1 in cancer immunology: opportunities for immunotherapy." Advances in Molecular Pathology (2023): 309-328. [HTML]
105) Ahuja, S. and Zaheer, S. "Multifaceted TGF-β signaling, a master regulator: From bench-to-bedside, intricacies, and complexities." Cell Biology International (2024). [HTML]
106) Hou, F., Xiao, J., Wang, H., Xiao, K., Yang, W., and Zhao…, D. "Alveolar macrophage-derived TGF-β promotes acute lung injury recovery by regulating inflammatory monocyte-derived macrophages." Journal of Advanced … (2025). sciencedirect.com
107) Park, Sei Hyun, Ryounho Eun, Janghun Heo, and Yong Taik Lim. "Nanoengineered drug delivery in cancer immunotherapy for overcoming immunosuppressive tumor microenvironment." Drug Delivery and Translational Research 13, no. 7 (2023): 2015-2031. researchsquare.com
108) Bai, Lizhi, Yu Wang, Guanyi Li, Yi Song, Yongliang Yu, and Rongbin Tang. "YEATS2/TAK1 axis mediates TGF-β1 driven adaptive resistance to sorafenib in hepatocellular carcinoma." Biochemical and Biophysical Research Communications (2026): 153693. [HTML]
109) Stojanovic, Ana, Sebastiano Giorgetta, David Vonhören, Eva I. Krieghoff-Henning, Michael Platten, Sonja Loges, Sonia Tugues, and Adelheid Cerwenka. "TISSUE-SPECIFIC SPATIAL REGULATION OF INNATE IMMUNE CHECKPOINTS IN CANCER." Cancer Discovery (2026). [HTML]
110) Feng, Q. S., Shan, X. F., Yau, V., Cai, Z. G., and Xie, S. "Facilitation of Tumor Stroma-Targeted therapy: model difficulty and Co-Culture organoid method." Pharmaceuticals (2025). mdpi.com
111) K. Chimal-Ramírez, G., A. Espinoza-Sánchez, N., and M. Fuentes-Pananá, E. "Protumor Activities of the Immune Response: Insights in the Mechanisms of Immunological Shift, Oncotraining, and Oncopromotion." (2013). ncbi.nlm.nih.gov
112) Zhao, H., Wu, L., Yan, G., Chen, Y., Zhou, M., Wu, Y., and Li, Y. "Inflammation and tumor progression: signaling pathways and targeted intervention." (2021). ncbi.nlm.nih.gov
113) Zou, Z., Lin, H., Li, M., and Lin, B. "Tumor− associated macrophage polarization in the inflammatory tumor microenvironment." Frontiers in oncology (2023). frontiersin.org
114) Sezginer, O. and Unver, N. "Dissection of pro-tumoral macrophage subtypes and immunosuppressive cells participating in M2 polarization." Inflammation Research (2024). springer.com
115) Saeed, A. F. "Tumor-associated macrophages: polarization, immunoregulation, and immunotherapy." Cells (2025). mdpi.com

116) Wei, Guohao, Bin Li, Mengyang Huang, Mengyao Lv, Zihui Liang, Chuandong Zhu, Lilin Ge, and Jing Chen. "Polarization of Tumor Cells and Tumor-Associated Macrophages: Molecular Mechanisms and Therapeutic Targets." MedComm 6, no. 9 (2025): e70372. wiley.com
117) Grover, Amit, Evgenii N. Tcyganov, and Dmitry I. Gabrilovich. "Myeloid Cell Reprogramming and Immune Suppression." Annual Review of Physiology 88 (2025). annualreviews.org
118) Basak, Udit, Tania Sarkar, Sumon Mukherjee, Sourio Chakraborty, Apratim Dutta, Saikat Dutta, Debadatta Nayak, Subhash Kaushik, Tanya Das, and Gaurisankar Sa. "Tumor-associated macrophages: an effective player of the tumor microenvironment." Frontiers in immunology 14 (2023): 1295257. frontiersin.org
119) Momčilović, Sanja, Maja Milošević, Dušica M. Kočović, Dragana Marković, Darko Zdravković, and Sanja Vignjević Petrinović. "Macrophages at the Crossroads of Chronic Stress and Cancer." International Journal of Molecular Sciences 26, no. 14 (2025): 6838. mdpi.com
120) Huang, Ruizhe, Ting Kang, and Siyu Chen. "The role of tumor-associated macrophages in tumor immune evasion." Journal of cancer research and clinical oncology 150, no. 5 (2024): 238. springer.com
121) Andrews, M., Reuben, A., Gopalakrishnan, V., and A. Wargo, J. "Concepts Collide: Genomic, Immune, and Microbial Influences on the Tumor Microenvironment and Response to Cancer Therapy." (2018). ncbi.nlm.nih.gov
122) Aghamajidi, A. and Maleki Vareki, S. "The Effect of the Gut Microbiota on Systemic and Anti-Tumor Immunity and Response to Systemic Therapy against Cancer." (2022). ncbi.nlm.nih.gov
123) Wang, Fayuan, Weidong Chen, Yingtian Jia, Tao He, Siyi Wu, Jiahui Xiang, Rui Chen et al. "Gut microbiota reshapes the tumor microenvironment and affects the efficacy of colorectal cancer immunotherapy." Cancer Medicine 14, no. 12 (2025): e70994. wiley.com
124) Frąk, M., Grenda, A., Krawczyk, P., Milanowski, J., and Kalinka, E. "Interactions between dietary micronutrients, composition of the microbiome and efficacy of immunotherapy in cancer patients." Cancers (2022). mdpi.com
125) Yu, Xin, Wenge Li, Zhi Li, Qi Wu, and Shengrong Sun. "Influence of microbiota on tumor immunotherapy." International Journal of Biological Sciences 20, no. 6 (2024): 2264. nih.gov
126) Fernandes, Miriam R., Poonam Aggarwal, Raquel GF Costa, Alicia M. Cole, and Giorgio Trinchieri. "Targeting the gut microbiota for cancer therapy." Nature Reviews Cancer 22, no. 12 (2022): 703-722. [HTML]
127) Guo, Ciliang, Lingkai Kong, Lingjun Xiao, Kua Liu, Huawei Cui, Qilei Xin, Xiaosong Gu, Chunping Jiang, and Junhua Wu. "The impact of the gut microbiome on tumor immunotherapy: from mechanism to application strategies." Cell & Bioscience 13, no. 1 (2023): 188. springer.com
128) Yousefi, Y., Baines, K. J., and Vareki, S. M. "Microbiome bacterial influencers of host immunity and response to immunotherapy." Cell Reports Medicine (2024). cell.com
129) Davis, J. C. and Waltz, S. E. "The MET family of receptor tyrosine kinases promotes a shift to pro-tumor metabolism." Genes (2024). mdpi.com
130) Linossi, Edmond M., Carla A. Espinoza, Gabriella O. Estevam, James S. Fraser, and Natalia Jura. "Autoregulation of the MET receptor tyrosine kinase by its intracellular juxtamembrane domain." Biochemical Journal 482, no. 24 (2025): 1859-1875. portlandpress.com
131) Gadiyar, Varsha, Gopi Patel, Jesse Chen, Dominico Vigil, Nan Ji, Veronica Campbell, Kirti Sharma et al. "Targeted degradation of MERTK and other TAM receptor paralogs by heterobifunctional targeted protein degraders." Frontiers in immunology 14 (2023): 1135373. frontiersin.org
132) Khan, Noreen A., Athira C. Rajeev, Althaf Mahin, Athira Perunelly Gopalakrishnan, Prathik Basthikoppa Shivamurthy, Nazah Naurah V, Alimath Sambreena, and Rajesh Raju. "Decoding the Evolution and Co-Phospho-Regulatory Networks of SHROOM Proteins." Journal of Molecular Evolution (2026): 1-25. [HTML]
133) Yu, Shanshan, Cheng Chen, Ming Chen, Jinxiao Liang, Kecheng Jiang, Bin Lou, Jun Lu, Xiaohua Zhu, and Donghui Zhou. "MAGOH promotes gastric cancer progression via hnRNPA1 expression inhibition-mediated RONΔ160/PI3K/AKT signaling pathway activation." Journal of Experimental & Clinical Cancer Research 43, no. 1 (2024): 32. springer.com
134) Zada, A., Lv, M., and Li, J. "Molecular lesions in BRI1 and Its orthologs in the plant kingdom." International Journal of Molecular Sciences (2024). mdpi.com

135) Tanim, K. M., Alisha Holtzhausen, Aashis Thapa, Justus M. Huelse, Douglas K. Graham, and H. Shelton Earp. "MERTK inhibition as a targeted novel cancer therapy." International Journal of Molecular Sciences 25, no. 14 (2024): 7660. mdpi.com
136) V. Masucci, G., Cesano, A., Hawtin, R., Janetzki, S., Zhang, J., Kirsch, I., K. Dobbin, K., Alvarez, J., B. Robbins, P., R. Selvan, S., Z. Streicher, H., H. Butterfield, L., and Thurin, M. "Validation of biomarkers to predict response to immunotherapy in cancer: Volume I — pre-analytical and analytical validation." (2016). ncbi.nlm.nih.gov
137) Yuan, J., S. Hegde, P., Clynes, R., G. Foukas, P., Harari, A., O. Kleen, T., Kvistborg, P., Maccalli, C., T. Maecker, H., B. Page, D., Robins, H., Song, W., C. Stack, E., Wang, E., L. Whiteside, T., Zhao, Y., Zwierzina, H., H. Butterfield, L., and A. Fox, B. "Novel technologies and emerging biomarkers for personalized cancer immunotherapy." (2016). ncbi.nlm.nih.gov
138) Passaro, Antonio, Maise Al Bakir, Emily G. Hamilton, Maximilian Diehn, Fabrice André, Sinchita Roy-Chowdhuri, Giannis Mountzios, Ignacio I. Wistuba, Charles Swanton, and Solange Peters. "Cancer biomarkers: Emerging trends and clinical implications for personalized treatment." Cell 187, no. 7 (2024): 1617-1635. cell.com
139) Das, S., Dey, M. K., Devireddy, R., and Gartia, M. R. "Biomarkers in cancer detection, diagnosis, and prognosis." Sensors (2023). mdpi.com
140) Chiu, F. Y. and Yen, Y. "Imaging biomarkers for clinical applications in neuro-oncology: current status and future perspectives." Biomarker research (2023). springer.com
141) Purkayastha, Kakali, Ruby Dhar, Karthikeyan Pethusamy, Tryambak Srivastava, Abhishek Shankar, Goura Kishor Rath, and Subhradip Karmakar. "The issues and challenges with cancer biomarkers." Journal of cancer research and therapeutics 19, no. Suppl 1 (2023): S20-S35. lww.com
142) Radaic, Allan, Pachiyappan Kamarajan, Alex Cho, Sandy Wang, Guo-Chin Hung, Fereshteh Najarzadegan, David T. Wong, Hung Ton-That, Cun-Yu Wang, and Yvonne L. Kapila. "Biological biomarkers of oral cancer." Periodontology 2000 96, no. 1 (2024): 250-280. wiley.com
143) Clark, A. J. and Lillard Jr, J. W. "A comprehensive review of bioinformatics tools for genomic biomarker discovery driving precision oncology." Genes (2024). mdpi.com
144) Asleh, Karama, Valerie Dery, Catherine Taylor, Michelle Davey, Marie-Ange Djeungoue-Petga, and Rodney J. Ouellette. "Extracellular vesicle-based liquid biopsy biomarkers and their application in precision immuno-oncology." Biomarker research 11, no. 1 (2023): 99. springer.com
145) Volesky-Avellaneda, Karena D., Samantha Morais, Stephen D. Walter, Thomas R. O'Brien, Allan Hildesheim, Eric A. Engels, Mariam El-Zein, and Eduardo L. Franco. "Cancers attributable to infections in the US in 2017: a meta-analysis." JAMA oncology 9, no. 12 (2023): 1678-1687. jamanetwork.com
146) Ao, Ting, Nan Wu, Yingxiu Huang, Ming Hu, Peng Zhen, and Wentao Ni. "Associations between infectious agents and subsequent cancer risk: a longitudinal analysis from the UK Biobank." International Journal of Surgery 112, no. 3 (2026): 6826-6836. lww.com
147) Ou, Ling, Hengrui Liu, Chang Peng, Yuanjing Zou, Junwei Jia, Hui Li, Zhong Feng, Guimin Zhang, and Meicun Yao. "Helicobacter pylori infection facilitates cell migration and potentially impact clinical outcomes in gastric cancer." Heliyon 10, no. 17 (2024). cell.com
148) Chen, Yilin, Yuhong Huang, Wei Li, Teng Zhu, Minyi Cheng, Cangui Wu, Liulu Zhang, Hao Peng, and Kun Wang. "Intratumoral microbiota-aided fusion radiomics model for predicting tumor response to neoadjuvant chemoimmunotherapy in triple-negative breast cancer." Journal of translational medicine 23, no. 1 (2025): 352. springer.com
149) Chen, Yilin, Lu Yang, Yuhong Huang, Teng Zhu, Liulu Zhang, Minyi Cheng, Cangui Wu et al. "Intratumoral microbiota predicts the response to neoadjuvant chemoimmunotherapy in triple-negative breast cancer." Journal for immunotherapy of cancer 13, no. 4 (2025): e010365. nih.gov
150) Hut, Alexandru-Romulus, Eugen Radu Boia, Diana Para, Gheorghe Iovanescu, Delia Horhat, Loredan Mikša, Maria Chiriac, Raphaël Galant, Alexandru Catalin Motofelea, and Nicolae Constantin Balica. "Laryngeal cancer in the modern era: evolving trends in diagnosis, treatment, and survival outcomes." Journal of Clinical Medicine 14, no. 10 (2025): 3367. mdpi.com
151) Roy, R. and Singh, S. K. "The microbiome modulates the immune system to influence cancer therapy." Cancers (2024). mdpi.com

152) Zhao, S., Fu, P., Lin, L., Zhou, H., Huang, Y., Li, Y., and Tang, C. "Exploring the association between complete blood cell count-derived inflammatory biomarkers and cancer incidence through interpretable machine learning models …." Medicine (2026). lww.com
153) Patel, P., Oh, M., and Parang, K. "Global Cancer Etiology: Molecular Signatures, Therapeutic Disparities, and the role of Socio-economic Determinants." Chemical biology letters (2026). nih.gov
154) Paliard, X. and Rixe, O. "Precision Oncology for Cancer Immunotherapies in Early-Phase Clinical Trials." (2019). ncbi.nlm.nih.gov
155) Almawash, S. "Revolutionary cancer therapy for personalization and improved efficacy: strategies to overcome resistance to immune checkpoint inhibitor therapy." Cancers (2025). mdpi.com
156) Ghemrawi, Rose, Lama Abuamer, Sedra Kremesh, Ghadeer Hussien, Rahaf Ahmed, Walaa Mousa, Ghalia Khoder, and Mostafa Khair. "Revolutionizing cancer treatment: recent advances in immunotherapy." Biomedicines 12, no. 9 (2024): 2158. mdpi.com
157) Kong, X., Zhang, J., Chen, S., Wang, X., and Xi…, Q. "Immune checkpoint inhibitors: breakthroughs in cancer treatment." Cancer biology & … (2024). cancerbiomed.org
158) Imran, A. and Jamil, S. "Emerging Trends in Immunotherapy: A Revolutionary Approach in Cancer Treatment." Journal of Health . jhmri.com
159) Raghani, Neha R., Mehul R. Chorawala, Mayuresh Mahadik, Rakesh B. Patel, Bhupendra G. Prajapati, and Priyajeet S. Parekh. "Revolutionizing cancer treatment: comprehensive insights into immunotherapeutic strategies." Medical Oncology 41, no. 2 (2024): 51. [HTML]
160) Zafar, A., Khan, M. J., Abu, J., and Naeem, A. "Revolutionizing cancer care strategies: immunotherapy, gene therapy, and molecular targeted therapy." Molecular biology reports (2024). springer.com
161) PRIYANKA, VEMU. "REVOLUTIONIZING ONCOLOGY: RECENT ADVANCES IN IMMUNOTHERAPY AND IMMUNE CHECKPOINT INHIBITORS FOR CANCER TREATMENT." Scientific Hub of Applied Research in Emerging Medical science & technology 4, no. 4 (2025): 165-176. joinjet.org
162) Miller, Eric A., Houtan Totonchi Afshar, Jyoti Mishra, Roger S. McIntyre, and Dhakshin Ramanathan. "Predicting non-response to ketamine for depression: An exploratory symptom-level analysis of real-world data among military veterans." Psychiatry Research 335 (2024): 115858. sciencedirect.com
163) Zhang, L., Bai, A., Tang, Z., Liu, X., Li, Y., and Ma, J. "Incidence and factors associated of early non-response in first-treatment and drug-naïve patients with schizophrenia: a real-world study." Frontiers in Psychiatry (2023). frontiersin.org
164) Akdogan, Neslihan, Ömer Kutay Mutlu, Erdem Karabulut, Basak Yalici-Armagan, Duygu Gulseren, and Sibel Dogan Gunaydın. "Early response is a strong predictor of the long-term response in psoriasis patients receiving risankizumab or guselkumab in the real-world: a retrospective analysis." Expert Review of Clinical Pharmacology 18, no. 6 (2025): 417-423. [HTML]
165) Kökoğlu, Emel Oğuz, Hüseyin Kaplan, Melih Kızıltepe, Tuğba Kahraman Denizhan, Celil Barlas Cengiz, and Abdurrahman Soner Şenel. "An Evaluation of Factors Contributing to Primary Nonresponse to Biological Therapy in Patients with Spondyloarthropathy: A Retrospective Cohort Study." Archives of Rheumatology (2026). archivesofrheumatology.org
166) Hu, F., Gong, J., Li, Y., Tao, X., and Zhang, L. "Machine learning-based prediction of PASI100 response to secukinumab in patients with psoriasis: a real-world study with SHAP interpretability analysis." Frontiers in Medicine (2026). frontiersin.org
167) Zhu, J., Wu, J., Liu, X., and Ma, J. "Relationship between efficacy and common metabolic parameters in first-treatment drug-Naïve patients with early non-response schizophrenia: a retrospective study." Annals of General Psychiatry (2023). springer.com
168) Wang, Liang-Fang, Ping-Run Chen, Si-Ke He, Shi-Hao Duan, and Yan Zhang. "Predictors and optimal management of tumor necrosis factor antagonist nonresponse in inflammatory bowel disease: A literature review." World Journal of Gastroenterology 29, no. 29 (2023): 4481. nih.gov
169) Koch, Elise, Sophie Smart, Guðmundur Einarsson, Anders Kämpe, Lina Jonsson, Maris Alver, Matthew Iveson et al. "Recommendations for defining treatment outcomes in major psychiatric disorders using real-world data." The Lancet Psychiatry 12, no. 6 (2025): 457-468. ed.ac.uk

170) Lee, Hyun-Young, Hyun-Seob Jeon, Jae-Hyuk Jang, Youngsoo Lee, Yoo Seob Shin, Dong-Ho Nahm, Hae-Sim Park, and Young-Min Ye. "Predicting responses to omalizumab in antihistamine-refractory chronic urticaria: A real-world longitudinal study." Journal of Allergy and Clinical Immunology: Global 3, no. 2 (2024): 100245. sciencedirect.com
171) Xiao, Xiaoyue, Qianying Yu, Bingying Han, Min Fu, and Mingling Chen. "Predictive role of peripheral blood indicators in the prognosis of patients with cutaneous squamous cell carcinoma treated with immune checkpoint inhibitors." American Journal of Cancer Research 15, no. 4 (2025): 1705. nih.gov
172) Oliner, Kelly S., Michelle Shiller, Peter Schmid, Marianne J. Ratcliffe, Aaron J. Schetter, and Ming-Sound Tsao. "Challenges to Innovation Arising from Current Companion Diagnostic Regulations and Suggestions for Improvements." Clinical Cancer Research 31, no. 5 (2025): 795-800. aacrjournals.org
173) Liu, X., Yang, F., Wang, K., Zhang, Z., Dai, P., Zhao, J., and Chen, Z. "Application of the PDCA cycle in companion diagnostic PD-L1 SP263 immunohistochemical testing." BMC cancer (2025). springer.com
174) Choi, Daheui, Alan M. Gonzalez-Suarez, Mihai G. Dumbrava, Michael Medlyn, Jose M. de Hoyos-Vega, Frank Cichocki, Jeffrey S. Miller et al. "Microfluidic organoid cultures derived from pancreatic cancer biopsies for personalized testing of chemotherapy and immunotherapy." Advanced Science 11, no. 5 (2024): 2303088. wiley.com
175) Locke, D. and Hoyt, C. C. "Companion diagnostic requirements for spatial biology using multiplex immunofluorescence and multispectral imaging." Frontiers in Molecular Biosciences (2023). frontiersin.org
176) Kirtane, Kedar, Michael Kalos, Rocky Billups, Aude G. Chapuis, Vicki Coutinho, Steven A. Feldman, Brian Gastman et al. "Advancing Cell Therapies for Solid Tumors: A Pathway to Overcome Biological, Operational, and Regulatory Hurdles." Transplantation and cellular therapy (2026). astctjournal.org
177) Kulkarni, H. R. "Theranostics: When Targeted Imaging Guides Targeted Therapy." PET clinics (2026). [HTML]
178) Zdrenka, Marek, Adam Kowalewski, Navid Ahmadi, Rizwan Ullah Sadiqi, Łukasz Chmura, Jędrzej Borowczak, Mateusz Maniewski, and Łukasz Szylberg. "Refining PD-1/PD-L1 assessment for biomarker-guided immunotherapy: A review." Biomolecules and Biomedicine 24, no. 1 (2024): 14. nih.gov
179) Ma, Kim, Basile Tessier-Cloutier, Alon D. Altman, Mark S. Carey, Josee-Lyne Ethier, Susie Lau, Cheng-Han Lee et al. "Consensus Statement from the Society of Gynecologic Oncology of Canada on Folate Receptor α Testing in Ovarian Cancer." Current Oncology 33, no. 6 (2026): 330. mdpi.com
180) Bednarz, B. "Theranostics and patient-specific dosimetry." Seminars in radiation oncology (2023). sciencedirect.com
181) Karnik, I., Her, Z., Neo, S. H., Liu, W. N., and Chen, Q. "Emerging preclinical applications of humanized mouse models in the discovery and validation of novel immunotherapeutics and their mechanisms of action …." Pharmaceutics (2023). mdpi.com
182) Wakefield, L., Agarwal, S., and Tanner, K. "Preclinical models for drug discovery for metastatic disease." Cell (2023). cell.com
183) Emens, Leisha A., Pedro J. Romero, Ana Carrizosa Anderson, Tullia C. Bruno, Christian M. Capitini, Deborah Collyar, James L. Gulley et al. "Challenges and opportunities in cancer immunotherapy: a Society for Immunotherapy of Cancer (SITC) strategic vision." Journal for immunotherapy of cancer 12, no. 6 (2024): e009063. nih.gov
184) Cigliano, Antonio, Weiting Liao, Giovanni A. Deiana, Davide Rizzo, Xin Chen, and Diego F. Calvisi. "Preclinical models of hepatocellular carcinoma: current utility, limitations, and challenges." Biomedicines 12, no. 7 (2024): 1624. mdpi.com
185) Lehmann, F., Lacombe, D., Therasse, P., and MM Eggermont, A. "Integration of Translational Research in the European Organization for Research and Treatment of Cancer Research (EORTC) Clinical Trial Cooperative Group Mechanisms." (2003). ncbi.nlm.nih.gov
186) Tapescu, Iulia, Peter J. Madsen, Pedro R. Lowenstein, Maria G. Graciela Castro, Stephen J. Bagley, Yi Fan, and Steven Brem. "The transformative potential of mRNA vaccines for glioblastoma and

human cancer: technological advances and translation to clinical trials." Frontiers in Oncology 14 (2024): 1454370. frontiersin.org

187) Zaccariotto, Gabriel de Camargo, Maria Julia Bistaffa, Angelica Maria Mazuera Zapata, Camila Rodero, Fernanda Coelho, Joao Victor Brandao Quitiba, Lorena Lima, Raquel Sterman, Valeria Maria de Oliveira Cardoso, and Valtencir Zucolotto. "Cancer nanovaccines: mechanisms, design principles, and clinical translation." ACS Nano 19, no. 17 (2025): 16204-16223. acs.org
188) Chehelgerdi, M. and Chehelgerdi, M. "The use of RNA-based treatments in the field of cancer immunotherapy." Molecular cancer (2023). springer.com
189) Joshi, Deepak Chandra, Anurag Sharma, Sonima Prasad, Karishma Singh, Mayank Kumar, Kajal Sherawat, Hardeep Singh Tuli, and Madhu Gupta. "Novel therapeutic agents in clinical trials: emerging approaches in cancer therapy." Discover oncology 15, no. 1 (2024): 342. springer.com
190) Klebanoff, Christopher A., Smita S. Chandran, Brian M. Baker, Sergio A. Quezada, and Antoni Ribas. "T cell receptor therapeutics: immunological targeting of the intracellular cancer proteome." Nature Reviews Drug Discovery 22, no. 12 (2023): 996-1017. nih.gov
191) Zhang, Pengfei, Yufen Xiao, Xue Sun, Xiaoning Lin, Seyoung Koo, Alexey V. Yaremenko, Duotian Qin, Na Kong, Omid C. Farokhzad, and Wei Tao. "Cancer nanomedicine toward clinical translation: Obstacles, opportunities, and future prospects." Med 4, no. 3 (2023): 147-167. cell.com
192) Wu, Q., Yao, X., Duan, X., Chen, X., and Zhang, J. "Nanomedicine reimagined: translational strategies for precision tumor theranostics." Advanced Materials (2026). [HTML]
193) W. Wilkinson, R. and J. Leishman, A. "Further Advances in Cancer Immunotherapy: Going Beyond Checkpoint Blockade." (2018). ncbi.nlm.nih.gov
194) Desai, Sharav A., Vipul P. Patel, Kunal P. Bhosle, Sandip D. Nagare, and Kirti C. Thombare. "The tumor microenvironment: shaping cancer progression and treatment response." Journal of Chemotherapy 37, no. 1 (2025): 15-44. [HTML]
195) Bigos, Kamilla JA, Conrado G. Quiles, Sapna Lunj, Danielle J. Smith, Mechthild Krause, Esther GC Troost, Catharine M. West, Peter Hoskin, and Ananya Choudhury. "Tumour response to hypoxia: understanding the hypoxic tumour microenvironment to improve treatment outcome in solid tumours." Frontiers in oncology 14 (2024): 1331355. frontiersin.org
196) Sharma, Anirudh, Shivam Jasrotia, and Ajay Kumar. "Effects of chemotherapy on the immune system: implications for cancer treatment and patient outcomes." Naunyn-Schmiedeberg's Archives of Pharmacology 397, no. 5 (2024): 2551-2566. [HTML]
197) Wozniakova, Maria, Jozef Skarda, and Milan Raska. "The role of tumor microenvironment and immune response in colorectal cancer development and prognosis." Pathology and Oncology Research 28 (2022): 1610502. por-journal.com
198) Khosravi, Gholam-Reza, Samaneh Mostafavi, Sanaz Bastan, Narges Ebrahimi, Roya Safari Gharibvand, and Nahid Eskandari. "Immunologic tumor microenvironment modulators for turning cold tumors hot." Cancer Communications 44, no. 5 (2024): 521-553. wiley.com
199) Golan, T., Milella, M., Ackerstein, A., and Berger, R. "The changing face of clinical trials in the personalized medicine and immuno-oncology era: report from the international congress on clinical trials in Oncology & Hemato-Oncology (ICTO 2017)." (2017). ncbi.nlm.nih.gov
200) Yu, Helena A., Yasushi Goto, Hidetoshi Hayashi, Enriqueta Felip, James Chih-Hsin Yang, Martin Reck, Kiyotaka Yoh et al. "HERTHENA-Lung01, a phase II trial of patritumab deruxtecan (HER3-DXd) in epidermal growth factor receptor–mutated non–small-cell lung cancer after epidermal growth factor receptor tyrosine kinase inhibitor therapy and platinum-based chemotherapy." Journal of Clinical Oncology 41, no. 35 (2023): 5363-5375. ascopubs.org
201) Ngcobo, N. N. "Influence of Ageing on the Pharmacodynamics and Pharmacokinetics of Chronically Administered Medicines in Geriatric Patients: A Review: NN Ngcobo." Clinical pharmacokinetics (2025). springer.com
202) Goto, Koichi, Yasushi Goto, Toshio Kubo, Kiichiro Ninomiya, Sang-We Kim, David Planchard, Myung-Ju Ahn et al. "Trastuzumab deruxtecan in patients with HER2-mutant metastatic non–small-cell lung cancer: primary results from the randomized, phase II DESTINY-Lung02 trial." Journal of Clinical Oncology 41, no. 31 (2023): 4852-4863. ascopubs.org
203) Ou, Sai-Hong Ignatius, Pasi A. Jänne, Ticiana A. Leal, Igor I. Rybkin, Joshua K. Sabari, Minal A. Barve, Lyudmila Bazhenova et al. "First-in-human phase I/IB dose-finding study of adagrasib

(MRTX849) in patients with advanced KRAS G12C solid tumors (KRYSTAL-1)." Journal of Clinical Oncology 40, no. 23 (2022): 2530-2538. ascopubs.org

204) Budde, Lihua E., Sarit Assouline, Laurie H. Sehn, Stephen J. Schuster, Sung-Soo Yoon, Dok Hyun Yoon, Matthew J. Matasar et al. "Single-agent mosunetuzumab shows durable complete responses in patients with relapsed or refractory B-cell lymphomas: phase I dose-escalation study." Journal of Clinical Oncology 40, no. 5 (2022): 481-491. ascopubs.org
205) Liu, Jun, Yang Yang, Zhichao Liu, Xiaolong Fu, Xiaoyue Cai, Hongxuan Li, Li Zhu et al. "Multicenter, single-arm, phase II trial of camrelizumab and chemotherapy as neoadjuvant treatment for locally advanced esophageal squamous cell carcinoma." Journal for immunotherapy of cancer 10, no. 3 (2022): e004291. nih.gov
206) Subbiah, V., N. O. Iannotti, M. Gutierrez, D. C. Smith, L. Féliz, C. F. Lihou, C. Tian, I. M. Silverman, T. Ji, and M. Saleh. "FIGHT-101, a first-in-human study of potent and selective FGFR 1-3 inhibitor pemigatinib in pan-cancer patients with FGF/FGFR alterations and advanced malignancies." Annals of Oncology 33, no. 5 (2022): 522-533. sciencedirect.com
207) Todo, Tomoki, Yasushi Ino, Hiroshi Ohtsu, Junji Shibahara, and Minoru Tanaka. "A phase I/II study of triple-mutated oncolytic herpes virus G47Δ in patients with progressive glioblastoma." Nature communications 13, no. 1 (2022): 4119. nature.com
208) Gross, Neil D., David M. Miller, Nikhil I. Khushalani, Vasu Divi, Emily S. Ruiz, Evan J. Lipson, Friedegund Meier et al. "Neoadjuvant cemiplimab for stage II to IV cutaneous squamous-cell carcinoma." New England Journal of Medicine 387, no. 17 (2022): 1557-1568. nejm.org
209) Christofi, T., Baritaki, S., Falzone, L., Libra, M., and Zaravinos, A. "Current Perspectives in Cancer Immunotherapy." (2019). ncbi.nlm.nih.gov
210) Cattaneo, Carlo Gugliemo, Giuditta Chiloiro, Angela Romano, Giulia Panza, Matteo Galetto, Matteo Nardini, Lorenzo Placidi, Maria Antonietta Gambacorta, and Luca Boldrini. "Stereotactic body radiotherapy combined with immunotherapy: a systematic review focus on timing and toxicity profile." Technical Innovations & Patient Support in Radiation Oncology (2026): 100399. sciencedirect.com
211) Jayasinghe, Migara Kavishka, Yock Sin Lay, Dawn Xiao Tian Liu, Chang Yu Lee, Chang Gao, Brendon Zhijie Yeo, Faith Yuan Xin How et al. "Extracellular vesicle surface display enhances the therapeutic efficacy and safety profile of cancer immunotherapy." Molecular Therapy 32, no. 10 (2024): 3558-3579. cell.com
212) Qing, Yue, Ke Jiang, Hua Jiang, Yaru Zhao, Chu-Hu Lai, Alexandra Aicher, Zonghai Li, and Christopher Heeschen. "CLDN18. 2 CAR-derived Extracellular Vesicle Immunotherapy Improves Outcome in Murine Pancreatic Cancer." Advanced healthcare materials 14, no. 16 (2025): 2500546. wiley.com
213) Bharadia, Hetvi, Akshada Dabhade, Aayushi C. Shah, Rajanikant Patel, Mehul R. Chorawala, Artiben Patel, and Palak A. Shah. "CAR T-cell immunotherapy as the next horizon in cancer eradication: current landscape, challenges, and future directions." Medical Oncology 42, no. 9 (2025): 410. [HTML]
214) Abraham, A., Menon, A., Joseph, K., Roa, W., and Kunheri, B. "Immunotherapy and Stereotactic Body Radiation Treatment—An Overview of the Current Landscape of the Strategic Combination of Two Treatment …." Cancers (2026). mdpi.com
215) Santollani, L. and Wittrup, K. D. "Spatiotemporally programming cytokine immunotherapies through protein engineering." Immunological Reviews (2023). [HTML]
216) Lu, P., Liu, X., Chu, X., Wang, F., and Jiang, J. H. "Membrane-tethered activation design of a photosensitizer boosts systemic antitumor immunity via pyroptosis." Chemical Science (2023). rsc.org
217) Gaikwad, Utpal, Jyoti Bajpai, and Rakesh Jalali. "Combinatorial approach of immuno-proton therapy in cancer: rationale and potential impact." Asia-Pacific Journal of Clinical Oncology 20, no. 2 (2024): 188-197. wiley.com
218) Lisovska, N. "Multilevel mechanism of immune checkpoint inhibitor action in solid tumors: History, present issues and future development." (2022). ncbi.nlm.nih.gov

219) Yin Lim, S. and Rizos, H. "Immune cell profiling in the age of immune checkpoint inhibitors: implications for biomarker discovery and understanding of resistance mechanisms." (2018). ncbi.nlm.nih.gov
220) Mc Neil, V. and Lee, S. W. "Advancing cancer treatment: A review of immune checkpoint inhibitors and combination strategies." Cancers (2025). mdpi.com
221) Li, B., Jin, J., Guo, D., Tao, Z., and Hu, X. "Immune checkpoint inhibitors combined with targeted therapy: the recent advances and future potentials." Cancers (2023). mdpi.com
222) Younis, A. and Gribben, J. "Immune checkpoint inhibitors: fundamental mechanisms, current status and future directions." Immuno (2024). mdpi.com
223) Sun, Qian, Zhenya Hong, Cong Zhang, Liangliang Wang, Zhiqiang Han, and Ding Ma. "Immune checkpoint therapy for solid tumours: clinical dilemmas and future trends." Signal transduction and targeted therapy 8, no. 1 (2023): 320. nature.com
224) Topalian, Suzanne L., Patrick M. Forde, Leisha A. Emens, Mark Yarchoan, Kellie N. Smith, and Drew M. Pardoll. "Neoadjuvant immune checkpoint blockade: a window of opportunity to advance cancer immunotherapy." Cancer cell 41, no. 9 (2023): 1551-1566. cell.com
225) Hasan, Nazeer, Arif Nadaf, Mohammad Imran, Umme Jiba, Afsana Sheikh, Waleed H. Almalki, Salem Salman Almujri, Yousuf Hussain Mohammed, Prashant Kesharwani, and Farhan Jalees Ahmad. "Skin cancer: understanding the journey of transformation from conventional to advanced treatment approaches." Molecular cancer 22, no. 1 (2023): 168. springer.com
226) Wei, J., Li, W., Zhang, P., Guo, F., and Liu, M. "Current trends in sensitizing immune checkpoint inhibitors for cancer treatment." Molecular Cancer (2024). springer.com
227) Marei, H. E., Hasan, A., Pozzoli, G., and Cenciarelli, C. "Cancer immunotherapy with immune checkpoint inhibitors (ICIs): potential, mechanisms of resistance, and strategies for reinvigorating T cell responsiveness when …." Cancer cell international (2023). springer.com
228) Zhou, Xiaoting, Yanghong Ni, Xiao Liang, Yi Lin, Biao An, Xiang He, and Xia Zhao. "Mechanisms of tumor resistance to immune checkpoint blockade and combination strategies to overcome resistance." Frontiers in immunology 13 (2022): 915094. frontiersin.org
229) Holder, Ashley M., Aikaterini Dedeilia, Kailan Sierra-Davidson, Sonia Cohen, David Liu, Aparna Parikh, and Genevieve M. Boland. "Defining clinically useful biomarkers of immune checkpoint inhibitors in solid tumours." Nature Reviews Cancer 24, no. 7 (2024): 498-512. researchgate.net
230) Gunjur, Ashray, Yan Shao, Timothy Rozday, Oliver Klein, Andre Mu, Bastiaan W. Haak, Ben Markman et al. "A gut microbial signature for combination immune checkpoint blockade across cancer types." Nature medicine 30, no. 3 (2024): 797-809. nature.com
231) Alsaafeen, B. H., Ali, B. R., and Elkord, E. "Resistance mechanisms to immune checkpoint inhibitors: updated insights." Molecular Cancer (2025). springer.com
232) Naimi, Adel, Rebar N. Mohammed, Ahmed Raji, Supat Chupradit, Alexei Valerievich Yumashev, Wanich Suksatan, Mohammed Nader Shalaby et al. "Tumor immunotherapies by immune checkpoint inhibitors (ICIs); the pros and cons." Cell communication and signaling 20, no. 1 (2022): 44. springer.com
233) Harel, Michal, Coren Lahav, Eyal Jacob, Nili Dahan, Itamar Sela, Yehonatan Elon, Shani Raveh Shoval et al. "Longitudinal plasma proteomic profiling of patients with non-small cell lung cancer undergoing immune checkpoint blockade." Journal for ImmunoTherapy of Cancer 10, no. 6 (2022): e004582. nih.gov
234) Meza Pacheco, M. F. and Tai, L. H. "Reprogramming the tumor microenvironment to boost adoptive T cell therapy." Frontiers in Immunology (2025). frontiersin.org
235) Zhang, P., Zhang, G., and Wan, X. "Challenges and new technologies in adoptive cell therapy." Journal of Hematology & Oncology (2023). springer.com
236) Li, Yinqi, Yeteng Zheng, Taiqing Liu, Chuanyun Liao, Guobo Shen, and Zhiyao He. "The potential and promise for clinical application of adoptive T cell therapy in cancer." Journal of Translational Medicine 22, no. 1 (2024): 413. springer.com
237) Xu, Meng-Yao, Na Zeng, Chen-Qian Liu, Jian-Xuan Sun, Ye An, Si-Han Zhang, Jin-Zhou Xu et al. "Enhanced cellular therapy: revolutionizing adoptive cellular therapy." Experimental Hematology & Oncology 13, no. 1 (2024): 47. springer.com

238) Nejatfard, Anahita, John H. Klich, Noah Eckman, Sophia J. Bailey, Kyra Gillard, Daniel Ramos Mejia, Ben S. Ou, Jerry Yan, John W. Hickey, and Eric A. Appel. "A Transient Immunostimulatory Niche Synergizes Adoptive and Endogenous Immunity for Enhanced Tumor Control." bioRxiv (2025): 2025-08. biorxiv.org
239) McKenzie, Grace M., Josie Voss, Emmanuel Katsanis, Richard J. Simpson, and Forrest L. Baker. "TIGIT Blockade Potentiates the Anti-Leukemic Activity of Exercise-Mobilized Donor Lymphocytes and Expanded γδ T-Cells." Cancers 18, no. 5 (2026): 797. mdpi.com
240) Batatinha, Helena, Douglass M. Diak, Grace M. Niemiro, Forrest L. Baker, Kyle A. Smith, Tiffany M. Zúñiga, Preteesh L. Mylabathula et al. "Human lymphocytes mobilized with exercise have an anti-tumor transcriptomic profile and exert enhanced graft-versus-leukemia effects in xenogeneic mice." Frontiers in immunology 14 (2023): 1067369. frontiersin.org
241) Allan, David SJ, Chuanfeng Wu, Ryland D. Mortlock, Mala Chakraborty, Katayoun Rezvani, Jan K. Davidson-Moncada, Cynthia E. Dunbar, and Richard W. Childs. "Expanded NK cells used for adoptive cell therapy maintain diverse clonality and contain long-lived memory-like NK cell populations." Molecular Therapy-Oncolytics 28 (2023): 74-87. cell.com
242) Lin, Pei, Yunfan Lin, Zizhao Mai, Yucheng Zheng, Jiarong Zheng, Zihao Zhou, Xinyuan Zhao, and Li Cui. "Targeting cancer with precision: strategical insights into TCR-engineered T cell therapies." Theranostics 15, no. 1 (2025): 300. nih.gov
243) Baulu, E., Gardet, C., Chuvin, N., and Depil, S. "TCR-engineered T cell therapy in solid tumors: State of the art and perspectives." Science advances (2023). science.org
244) Li, J., Xiao, Z., Wang, D., Jia, L., Nie, S., Zeng, X., and Hu, W. "The screening, identification, design and clinical application of tumor-specific neoantigens for TCR-T cells." Molecular cancer (2023). springer.com
245) Foy, Susan P., Kyle Jacoby, Daniela A. Bota, Theresa Hunter, Zheng Pan, Eric Stawiski, Yan Ma et al. "Non-viral precision T cell receptor replacement for personalized cell therapy." Nature 615, no. 7953 (2023): 687-696. nature.com
246) Shao, Weihuan, Yiran Yao, Ludi Yang, Xiaoran Li, Tongxin Ge, Yue Zheng, Qiuyi Zhu et al. "Novel insights into TCR-T cell therapy in solid neoplasms: optimizing adoptive immunotherapy." Experimental Hematology & Oncology 13, no. 1 (2024): 37. springer.com
247) Zhao, X., Shao, S., and Hu, L. "The recent advancement of TCR-T cell therapies for cancer treatment: TCR-T cell therapies for cancer treatment." Acta biochimica et biophysica Sinica (2024). nih.gov
248) Hemminki, A. "Oncolytic Immunotherapy: Where Are We Clinically?." (2014). ncbi.nlm.nih.gov
249) Hamid, O., Hoffner, B., Gasal, E., Hong, J., and D. Carvajal, R. "Oncolytic immunotherapy: unlocking the potential of viruses to help target cancer." (2017). ncbi.nlm.nih.gov
250) Bastin, D., R. Walsh, S., Al Saigh, M., and Wan, Y. "Capitalizing on Cancer Specific Replication: Oncolytic Viruses as a Versatile Platform for the Enhancement of Cancer Immunotherapy Strategies." (2016). ncbi.nlm.nih.gov
251) Katsikis, P. D., Ishii, K. J., and Schliehe, C. "Challenges in developing personalized neoantigen cancer vaccines." Nature Reviews Immunology (2024). nih.gov
252) Peng, K., Zhao, X., Fu, Y. X., and Liang, Y. "Eliciting antitumor immunity via therapeutic cancer vaccines." Cellular & Molecular Immunology (2025). nature.com
253) Khleif, S. N. and Gupta, S. "Cancer vaccines as enablers of immunotherapy." Nature Immunology (2025). [HTML]
254) Ariail, E., Espinoza, N. G., Stephenson, A. C., and Spangler, J. B. "Emerging approaches for T cell-stimulating platform development." Cell systems (2024). nih.gov
255) Chen, Shuyu, Xuyang Xu, Yufei Zhang, Linfei Ye, Lei Zhang, Long Li, and Guosong Chen. "Nanovaccine based on a biepitope antigen to potentiate the immunogenicity of a neoantigen." ACS Macro Letters 12, no. 2 (2023): 281-287. [HTML]
256) Nguyen, N. T. and Youn, Y. S. "Strategies to Design and Optimize Artificial Antigen-Presenting Cells for T Cell Expansion in Cancer Immunotherapy." Advanced Functional Materials (2025). wiley.com
257) Peng, K., Fu, Y. X., and Liang, Y. "Engineering cytokines for tumor-targeting and selective T cell activation." Trends in Molecular Medicine (2025). [HTML]

258) Zhou, Xia, Wei Liu, Jing Hu, Qi Yao, Futing Zhang, Qi Wu, Liya Li et al. "Kupffer cell calibration of T cell responses via VSIG4–CD5 interaction promotes tumor evasion." Nature Immunology (2026): 1-15. [HTML]
259) Day, D. and L. Siu, L. "Approaches to modernize the combination drug development paradigm." (2016). ncbi.nlm.nih.gov
260) Butterfield, L. H. and Najjar, Y. G. "Immunotherapy combination approaches: mechanisms, biomarkers and clinical observations." Nature Reviews Immunology (2024). nih.gov
261) Muller, Patrick Y., Johannes Eisinger, Pakeeza Sayyed, Gregory Finn, Orlando Bueno, Michael Smith, and Federico Manevy. "Clinical Development of Novel-Novel Multi-Company Combination Therapies in Oncology." Current Oncology Reports 28, no. 1 (2026): 46. researchgate.net
262) Ismaili, N. "Redefining standards: a comprehensive systematic review of practice changing advances in GU oncology from ASCO and ESMO 2025." Frontiers in Endocrinology (2026). frontiersin.org
263) Colciago, Riccardo Ray, Irene Fischetti, Carlotta Giandini, Eliana La Rocca, Tiziana Rancati T, Alicia Rejas Mateo, Mario Paolo Colombo et al. "Overview of the synergistic use of radiotherapy and immunotherapy in cancer treatment: current challenges and scopes of improvement." Expert Review of Anticancer Therapy 23, no. 2 (2023): 135-145. tandfonline.com
264) Gridelli, Cesare, Solange Peters, Tony Mok, Marina Garassino, Luis Paz-Ares, Ilaria Attili, and Filippo de Marinis. "Face to face among different chemo-immunotherapy combinations in the first line treatment of patients with advanced non-small cell lung cancer: Results of an international expert panel meeting by the italian association of thoracic oncology (AIOT)." Lung Cancer 187 (2024): 107441. [HTML]
265) Santoni, Matteo, Alessandro Rizzo, Jakub Kucharz, Veronica Mollica, Matteo Rosellini, Andrea Marchetti, Elisa Tassinari et al. "Complete remissions following immunotherapy or immuno-oncology combinations in cancer patients: the MOUSEION-03 meta-analysis." Cancer Immunology, Immunotherapy 72, no. 6 (2023): 1365-1379. nih.gov
266) Chen, Emerson Y., Manoj Rai, Yash Tadikonda, Preeyam Roy, Dakota W. Nollner, Akshit Chitkara, Julia Hamilton, and Rajat Thawani. "Trends in complexity of single-agent and combination therapies for solid tumor cancers approved by the US Food and Drug Administration." The oncologist 30, no. 3 (2025): oyae302. oup.com
267) Mekala, Bhaskar. "Review on immunooncology drugs for the treatment of cancer." International Journal of Alternative and Complementary Medicine (2025): 12-17. saapjournals.org
268) Fessas, P., Possamai, L. A., Clark, J., Daniels, E., Gudd, C., Mullish, B. H., Alexander, J. L., and Pinato, D. J. "Immunotoxicity from checkpoint inhibitor therapy: clinical features and underlying mechanisms.." (2019). [PDF]
269) Si, X., Song, P., Ni, J., Di, M., He, C., Zhang, L., Liu, X., Li, Y., Wang, H., Guo, X., Zhou, J., Duan, L., Yang, X., Wang, M., and Zhang, L. "Management of immune checkpoint inhibitor-related adverse events: A review of case reports." (2020). ncbi.nlm.nih.gov
270) Ertl, Carolin, Theresa Ruf, Dirk Mentzer, Mingzi Kong, Rafaela Kramer, Michael von Bergwelt-Baildon, Marion Subklewe et al. "The side effect registry immuno-oncology (SERIO)–A tool for systematic analysis of immunotherapy-induced side effects." European Journal of Cancer 199 (2024): 113505. sciencedirect.com
271) Ruf, Theresa, Rafaela Kramer, Andrea Forschner, Ulrike Leiter, Friedegund Meier, Lydia Reinhardt, Pia Dücker et al. "Second-line therapies for steroid-refractory immune-related adverse events in patients treated with immune checkpoint inhibitors." European Journal of Cancer 203 (2024): 114028. sciencedirect.com
272) Rosenbaum, Evan, Kenneth Seier, Martina Bradic, Ciara Kelly, Sujana Movva, Benjamin A. Nacev, Mrinal M. Gounder et al. "Immune-related adverse events after immune Checkpoint blockade–based therapy are associated with improved survival in advanced Sarcomas." Cancer Research Communications 3, no. 10 (2023): 2118-2125. aacrjournals.org
273) Naidoo, Jarushka, Catherine Murphy, Michael B. Atkins, Julie R. Brahmer, Stephane Champiat, David Feltquate, Lee M. Krug et al. "Society for Immunotherapy of Cancer (SITC) consensus definitions for immune checkpoint inhibitor-associated immune-related adverse events (irAEs) terminology." Journal for immunotherapy of cancer 11, no. 3 (2023): e006398. nih.gov

274) Pepys, Jack, Ronen Stoff, Roni Ramon-Gonen, Guy Ben-Betzalel, Shirly Grynberg, Ronnie Shapira Frommer, Jacob Schachter et al. "Incidence and outcome of neurologic immune-related adverse events associated with immune checkpoint inhibitors in patients with melanoma." Neurology 101, no. 24 (2023): e2472-e2482. nih.gov
275) Frey, C. and Etminan, M. "Immune-related adverse events associated with atezolizumab: insights from real-world pharmacovigilance data." Antibodies (2024). mdpi.com
276) Shen, Xin, Jun Yang, Geng Qian, Mingyu Sheng, Yu Wang, Guohui Li, and Jiaqing Yan. "Treatment-related adverse events of immune checkpoint inhibitors in clinical trials: a systematic review and meta-analysis." Frontiers in Oncology 14 (2024): 1391724. frontiersin.org
277) Du, H., Wang, J., and Wang, Z. "Cardiovascular adverse effects of immunotherapy in cancer: insights and implications." Frontiers in Oncology (2025). frontiersin.org
278) Roznovan, Claudiu Natanael, Luminița Gabriela Măruțescu, and Gratiela Gradisteanu Pircalabioru. "Immuno-oncology at the crossroads: Confronting challenges in the quest for effective cancer therapies." International Journal of Molecular Sciences 26, no. 13 (2025): 6177. mdpi.com
279) Zhong, D. and Shi, C. "Unveiling the Scientific Landscape and Trends of Cutaneous Immune-Related Adverse Events: A Bibliometric Analysis." Cureus (2026). cureus.com
280) Ruggiero, Rosanna, Raffaella Di Napoli, Nunzia Balzano, Donatella Ruggiero, Consiglia Riccardi, Antonietta Anatriello, Andrea Cantone, Liberata Sportiello, Francesco Rossi, and Annalisa Capuano. "Immune-related adverse events and immune checkpoint inhibitors: a focus on neurotoxicity and clinical management." Expert Review of Clinical Pharmacology 16, no. 5 (2023): 423-434. [HTML]
281) Zhang, Siqi, Lina Miao, Xiaoxia Tian, Bingxu Yang, and Baoping Luo. "Opportunities and challenges of immuno-oncology: A bibliometric analysis from 2014 to 2023." Human Vaccines & Immunotherapeutics 21, no. 1 (2025): 2440203. tandfonline.com
282) Imodoye, S. O. and Adedokun, K. A. "EMT-induced immune evasion: connecting the dots from mechanisms to therapy." Clinical and Experimental Medicine (2023). [HTML]
283) Wang, Bin, Yin Han, Yuyu Zhang, Qin Zhao, Huanhuan Wang, Jinlong Wei, Lingbin Meng, Ying Xin, and Xin Jiang. "Overcoming acquired resistance to cancer immune checkpoint therapy: potential strategies based on molecular mechanisms." Cell & Bioscience 13, no. 1 (2023): 120. springer.com
284) Mitra, A., Kumar, A., Amdare, N. P., and Pathak, R. "Current landscape of cancer immunotherapy: harnessing the immune arsenal to overcome immune evasion." Biology (2024). mdpi.com
285) Kostecki, Kourtney L., Mari Iida, Bridget E. Crossman, Ravi Salgia, Paul M. Harari, Justine Y. Bruce, and Deric L. Wheeler. "Immune escape strategies in head and neck cancer: evade, resist, inhibit, recruit." Cancers 16, no. 2 (2024): 312. mdpi.com
286) Mestrallet, Guillaume, Matthew Brown, Cansu Cimen Bozkus, and Nina Bhardwaj. "Immune escape and resistance to immunotherapy in mismatch repair deficient tumors." Frontiers in Immunology 14 (2023): 1210164. frontiersin.org
287) Yang, Y. and Wang, W. "Recent progress in immune evasion mechanisms of triple-negative breast cancer." Journal of Translational Medicine (2025). springer.com
288) Zhang, Lei, Jianli Ma, Lei Liu, Guozheng Li, Hui Li, Yi Hao, Xin Zhang et al. "Adaptive therapy: a tumor therapy strategy based on Darwinian evolution theory." Critical Reviews in Oncology/Hematology 192 (2023): 104192. sciencedirect.com
289) Kumagai, S., Momoi, Y., and Nishikawa, H. "Immunogenomic cancer evolution: a framework to understand cancer immunosuppression." Science Immunology (2025). science.org
290) Liu, D., Che, X., Wang, X., Ma, C., and Wu, G. "Tumor vaccines: unleashing the power of the immune system to fight cancer." Pharmaceuticals (2023). mdpi.com
291) Kornepati, A. V. R., Rogers, C. M., Sung, P., and Curiel, T. J. "The complementarity of DDR, nucleic acids and anti-tumour immunity." Nature (2023). yuntsg.com
292) Andersen, M. H. "Immune modulatory vaccines targeting tumor microenvironment antigens: recent advances in oncology and beyond." Signal Transduction and Targeted Therapy (2026). nature.com
293) S. Lefler, D., A. Manobianco, S., and Bashir, B. "Immunotherapy resistance in solid tumors: mechanisms and potential solutions." (2024). ncbi.nlm.nih.gov
294) de Charette, M. and Houot, R. "Hide or defend, the two strategies of lymphoma immune evasion: potential implications for immunotherapy." (2018). ncbi.nlm.nih.gov

295) J. van Elsas, M., van Hall, T., and H. van der Burg, S. "Future Challenges in Cancer Resistance to Immunotherapy." (2020). ncbi.nlm.nih.gov
296) Zingoni, Alessandra, Fabrizio Antonangeli, Silvano Sozzani, Angela Santoni, Marco Cippitelli, and Alessandra Soriani. "The senescence journey in cancer immunoediting." Molecular Cancer 23, no. 1 (2024): 68. springer.com
297) Baird, T. "Using Tumour Evolution to Understand the Epigenetic and Transcriptional Adaptations of Cancer to Host Immunity." (2024). cam.ac.uk
298) Agie, D. and Sakha, M. "Immune Editing of Stem Cell Fate: Implications for Cancer Initiation and Therapy Resistance." Journal of Cancer and Tumor International (2026). researchgate.net
299) Mukherjee, Sumon, Ahana Ghosh, Sourio Chakraborty, Udit Basak, Sumoyee Mukherjee, Tanya Das, and Gaurisankar Sa. "Tumor-infiltrating lymphocytes and tumor-associated macrophages in cancer immunoediting: a targetable therapeutic axis." Frontiers in Immunology 16 (2025): 1655176. frontiersin.org
300) Mariuzza, R. A., Wu, D., and Pierce, B. G. "Structural basis for T cell recognition of cancer neoantigens and implications for predicting neoepitope immunogenicity." Frontiers in immunology (2023). frontiersin.org
301) Zheng, X., Zhao, Y., and Liu, Z. "Neoantigen identification and TCR-T therapy development for solid tumors: current advances and future perspectives." Journal of the National Cancer Center (2025). sciencedirect.com
302) Alban, Tyler J., Nadeem Riaz, Prerana Parthasarathy, Vladimir Makarov, Sviatoslav Kendall, Seong-Keun Yoo, Rachna Shah et al. "Neoantigen immunogenicity landscapes and evolution of tumor ecosystems during immunotherapy with nivolumab." Nature medicine 30, no. 11 (2024): 3209-3222. nih.gov
303) Zhang, T., Kurban, E., and Wang, Z. "Neoantigens: the novel precision cancer immunotherapy." Biologics (2023). mdpi.com
304) Shatalov, Peter A., Anna A. Bukaeva, Egor M. Veselovsky, Alexey A. Traspov, Daria V. Bagdasarova, Irina A. Leukhina, Anna P. Shinkarkina et al. "Neoantigen-Driven Immunotherapy in Triple-Negative Breast Cancer: Emerging Strategies and Clinical Potential." Biomedicines 13, no. 9 (2025): 2213. mdpi.com
305) Sharma, Padmanee, Sangeeta Goswami, Deblina Raychaudhuri, Bilal A. Siddiqui, Pratishtha Singh, Ashwat Nagarajan, Jielin Liu et al. "Immune checkpoint therapy—current perspectives and future directions." Cell 186, no. 8 (2023): 1652-1669. cell.com
306) Berland, Lea, Zeina Gabr, Michelle Chang, Marius Ilié, Véronique Hofman, Guylène Rignol, Francois Ghiringhelli, Baharia Mograbi, Mohamad Rashidian, and Paul Hofman. "Further knowledge and developments in resistance mechanisms to immune checkpoint inhibitors." Frontiers in Immunology 15 (2024): 1384121. frontiersin.org
307) Kawashima, S. and Togashi, Y. "Resistance to immune checkpoint inhibitors and the tumor microenvironment." Experimental Dermatology (2023). wiley.com
308) Passaro, Antonio, Julie Brahmer, Scott Antonia, Tony Mok, and Solange Peters. "Managing resistance to immune checkpoint inhibitors in lung cancer: treatment and novel strategies." Journal of Clinical Oncology 40, no. 6 (2022): 598-610. [HTML]
309) De Lorenzo, S., Tovoli, F., and Trevisani, F. "Mechanisms of primary and acquired resistance to immune checkpoint inhibitors in patients with hepatocellular carcinoma." Cancers (2022). mdpi.com
310) Dakal, T. C., George, N., Xu, C., Suravajhala, P., and Kumar, A. "Predictive and prognostic relevance of tumor-infiltrating immune cells: tailoring personalized treatments against different cancer types." Cancers (2024). mdpi.com
311) Yang, Yan, Sijia Li, Kenneth KW To, Shuangli Zhu, Fang Wang, and Liwu Fu. "Tumor-associated macrophages remodel the suppressive tumor immune microenvironment and targeted therapy for immunotherapy." Journal of Experimental & Clinical Cancer Research 44, no. 1 (2025): 145. springer.com
312) Qin, Rui, Weihong Ren, Guoqi Ya, Bei Wang, Jiao He, Shaoxin Ren, Lu Jiang, and Shuo Zhao. "Role of chemokines in the crosstalk between tumor and tumor-associated macrophages." Clinical and experimental medicine 23, no. 5 (2023): 1359-1373. springer.com

313) Becherini, Carlotta, Andrea Lancia, Beatrice Detti, Sara Lucidi, Daniele Scartoni, Gianluca Ingrosso, Maria Grazia Carnevale et al. "Modulation of tumor-associated macrophage activity with radiation therapy: a systematic review." Strahlentherapie und Onkologie 199, no. 12 (2023): 1173-1190. springer.com
314) Ruocco, Maria Rosaria, Armando Gisonna, Vittoria Acampora, Anna D'Agostino, Barbara Carrese, Jessie Santoro, Alessandro Venuta et al. "Guardians and mediators of metastasis: exploring T lymphocytes, myeloid-derived suppressor cells, and tumor-associated macrophages in the breast cancer microenvironment." International Journal of Molecular Sciences 25, no. 11 (2024): 6224. mdpi.com
315) Yang, J., Liu, Q., and Shyr, Y. "A large-scale meta-analysis reveals positive feedback between macrophages and T cells that sensitizes tumors to immunotherapy." Cancer research (2024). aacrjournals.org
316) Peyraud, Florent, Jean-Philippe Guegan, Lucile Vanhersecke, Maxime Brunet, Diego Teyssonneau, Lola-Jade Palmieri, Alban Bessede, and Antoine Italiano. "Tertiary lymphoid structures and cancer immunotherapy: From bench to bedside." Med 6, no. 1 (2025). cell.com
317) Delhalle, S., F. N. Bode, S., Balling, R., Ollert, M., and Q. He, F. "A roadmap towards personalized immunology.." (2018). [PDF]
318) Bautista, Jhommara, María Paula Fuentes-Yépez, Joseth Adatty-Molina, and Andrés López-Cortés. "Microbial signatures in metastatic cancer." Frontiers in Medicine 12 (2025): 1654792. frontiersin.org
319) Yang, Li, Aitian Li, Ying Wang, and Yi Zhang. "Intratumoral microbiota: roles in cancer initiation, development and therapeutic efficacy." Signal Transduction and Targeted Therapy 8, no. 1 (2023): 35. nature.com
320) Xia, Shuting, Likun Wang, Yangzhuo Xu, Jiaqi Zhang, Zeyang Zhou, Libing Sun, Heng Li et al. "Microbial influences on immune modulation and colorectal cancer progression through combined transcriptomic and microbiomic analysis." iMetaOmics 3, no. 1 (2026): e70072. wiley.com
321) Lin, Yufeng, Mingxu Xie, Harry Cheuk-Hay Lau, Ruijie Zeng, Ruyi Zhang, Luyao Wang, Qing Li et al. "Effects of gut microbiota on immune checkpoint inhibitors in multi-cancer and as microbial biomarkers for predicting therapeutic response." Med 6, no. 3 (2025). cell.com
322) Sulit, A. K., M. Daigneault, E. Allen-Vercoe, O. K. Silander, B. Hock, J. McKenzie, J. Pearson, F. A. Frizelle, S. Schmeier, and R. Purcell. "Bacterial lipopolysaccharide modulates immune response in the colorectal tumor microenvironment." npj Biofilms and Microbiomes 9, no. 1 (2023): 59. nature.com
323) Blake, S. J., Wolf, Y., Boursi, B., and Lynn, D. J. "Role of the microbiota in response to and recovery from cancer therapy." Nature Reviews Immunology (2024). [HTML]
324) Marks, Jennifer, Arthi Sridhar, Angela Ai, Lauren Kiel, Rebekah Kaufman, Oyepeju Abioye, Courtney Mantz, and Narjust Florez. "Precision immuno-oncology in NSCLC through gender equity lenses." Cancers 16, no. 7 (2024): 1413. mdpi.com
325) Ajjawi, I. and Lustberg, M. B. "Addressing social and economic disparities in triple-negative breast cancer immunotherapy: a US-focused review." Immunotherapy (2025). [HTML]
326) Dent, Jennifer, Micaella Jorge, Nora Sobrevilla, Thomas S. Uldrick, Innocent Adoubi, Jyoti Bajpai, Mauricio Burotto et al. "Cancer immunotherapy clinical trials to support urgently needed access in low-and middle-income countries: a report from the SITC global access and impact committee." Journal for immunotherapy of cancer 13, no. 6 (2025): e011258. nih.gov
327) Carroll, Caitlin E., Mary Beth Landrum, Alexi A. Wright, and Nancy L. Keating. "Adoption of innovative therapies across oncology practices—evidence from immunotherapy." JAMA oncology 9, no. 3 (2023): 324-333. jamanetwork.com
328) Bao, Riyue, Alan Hutson, Anant Madabhushi, Vanessa D. Jonsson, Spencer R. Rosario, Jill S. Barnholtz-Sloan, Elana J. Fertig et al. "Ten challenges and opportunities in computational immuno-oncology." Journal for immunotherapy of cancer 12, no. 10 (2024): e009721. nih.gov
329) Ravi, Nanthini, Gee Jun Tye, Satvinder Singh Dhaliwal, Muhamad Yusri Musa, Matthew Tze Jian Wong, and Ngit Shin Lai. "Immune profiling in oncology: bridging the gap between technology and treatment." Medical Oncology 42, no. 10 (2025): 446. springer.com

330) Olateju, O., Zeng, Z., Douglas Thornton, J., Mgbere, O., and James Essien, E. "Management of metastatic melanoma in Texas: disparities in the utilization of immunotherapy following the regulatory approval of immune checkpoint inhibitors." (2023). ncbi.nlm.nih.gov
331) Sood, Karan, and Prashant Mehta. "The ethics of immunotherapy access: Beyond regulatory approvals in resource-constrained settings." International Journal of Molecular and Immuno Oncology 10, no. 3 (2025): 100-103. ijmio.com
332) Contreras, Jorge, Lauren Herschbein, Nimisha Mathur, and Monica L. Guzman. "Access to CAR-T therapy in Latin America: Barriers, gaps, and pathways forward." In Seminars in Immunology, vol. 82, p. 102029. Academic Press, 2026. [HTML]
333) Adeyemo, Tosin, Tim Wilsdon, Michael Hartevelt, Jobin Joseph Kalappura, Alexander Roediger, Sjaak Vink, Tom Roane et al. "Minimum requirements for the introduction of immuno-oncology medicines in low-and lower middle-income countries." International Journal of Healthcare Management 18, no. 2 (2025): 205-220. tandfonline.com
334) Page, David B., Glenn Broeckx, Chowdhury Arif Jahangir, Sara Verbandt, Rajarsi R. Gupta, Jeppe Thagaard, Reena Khiroya et al. "Spatial analyses of immune cell infiltration in cancer: current methods and future directions: A report of the International Immuno-Oncology Biomarker Working Group on Breast Cancer." The Journal of pathology 260, no. 5 (2023): 514-532. wiley.com
335) Crimini, Edoardo, Giulia Tini, Paolo Tarantino, Liliana Ascione, Matteo Repetto, Paolo Beria, Alberto Ranghiero et al. "Evaluation of the geographical accessibility of genome-matched clinical trials on a national experience." The Oncologist 29, no. 2 (2024): 159-165. oup.com